

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226B – DECEMBER 2003 – REVISED MAY 2008

- Qualified for Automotive Applications
- Direct Upgrades to TL05x, TL07x, and TL08x BiFET Operational Amplifiers
- Greater Than 2× Bandwidth (10 MHz) and 3× Slew Rate (45 V/μs) Than TL07x
- Ensured Maximum Noise Floor 17 nV/√Hz
- On-Chip Offset Voltage Trimming for Improved DC Performance
- Wider Supply Rails Increase Dynamic Signal Range to ±19 V

## description/ordering information

The TLE207x series of JFET-input operational amplifiers more than double the bandwidth and triple the slew rate of the TL07x and TL08x families of BiFET operational amplifiers. Texas Instruments Excalibur process yields a typical noise floor of 11.6 nV/√Hz, 17-nV/√Hz ensured maximum, offering immediate improvement in noise-sensitive circuits designed using the TL07x. The TLE207x also has wider supply voltage rails, increasing the dynamic signal range for BiFET circuits to ±19 V. On-chip zener trimming of offset voltage yields precision grades for greater accuracy in dc-coupled applications. The TLE207x are pin-compatible with lower performance BiFET operational amplifiers for ease in improving performance in existing designs.

BiFET operational amplifiers offer the inherently higher input impedance of the JFET-input transistors, without sacrificing the output drive associated with bipolar amplifiers. This makes them better suited for interfacing with high-impedance sensors or very low-level ac signals. They also feature inherently better ac response than bipolar or CMOS devices having comparable power consumption.

The TLE207x family of BiFET amplifiers are Texas Instruments highest performance BiFETs, with tighter input offset voltage and ensured maximum noise specifications. Designers requiring less stringent specifications but seeking the improved ac characteristics of the TLE207x should consider the TLE208x operational amplifier family.

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

## ORDERING INFORMATION†

| T <sub>A</sub> | V <sub>IO</sub> max<br>AT 25°C | PACKAGE‡ |               | ORDERABLE<br>PART NUMBER | TOP-SIDE<br>MARKING |
|----------------|--------------------------------|----------|---------------|--------------------------|---------------------|
| –40°C to 125°C | 2 mV                           | SOIC – D | Tape and reel | TLE2071AQDRQ1            | 2071AQ              |
|                | 4 mV                           | SOIC – D | Tape and reel | TLE2071QDRQ1             | 2071Q1              |
|                | 3.5 mV                         | SOIC – D | Tape and reel | TLE2072AQDRQ1            | 2072AQ              |
|                | 6 mV                           | SOIC – D | Tape and reel | TLE2072QDRQ1             | 2072Q1              |
|                | 4 mV                           | SOP – DW | Tape and reel | TLE2074AQDWRQ1§          | TLE2074AQ1          |
|                | 7 mV                           | SOP – DW | Tape and reel | TLE2074QDWRQ1§           | TLE2074Q1           |

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at <http://www.ti.com>.

‡ Package drawings, thermal data, and symbolization are available at <http://www.ti.com/packaging>.

§ Product Preview



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

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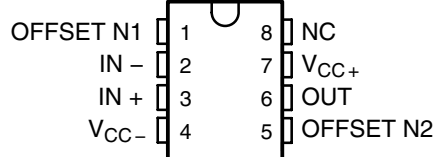
# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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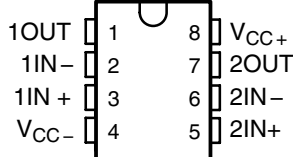
## description/ordering information (continued)

The TLE207x are fully specified at  $\pm 15$  V and  $\pm 5$  V. For operation in low-voltage and/or single-supply systems, Texas Instruments LinCMOS families of operational amplifiers (TLC- and TLV-prefix) are recommended. When moving from BiFET to CMOS amplifiers, particular attention should be paid to slew rate and bandwidth requirements and output loading.

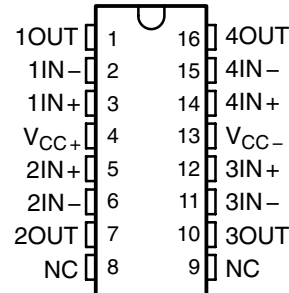
**TLE2071 AND TLE2071A  
D PACKAGE  
(TOP VIEW)**



**TLE2072 AND TLE2072A  
D PACKAGE  
(TOP VIEW)**

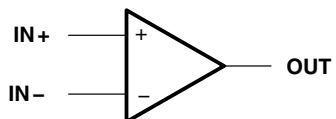


**TLE2074 AND TLE2074A  
DW PACKAGE  
(TOP VIEW)**



NC – No internal connection

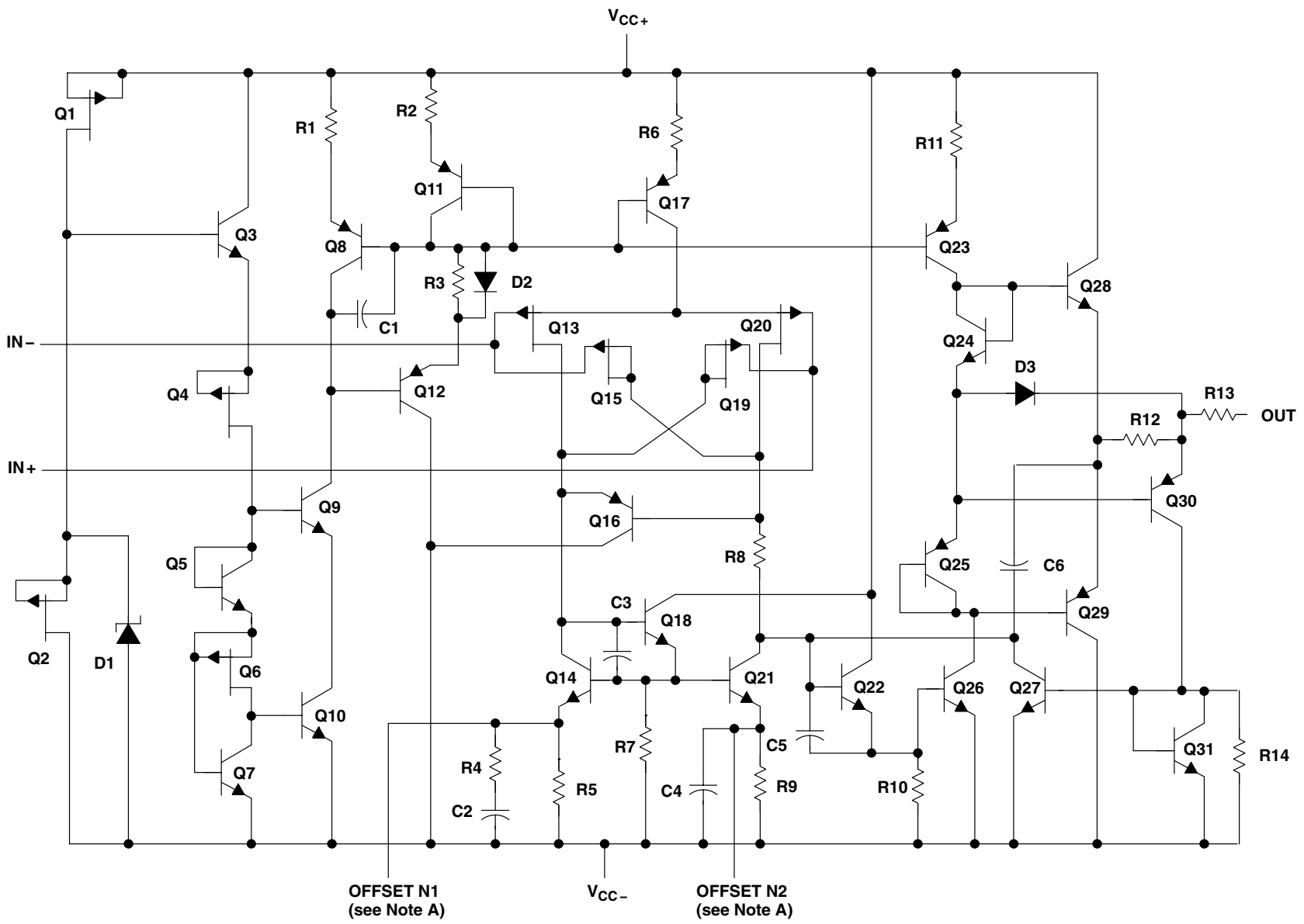
## symbol



**TLE207x-Q1, TLE207xA-Q1**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT OPERATIONAL AMPLIFIERS**

SLOS181A – FEBRUARY 1997 – REVISED MARCH 2000 (sourced from

equivalent schematic



NOTES: A. OFFSET N1 AND OFFSET N2 are only available on the TLE2071x devices.

**TLE207x-Q1, TLE207xA-Q1**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT OPERATIONAL AMPLIFIERS**  
SLOS181A – FEBRUARY 1997 – REVISED MARCH 2000 (sourced from)

| ACTUAL DEVICE COMPONENT COUNT |         |         |         |
|-------------------------------|---------|---------|---------|
| COMPONENT                     | TLE2071 | TLE2072 | TLE2074 |
| Transistors                   | 33      | 57      | 114     |
| Resistors                     | 25      | 37      | 74      |
| Diodes                        | 8       | 5       | 10      |
| Capacitors                    | 6       | 11      | 22      |

equivalent schematic (continued)

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|                                                                   |                        |
|-------------------------------------------------------------------|------------------------|
| Supply voltage, $V_{CC+}$ (see Note 1)                            | 19 V                   |
| Supply voltage, $V_{CC-}$ (see Note 1)                            | -19 V                  |
| Differential input voltage range, $V_{ID}$ (see Note 2)           | $V_{CC+}$ to $V_{CC-}$ |
| Input voltage range, $V_I$ (any input)                            | $V_{CC+}$ to $V_{CC-}$ |
| Input current, $I_I$ (each input)                                 | $\pm 1$ mA             |
| Output current, $I_O$ (each output)                               | $\pm 80$ mA            |
| Total current into $V_{CC+}$                                      | 160 mA                 |
| Total current out of $V_{CC-}$                                    | 160 mA                 |
| Duration of short-circuit current at (or below) 25°C (see Note 3) | unlimited              |
| Maximum Junction Temperature, $T_J$                               | 150°C                  |
| Package thermal impedance, $\theta_{JA}$ (see Note 4): D package  | 126°C/W                |
| DW package                                                        | 75°C/W                 |
| Operating free-air temperature range, $T_A$ : Q suffix            | -40°C to 125°C         |
| Storage temperature range                                         | -65°C to 150°C         |
| Lead temperature 1.6 mm (1/16 inch) from case for 3 seconds       | 300°C                  |

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 the noninverting input with respect to the inverting input.
3. The output may be shorted to either supply. Temperatures and/or supply voltages must be limited to ensure that the maximum dissipation rate is not exceeded.
4. The package thermal impedance is calculated in accordance with JESD 51-7.

|                                       |                        | MIN        | MAX      | UNIT |
|---------------------------------------|------------------------|------------|----------|------|
| Supply voltage, $V_{CC\pm}$           |                        | $\pm 2.25$ | $\pm 19$ | V    |
| Common-mode input voltage, $V_{IC}$   | $V_{CC\pm} = \pm 5$ V  | -0.8       | 5        | V    |
|                                       | $V_{CC\pm} = \pm 15$ V | -10.8      | 15       |      |
| Operating free-air temperature, $T_A$ |                        | -40        | 125      | °C   |

# TLE207x-Q1, TLE207xA-Q1

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT OPERATIONAL AMPLIFIERS

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**TLE2071-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**

| PARAMETER                                                                       | TEST CONDITIONS                                                    | $T_A^\dagger$         | TLE2071-Q1 |           |     | TLE2071A-Q1 |           |     | UNIT             |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------|-----------------------|------------|-----------|-----|-------------|-----------|-----|------------------|
|                                                                                 |                                                                    |                       | MIN        | TYP       | MAX | MIN         | TYP       | MAX |                  |
| $V_{IO}$ Input offset voltage                                                   | $V_{IC} = 0, V_O = 0,$<br>$R_S = 50 \Omega,$                       | 25°C                  | 0.34       | 4         |     | 0.3         | 2         |     | mV               |
|                                                                                 |                                                                    | Full range            |            |           | 9   |             |           | 7   |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                  |                                                                    | Full range            | 3.2        |           |     | 3.2         | 20        |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                   | $V_{IC} = 0, V_O = 0,$<br>See Figure 4                             | 25°C                  | 5          | 100       |     | 5           | 100       |     | pA               |
|                                                                                 |                                                                    | Full range            |            | 20        |     |             | 20        |     | nA               |
| $I_{IB}$ Input bias current                                                     |                                                                    | 25°C                  | 15         | 175       |     | 15          | 175       |     | pA               |
|                                                                                 |                                                                    | Full range            |            | 60        |     |             | 60        |     | nA               |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50 \Omega$                                                  | 25°C                  | 5 to -1    | 5 to -1.9 |     | 5 to -1     | 5 to -1.9 |     | V                |
|                                                                                 |                                                                    | Full range            | 5 to -0.8  |           |     | 5 to -0.8   |           |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                            | $I_O = -200 \mu A$                                                 | 25°C                  | 3.8        | 4.1       |     | 3.8         | 4.1       |     | V                |
|                                                                                 |                                                                    | Full range            | 3.6        |           |     | 3.6         |           |     |                  |
|                                                                                 | $I_O = -2$ mA                                                      | 25°C                  | 3.5        | 3.9       |     | 3.5         | 3.9       |     |                  |
|                                                                                 |                                                                    | Full range            | 3.3        |           |     | 3.3         |           |     |                  |
|                                                                                 | $I_O = -20$ mA                                                     | 25°C                  | 1.5        | 2.3       |     | 1.5         | 2.3       |     |                  |
|                                                                                 |                                                                    | Full range            | 1.4        |           |     | 1.4         |           |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                            | $I_O = 200 \mu A$                                                  | 25°C                  | -3.8       | -4.2      |     | -3.8        | -4.2      |     | V                |
|                                                                                 |                                                                    | Full range            | -3.6       |           |     | -3.6        |           |     |                  |
|                                                                                 | $I_O = 2$ mA                                                       | 25°C                  | -3.5       | -4.1      |     | -3.5        | -4.1      |     |                  |
|                                                                                 |                                                                    | Full range            | -3.3       |           |     | -3.3        |           |     |                  |
|                                                                                 | $I_O = 20$ mA                                                      | 25°C                  | -1.5       | -2.4      |     | -1.5        | -2.4      |     |                  |
|                                                                                 |                                                                    | Full range            | -1.4       |           |     | -1.4        |           |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification                        | $V_O = \pm 2.3$ V                                                  | $R_L = 600 \Omega$    | 25°C       | 80        | 91  | 80          | 91        |     | dB               |
|                                                                                 |                                                                    |                       | Full range | 78        |     | 78          |           |     |                  |
|                                                                                 |                                                                    | $R_L = 2$ k $\Omega$  | 25°C       | 90        | 100 | 90          | 100       |     |                  |
|                                                                                 |                                                                    |                       | Full range | 88        |     | 88          |           |     |                  |
|                                                                                 |                                                                    | $R_L = 10$ k $\Omega$ | 25°C       | 95        | 106 | 95          | 106       |     |                  |
|                                                                                 |                                                                    |                       | Full range | 93        |     | 93          |           |     |                  |
| $r_i$ Input resistance                                                          | $V_{IC} = 0$                                                       | 25°C                  | $10^{12}$  |           |     | $10^{12}$   |           |     | $\Omega$         |
| $c_i$ Input capacitance                                                         | $V_{IC} = 0,$<br>See Figure 5                                      | Common mode           | 25°C       | 11        |     | 11          |           |     | pF               |
|                                                                                 |                                                                    | Differential          | 25°C       | 2.5       |     | 2.5         |           |     |                  |
| $z_o$ Open-loop output impedance                                                | $f = 1$ MHz                                                        | 25°C                  | 80         |           |     | 80          |           |     | $\Omega$         |
| CMRR Common-mode rejection ratio                                                | $V_{IC} = V_{ICRmin},$<br>$V_O = 0, R_S = 50 \Omega$               | 25°C                  | 70         | 89        |     | 70          | 89        |     | dB               |
|                                                                                 |                                                                    | Full range            | 68         |           |     | 68          |           |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5$ V to $\pm 15$ V,<br>$V_O = 0, R_S = 50 \Omega$ | 25°C                  | 82         | 99        |     | 82          | 99        |     | dB               |
|                                                                                 |                                                                    | Full range            | 80         |           |     | 80          |           |     |                  |

$^\dagger$  Full range is  $-40^\circ C$  to  $125^\circ C$ .



**TLE207x-Q1, TLE207xA-Q1**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT OPERATIONAL AMPLIFIERS**

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**TLE2071-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted) (continued)**

| PARAMETER       |                              | TEST CONDITIONS             |                        | T <sub>A</sub> † | TLE2071-Q1 |     |     | TLE2071A-Q1 |     |     | UNIT |
|-----------------|------------------------------|-----------------------------|------------------------|------------------|------------|-----|-----|-------------|-----|-----|------|
|                 |                              |                             |                        |                  | MIN        | TYP | MAX | MIN         | TYP | MAX |      |
| I <sub>CC</sub> | Supply current               | V <sub>O</sub> = 0, No load |                        | 25°C             | 1.35       | 1.6 | 2.2 | 1.35        | 1.6 | 2.2 | mA   |
|                 |                              |                             |                        | Full range       | 2.2        |     |     | 2.2         |     |     |      |
| I <sub>OS</sub> | Short-circuit output current | V <sub>O</sub> = 0          | V <sub>ID</sub> = 1 V  | 25°C             | –35        |     |     | –35         |     |     | mA   |
|                 |                              |                             | V <sub>ID</sub> = –1 V |                  | 45         |     |     | 45          |     |     |      |

$^\dagger$  Full range is –40°C to 125°C.

**TLE2071-Q1 operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V**

| PARAMETER          |                                             | TEST CONDITIONS                                                                                                       |                                                            | T <sub>A</sub> <sup>†</sup>                       | TLE2071-Q1 |     |      | TLE2071A-Q1 |        |     | UNIT   |
|--------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|---------------------------------------------------|------------|-----|------|-------------|--------|-----|--------|
|                    |                                             |                                                                                                                       |                                                            |                                                   | MIN        | TYP | MAX  | MIN         | TYP    | MAX |        |
| SR +               | Positive slew rate                          | V <sub>O(PP)</sub> = ±2.3 V,<br>A <sub>VD</sub> = −1, R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF, See Figure 1 |                                                            | 25°C                                              | 35         |     |      | 35          |        |     | V/μs   |
|                    |                                             |                                                                                                                       |                                                            | Full range                                        | 20         |     |      | 20          |        |     |        |
| SR −               | Negative slew rate                          |                                                                                                                       |                                                            | 25°C                                              | 38         |     |      | 38          |        |     | V/μs   |
|                    |                                             |                                                                                                                       |                                                            | Full range                                        | 20         |     |      | 20          |        |     |        |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1,<br>2-V step,<br>R <sub>L</sub> = 1 kΩ,<br>C <sub>L</sub> = 100 pF                               | To 10 mV                                                   | 25°C                                              | 0.25       |     |      | 0.25        |        |     | μs     |
|                    |                                             |                                                                                                                       | To 1 mV                                                    |                                                   | 0.4        |     |      | 0.4         |        |     |        |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω,<br>See Figure 3                                                                                | f = 10 Hz                                                  | 25°C                                              | 28         | 55  | 28   | 55          | nV/√Hz |     |        |
|                    |                                             |                                                                                                                       | f = 10 kHz                                                 |                                                   | 11.6       | 17  | 11.6 | 17          |        |     |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage |                                                                                                                       | f = 10 Hz to 10 kHz                                        | 25°C                                              | 6          |     |      | 6           |        |     | μV     |
|                    |                                             |                                                                                                                       | f = 0.1 Hz to 10 Hz                                        |                                                   | 0.6        |     |      | 0.6         |        |     |        |
| I <sub>n</sub>     | Equivalent input noise current              |                                                                                                                       | V <sub>IC</sub> = 0, f = 10 kHz                            | 25°C                                              | 2.8        |     |      | 2.8         |        |     | fA/√Hz |
| THD + N            | Total harmonic distortion plus noise        |                                                                                                                       | V <sub>O(PP)</sub> = 5 V, f = 1 kHz, R <sub>S</sub> = 25 Ω | A <sub>VD</sub> = 10, R <sub>L</sub> = 2 kΩ, 25°C | 0.013%     |     |      | 0.013%      |        |     |        |
| B <sub>1</sub>     | Unity-gain bandwidth                        | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF, R <sub>L</sub> = 2 kΩ, See Figure 2                                   | 25°C                                                       | 9.4                                               |            |     | 9.4  |             |        | MHz |        |
| B <sub>OM</sub>    | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 4 V, R <sub>L</sub> = 2 kΩ , A <sub>VD</sub> = −1, C <sub>L</sub> = 25 pF                        | 25°C                                                       | 2.8                                               |            |     | 2.8  |             |        | MHz |        |
| φ <sub>m</sub>     | Phase margin at unity gain                  | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF, R <sub>L</sub> = 2 kΩ, See Figure 2                                   | 25°C                                                       | 56                                                |            |     | 56   |             |        |     |        |

$^\dagger$  Full range is –40°C to 125°C.

# TLE207x-Q1, TLE207xA-Q1

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT OPERATIONAL AMPLIFIERS

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**TLE2071-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                              | $T_A^\dagger$              | TLE2071-Q1  |             |     | TLE2071A-Q1 |             |     | UNIT             |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------------|----------------------------|-------------|-------------|-----|-------------|-------------|-----|------------------|
|                                                                               |                                                                              |                            | MIN         | TYP         | MAX | MIN         | TYP         | MAX |                  |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0, V_O = 0, R_S = 50 \Omega$                                       | 25°C                       | 0.49        | 4           |     | 0.47        | 2           |     | mV               |
|                                                                               |                                                                              | Full range                 |             |             | 9   |             |             | 7   |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                                              | Full range                 | 3.2         |             |     | 3.2         | 20          |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                 | $V_{IC} = 0, V_O = 0, \text{See Figure 4}$                                   | 25°C                       | 6           | 100         |     | 6           | 100         |     | pA               |
|                                                                               |                                                                              | Full range                 |             |             | 20  |             |             | 20  | nA               |
| $I_{IB}$ Input bias current                                                   |                                                                              | 25°C                       | 20          | 175         |     | 20          | 175         |     | pA               |
|                                                                               |                                                                              | Full range                 |             |             | 60  |             |             | 60  | nA               |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50 \Omega$                                                            | 25°C                       | 15 to -11   | 15 to -11.9 |     | 15 to -11   | 15 to -11.9 |     | V                |
|                                                                               |                                                                              | Full range                 | 15 to -10.9 |             |     | 15 to -10.9 |             |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                          | $I_O = -200 \mu A$                                                           | 25°C                       | 13.8        | 14.1        |     | 13.8        | 14.1        |     | V                |
|                                                                               |                                                                              | Full range                 | 13.6        |             |     | 13.6        |             |     |                  |
|                                                                               | $I_O = -2 \text{ mA}$                                                        | 25°C                       | 13.5        | 13.9        |     | 13.5        | 13.9        |     |                  |
|                                                                               |                                                                              | Full range                 | 13.3        |             |     | 13.3        |             |     |                  |
|                                                                               | $I_O = -20 \text{ mA}$                                                       | 25°C                       | 11.5        | 12.3        |     | 11.5        | 12.3        |     |                  |
|                                                                               |                                                                              | Full range                 | 11.4        |             |     | 11.4        |             |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                          | $I_O = 200 \mu A$                                                            | 25°C                       | -13.8       | -14.2       |     | -13.8       | -14.2       |     | V                |
|                                                                               |                                                                              | Full range                 | -13.6       |             |     | -13.6       |             |     |                  |
|                                                                               | $I_O = 2 \text{ mA}$                                                         | 25°C                       | -13.5       | -14         |     | -13.5       | -14         |     |                  |
|                                                                               |                                                                              | Full range                 | -13.3       |             |     | -13.3       |             |     |                  |
|                                                                               | $I_O = 20 \text{ mA}$                                                        | 25°C                       | -11.5       | -12.4       |     | -11.5       | -12.4       |     |                  |
|                                                                               |                                                                              | Full range                 | -11.4       |             |     | -11.4       |             |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10 \text{ V}$                                                     | $R_L = 600 \Omega$         | 25°C        | 80          | 96  | 80          | 96          |     | dB               |
|                                                                               |                                                                              |                            | Full range  | 78          |     | 78          |             |     |                  |
|                                                                               |                                                                              | $R_L = 2 \text{ k}\Omega$  | 25°C        | 90          | 109 | 90          | 109         |     |                  |
|                                                                               |                                                                              |                            | Full range  | 88          |     | 88          |             |     |                  |
|                                                                               |                                                                              | $R_L = 10 \text{ k}\Omega$ | 25°C        | 95          | 118 | 95          | 118         |     |                  |
|                                                                               |                                                                              |                            | Full range  | 93          |     | 93          |             |     |                  |
| $r_i$ Input resistance                                                        | $V_{IC} = 0$                                                                 | 25°C                       |             | $10^{12}$   |     |             | $10^{12}$   |     | $\Omega$         |
| $c_i$ Input capacitance                                                       | $V_{IC} = 0, \text{See Figure 5}$                                            | Common mode                | 25°C        | 7.5         |     | 7.5         |             |     | pF               |
|                                                                               |                                                                              | Differential               | 25°C        | 2.5         |     | 2.5         |             |     |                  |
| $z_o$ Open-loop output impedance                                              | $f = 1 \text{ MHz}$                                                          | 25°C                       |             | 80          |     |             | 80          |     | $\Omega$         |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50 \Omega$                              | 25°C                       | 80          | 98          |     | 80          | 98          |     | dB               |
|                                                                               |                                                                              | Full range                 | 78          |             |     | 78          |             |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}, V_O = 0, R_S = 50 \Omega$ | 25°C                       | 82          | 99          |     | 82          | 99          |     | dB               |
|                                                                               |                                                                              | Full range                 | 80          |             |     | 80          |             |     |                  |

$^\dagger$  Full range is  $-40^\circ C$  to  $125^\circ C$ .



**TLE207x-Q1, TLE207xA-Q1**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT OPERATIONAL AMPLIFIERS**

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**TLE2071-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted) (continued)**

| PARAMETER       |                              | TEST CONDITIONS             |                        | T <sub>A</sub> <sup>†</sup> | TLE2071-Q1 |     |     | TLE2071A-Q1 |     |     | UNIT |
|-----------------|------------------------------|-----------------------------|------------------------|-----------------------------|------------|-----|-----|-------------|-----|-----|------|
|                 |                              |                             |                        |                             | MIN        | TYP | MAX | MIN         | TYP | MAX |      |
| I <sub>CC</sub> | Supply current               | V <sub>O</sub> = 0, No load |                        | 25°C                        | 1.35       | 1.7 | 2.2 | 1.35        | 1.7 | 2.2 | mA   |
|                 |                              |                             |                        | Full range                  | 2.2        |     |     | 2.2         |     |     |      |
| I <sub>OS</sub> | Short-circuit output current | V <sub>O</sub> = 0          | V <sub>ID</sub> = 1 V  | 25°C                        | -30        | -45 |     | -30         | -45 | mA  |      |
|                 |                              |                             | V <sub>ID</sub> = -1 V |                             | 30         | 48  |     | 30          | 48  |     |      |

$^\dagger$  Full range is -40°C to 125°C.

**TLE2071-Q1 operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V**

| PARAMETER          |                                             | TEST CONDITIONS                                                                                               |                     | T <sub>A</sub> <sup>†</sup> | TLE2071-Q1 |        |     | TLE2071A-Q1 |     |        | UNIT |
|--------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------|------------|--------|-----|-------------|-----|--------|------|
|                    |                                             |                                                                                                               |                     |                             | MIN        | TYP    | MAX | MIN         | TYP | MAX    |      |
| SR +               | Positive slew rate                          | V <sub>O(PP)</sub> = 10 V, A <sub>VD</sub> = −1, R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, See Figure 1 |                     | 25°C                        | 30         | 40     |     | 30          | 40  |        | V/μs |
|                    |                                             |                                                                                                               |                     | Full range                  | 22         |        |     | 22          |     |        |      |
| SR −               | Negative slew rate                          |                                                                                                               |                     | 25°C                        | 30         | 45     |     | 30          | 45  |        | V/μs |
|                    |                                             |                                                                                                               |                     | Full range                  | 22         |        |     | 22          |     |        |      |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1, 10-V step, R <sub>L</sub> = 1 kΩ, C <sub>L</sub> = 100 pF                               | To 10 mV            | 25°C                        | 0.4        |        | 0.4 |             | μs  |        |      |
|                    |                                             |                                                                                                               | To 1 mV             |                             | 1.5        |        | 1.5 |             |     |        |      |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω, See Figure 3                                                                           | f = 10 Hz           | 25°C                        | 28         | 55     |     | 28          | 55  | nV/√Hz |      |
|                    |                                             |                                                                                                               | f = 10 kHz          |                             | 11.6       | 17     |     | 11.6        | 17  |        |      |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage |                                                                                                               | f = 10 Hz to 10 kHz | 25°C                        | 6          |        | 6   |             | μV  |        |      |
|                    |                                             |                                                                                                               | f = 0.1 Hz to 10 Hz |                             | 0.6        |        | 0.6 |             |     |        |      |
| I <sub>n</sub>     | Equivalent input noise current              | V <sub>IC</sub> = 0, f = 10 kHz                                                                               | 25°C                | 2.8                         |            | 2.8    |     | fA/√Hz      |     |        |      |
| THD + N            | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 20 V, A <sub>VD</sub> = 10, f = 1 kHz, R <sub>S</sub> = 25 Ω                             | 25°C                | 0.008%                      |            | 0.008% |     |             |     |        |      |
| B <sub>1</sub>     | Unity-gain bandwidth                        | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF, R <sub>L</sub> = 2 kΩ, See Figure 2                           | 25°C                | 8                           | 10         |        | 8   | 10          | MHz |        |      |
| B <sub>OM</sub>    | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ, A <sub>VD</sub> = −1, C <sub>L</sub> = 25 pF                | 25°C                | 478                         | 637        |        | 478 | 637         | kHz |        |      |
| φ <sub>m</sub>     | Phase margin at unity gain                  | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF, R <sub>L</sub> = 2 kΩ, See Figure 2                           | 25°C                | 57                          |            | 57     |     |             |     |        |      |

$^\dagger$  Full range is -40°C to 125°C.

# TLE207x-Q1, TLE207xA-Q1

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT OPERATIONAL AMPLIFIERS

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**TLE2072-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**

| PARAMETER                                                      | TEST CONDITIONS                                      | $T_A^\dagger$              | TLE2072-Q1 |           |     | TLE2072A-Q1 |           |     | UNIT             |
|----------------------------------------------------------------|------------------------------------------------------|----------------------------|------------|-----------|-----|-------------|-----------|-----|------------------|
|                                                                |                                                      |                            | MIN        | TYP       | MAX | MIN         | TYP       | MAX |                  |
| $V_{IO}$ Input offset voltage                                  | $V_{IC} = 0, V_O = 0,$<br>$R_S = 50 \Omega,$         | 25°C                       | 0.9        | 6         |     | 0.65        | 3.5       |     | mV               |
|                                                                |                                                      | Full range                 |            | 10        |     |             | 8         |     |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage |                                                      | Full range                 | 2.3        |           |     | 2.3         | 20        |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                  | $V_{IC} = 0, V_O = 0,$<br>See Figure 4               | 25°C                       | 5          | 100       |     | 5           | 100       |     | pA               |
|                                                                |                                                      | Full range                 |            | 20        |     |             | 20        |     | nA               |
| $I_{IB}$ Input bias current                                    |                                                      | 25°C                       | 15         | 175       |     | 15          | 175       |     | pA               |
|                                                                |                                                      | Full range                 |            | 60        |     |             | 60        |     | nA               |
| $V_{ICR}$ Common-mode input voltage range                      | $R_S = 50 \Omega$                                    | 25°C                       | 5 to -1    | 5 to -1.9 |     | 5 to -1     | 5 to -1.9 |     | V                |
|                                                                |                                                      | Full range                 | 5 to -0.8  |           |     | 5 to -0.8   |           |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing           | $I_O = -200 \mu A$                                   | 25°C                       | 3.8        | 4.1       |     | 3.8         | 4.1       |     | V                |
|                                                                |                                                      | Full range                 | 3.6        |           |     | 3.6         |           |     |                  |
|                                                                | $I_O = -2 \text{ mA}$                                | 25°C                       | 3.5        | 3.9       |     | 3.5         | 3.9       |     |                  |
|                                                                |                                                      | Full range                 | 3.3        |           |     | 3.3         |           |     |                  |
|                                                                | $I_O = -20 \text{ mA}$                               | 25°C                       | 1.5        | 2.3       |     | 1.5         | 2.3       |     |                  |
|                                                                |                                                      | Full range                 | 1.4        |           |     | 1.4         |           |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing           | $I_O = 200 \mu A$                                    | 25°C                       | -3.8       | -4.2      |     | -3.8        | -4.2      |     | V                |
|                                                                |                                                      | Full range                 | -3.6       |           |     | -3.6        |           |     |                  |
|                                                                | $I_O = 2 \text{ mA}$                                 | 25°C                       | -3.5       | -4.1      |     | -3.5        | -4.1      |     |                  |
|                                                                |                                                      | Full range                 | -3.3       |           |     | -3.3        |           |     |                  |
|                                                                | $I_O = 20 \text{ mA}$                                | 25°C                       | -1.5       | -2.4      |     | -1.5        | -2.4      |     |                  |
|                                                                |                                                      | Full range                 | -1.4       |           |     | -1.4        |           |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification       | $V_O = \pm 2.3 \text{ V}$                            | $R_L = 600 \Omega$         | 25°C       | 80        | 91  | 80          | 91        |     | dB               |
|                                                                |                                                      |                            | Full range | 78        |     | 78          |           |     |                  |
|                                                                |                                                      | $R_L = 2 \text{ k}\Omega$  | 25°C       | 90        | 100 | 90          | 100       |     |                  |
|                                                                |                                                      |                            | Full range | 88        |     | 88          |           |     |                  |
|                                                                |                                                      | $R_L = 10 \text{ k}\Omega$ | 25°C       | 95        | 106 | 95          | 106       |     |                  |
|                                                                |                                                      |                            | Full range | 93        |     | 93          |           |     |                  |
| $r_i$ Input resistance                                         | $V_{IC} = 0$                                         | 25°C                       |            | $10^{12}$ |     |             | $10^{12}$ |     | $\Omega$         |
| $c_i$ Input capacitance                                        | $V_{IC} = 0,$<br>See Figure 5                        | Common mode                | 25°C       | 11        |     | 11          |           |     | pF               |
|                                                                |                                                      | Differential               | 25°C       | 2.5       |     | 2.5         |           |     |                  |
| $z_o$ Open-loop output impedance                               | $f = 1 \text{ MHz}$                                  | 25°C                       |            | 80        |     |             | 80        |     | $\Omega$         |
| CMRR Common-mode rejection ratio                               | $V_{IC} = V_{ICRmin},$<br>$V_O = 0, R_S = 50 \Omega$ | 25°C                       | 70         | 89        |     | 70          | 89        |     | dB               |
|                                                                |                                                      | Full range                 | 68         |           |     | 68          |           |     |                  |

$^\dagger$  Full range is  $-40^\circ C$  to  $125^\circ C$ .



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**TLE207x-Q1, TLE207xA-Q1**  
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**TLE2072-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted) (continued)**

| PARAMETER        |                                                                       | TEST CONDITIONS                                                             |                        | T <sub>A</sub> <sup>†</sup> | TLE2072-Q1 |     |     | TLE2072A-Q1 |     |     | UNIT |
|------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------------|------------------------|-----------------------------|------------|-----|-----|-------------|-----|-----|------|
|                  |                                                                       |                                                                             |                        |                             | MIN        | TYP | MAX | MIN         | TYP | MAX |      |
| k <sub>SVR</sub> | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC±</sub> = ±5 V to ±15 V, V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω |                        | Full range                  | 80         |     |     | 80          |     |     | dB   |
| I <sub>CC</sub>  | Supply current (both channels)                                        | V <sub>O</sub> = 0,                                                         | No load                | 25°C                        | 2.7        | 2.9 | 3.6 | 2.7         | 2.9 | 3.6 | mA   |
|                  |                                                                       |                                                                             |                        | Full range                  | 3.6        |     |     | 3.6         |     |     |      |
| a <sub>x</sub>   | Crosstalk attenuation                                                 | V <sub>IC</sub> = 0,                                                        | R <sub>L</sub> = 2 kΩ  | 25°C                        | 120        |     |     | 120         |     |     | dB   |
| I <sub>OS</sub>  | Short-circuit output current                                          | V <sub>O</sub> = 0                                                          | V <sub>ID</sub> = 1 V  | 25°C                        | –35        |     |     | –35         |     |     | mA   |
|                  |                                                                       |                                                                             | V <sub>ID</sub> = –1 V |                             | 45         |     |     | 45          |     |     |      |

$^\dagger$  Full range is -40°C to 125°C.

**TLE2072-Q1 operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V**

| PARAMETER          |                                             | TEST CONDITIONS                                                                                |                                                 | T <sub>A</sub> <sup>†</sup> | TLE2072-Q1 |     |     | TLE2072A-Q1 |     |     | UNIT   |
|--------------------|---------------------------------------------|------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------|------------|-----|-----|-------------|-----|-----|--------|
|                    |                                             |                                                                                                |                                                 |                             | MIN        | TYP | MAX | MIN         | TYP | MAX |        |
| SR +               | Positive slew rate                          | V <sub>O(PP)</sub> = ±2.3 V,<br>A <sub>VD</sub> = -1,<br>C <sub>L</sub> = 100 pF, See Figure 1 |                                                 | 25°C                        | 35         |     |     | 35          |     |     | V/μs   |
|                    |                                             |                                                                                                |                                                 | Full range                  | 18         |     |     | 18          |     |     |        |
| SR –               | Negative slew rate                          |                                                                                                |                                                 | 25°C                        | 38         |     |     | 38          |     |     | V/μs   |
|                    |                                             |                                                                                                |                                                 | Full range                  | 18         |     |     | 18          |     |     |        |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = -1,<br>2-V step,<br>R <sub>L</sub> = 1 kΩ,<br>C <sub>L</sub> = 100 pF        | To 10 mV                                        | 25°C                        | 0.25       |     |     | 0.25        |     |     | μs     |
|                    |                                             |                                                                                                | To 1 mV                                         |                             | 0.4        |     |     | 0.4         |     |     |        |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω,<br>See Figure 3                                                         | f = 10 Hz                                       | 25°C                        | 28 55      |     |     | 28 55       |     |     | nV/√Hz |
|                    |                                             |                                                                                                | f = 10 kHz                                      |                             | 11.6 17    |     |     | 11.6 17     |     |     |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage |                                                                                                | f = 10 Hz to 10 kHz                             | 25°C                        | 6          |     |     | 6           |     |     | μV     |
|                    |                                             |                                                                                                | f = 0.1 Hz to 10 Hz                             |                             | 0.6        |     |     | 0.6         |     |     |        |
| I <sub>n</sub>     | Equivalent input noise current              | V <sub>IC</sub> = 0, f = 10 kHz                                                                |                                                 | 25°C                        | 2.8        |     |     | 2.8         |     |     | fA/√Hz |
| THD + N            | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 5 V,<br>f = 1 kHz,<br>R <sub>S</sub> = 25 Ω                               | A <sub>VD</sub> = 10,<br>R <sub>L</sub> = 2 kΩ, | 25°C                        | 0.013%     |     |     | 0.013%      |     |     |        |
| B <sub>1</sub>     | Unity-gain bandwidth                        | V <sub>I</sub> = 10 mV,<br>C <sub>L</sub> = 25 pF,                                             | R <sub>L</sub> = 2 kΩ,<br>See Figure 2          | 25°C                        | 9.4        |     |     | 9.4         |     |     | MHz    |
| B <sub>OM</sub>    | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 4 V,<br>R <sub>L</sub> = 2 kΩ ,                                           | A <sub>VD</sub> = -1,<br>C <sub>L</sub> = 25 pF | 25°C                        | 2.8        |     |     | 2.8         |     |     | MHz    |
| φ <sub>m</sub>     | Phase margin at unity gain                  | V <sub>I</sub> = 10 mV,<br>C <sub>L</sub> = 25 pF,                                             | R <sub>L</sub> = 2 kΩ,<br>See Figure 2          | 25°C                        | 56         |     |     | 56          |     |     |        |

$^\dagger$  Full range is -40°C to 125°C.

# TLE207x-Q1, TLE207xA-Q1

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT OPERATIONAL AMPLIFIERS

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**TLE2072-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS                                                              | $T_A^\dagger$              | TLE2072-Q1  |             |     | TLE2072A-Q1 |             |     | UNIT             |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------------|----------------------------|-------------|-------------|-----|-------------|-------------|-----|------------------|
|                                                                               |                                                                              |                            | MIN         | TYP         | MAX | MIN         | TYP         | MAX |                  |
| $V_{IO}$ Input offset voltage                                                 | $V_{IC} = 0, V_O = 0, R_S = 50 \Omega$                                       | 25°C                       | 1.1         | 6           |     | 0.7         | 3.5         |     | mV               |
|                                                                               |                                                                              | Full range                 |             |             | 10  |             |             | 8   |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                |                                                                              | Full range                 | 2.4         |             |     | 2.4         | 20          |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                 | $V_{IC} = 0, V_O = 0, \text{See Figure 4}$                                   | 25°C                       | 6           | 100         |     | 6           | 100         |     | pA               |
|                                                                               |                                                                              | Full range                 |             |             | 20  |             |             | 20  | nA               |
| $I_{IB}$ Input bias current                                                   |                                                                              | 25°C                       | 20          | 175         |     | 20          | 175         |     | pA               |
|                                                                               |                                                                              | Full range                 |             |             | 60  |             |             | 60  | nA               |
| $V_{ICR}$ Common-mode input voltage range                                     | $R_S = 50 \Omega$                                                            | 25°C                       | 15 to -11   | 15 to -11.9 |     | 15 to -11   | 15 to -11.9 |     | V                |
|                                                                               |                                                                              | Full range                 | 15 to -10.8 |             |     | 15 to -10.8 |             |     |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                          | $I_O = -200 \mu A$                                                           | 25°C                       | 13.8        | 14.1        |     | 13.8        | 14.1        |     | V                |
|                                                                               |                                                                              | Full range                 | 13.6        |             |     | 13.6        |             |     |                  |
|                                                                               | $I_O = -2 \text{ mA}$                                                        | 25°C                       | 13.5        | 13.9        |     | 13.5        | 13.9        |     |                  |
|                                                                               |                                                                              | Full range                 | 13.3        |             |     | 13.3        |             |     |                  |
|                                                                               | $I_O = -20 \text{ mA}$                                                       | 25°C                       | 11.5        | 12.3        |     | 11.5        | 12.3        |     |                  |
|                                                                               |                                                                              | Full range                 | 11.4        |             |     | 11.4        |             |     |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                          | $I_O = 200 \mu A$                                                            | 25°C                       | -13.8       | -14.2       |     | -13.8       | -14.2       |     | V                |
|                                                                               |                                                                              | Full range                 | -13.6       |             |     | -13.6       |             |     |                  |
|                                                                               | $I_O = 2 \text{ mA}$                                                         | 25°C                       | -13.5       | -14         |     | -13.5       | -14         |     |                  |
|                                                                               |                                                                              | Full range                 | -13.3       |             |     | -13.3       |             |     |                  |
|                                                                               | $I_O = 20 \text{ mA}$                                                        | 25°C                       | -11.5       | -12.4       |     | -11.5       | -12.4       |     |                  |
|                                                                               |                                                                              | Full range                 | -11.4       |             |     | -11.4       |             |     |                  |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10 \text{ V}$                                                     | $R_L = 600 \Omega$         | 25°C        | 80          | 96  | 80          | 96          |     | dB               |
|                                                                               |                                                                              |                            | Full range  | 78          |     | 78          |             |     |                  |
|                                                                               |                                                                              | $R_L = 2 \text{ k}\Omega$  | 25°C        | 90          | 109 | 90          | 109         |     |                  |
|                                                                               |                                                                              |                            | Full range  | 89          |     | 89          |             |     |                  |
|                                                                               |                                                                              | $R_L = 10 \text{ k}\Omega$ | 25°C        | 95          | 118 | 95          | 118         |     |                  |
|                                                                               |                                                                              |                            | Full range  | 93          |     | 93          |             |     |                  |
| $r_i$ Input resistance                                                        | $V_{IC} = 0$                                                                 | 25°C                       |             | $10^{12}$   |     |             | $10^{12}$   |     | $\Omega$         |
| $c_i$ Input capacitance                                                       | $V_{IC} = 0, \text{See Figure 5}$                                            | Common mode                | 25°C        | 7.5         |     | 7.5         |             |     | pF               |
|                                                                               |                                                                              | Differential               | 25°C        | 2.5         |     | 2.5         |             |     |                  |
| $z_o$ Open-loop output impedance                                              | $f = 1 \text{ MHz}$                                                          | 25°C                       |             | 80          |     |             | 80          |     | $\Omega$         |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50 \Omega$                              | 25°C                       | 80          | 98          |     | 80          | 98          |     | dB               |
|                                                                               |                                                                              | Full range                 | 78          |             |     | 78          |             |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}, V_O = 0, R_S = 50 \Omega$ | 25°C                       | 82          | 99          |     | 82          | 99          |     | dB               |
|                                                                               |                                                                              | Full range                 | 80          |             |     | 80          |             |     |                  |

$^\dagger$  Full range is  $-40^\circ C$  to  $125^\circ C$ .



**TLE207x-Q1, TLE207xA-Q1**  
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**TLE2072-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted) (continued)**

| PARAMETER       |                                   | TEST CONDITIONS      |                        | T <sub>A</sub> <sup>†</sup> | TLE2072-Q1 |     |     | TLE2072A-Q1 |     |     | UNIT |
|-----------------|-----------------------------------|----------------------|------------------------|-----------------------------|------------|-----|-----|-------------|-----|-----|------|
|                 |                                   |                      |                        |                             | MIN        | TYP | MAX | MIN         | TYP | MAX |      |
| I <sub>CC</sub> | Supply current<br>(both channels) | V <sub>O</sub> = 0,  | No load                | 25°C                        | 2.7        | 3.1 | 3.6 | 2.7         | 3.1 | 3.6 | mA   |
|                 |                                   |                      |                        | Full range                  | 3.6        |     |     | 3.6         |     |     |      |
| a <sub>x</sub>  | Crosstalk attenuation             | V <sub>IC</sub> = 0, | R <sub>L</sub> = 2 kΩ  | 25°C                        | 120        |     |     | 120         |     |     | dB   |
| I <sub>OS</sub> | Short-circuit output<br>current   | V <sub>O</sub> = 0   | V <sub>ID</sub> = 1 V  | 25°C                        | -30        | -45 |     | -30         | -45 |     | mA   |
|                 |                                   |                      | V <sub>ID</sub> = -1 V |                             | 30         | 48  |     | 30          | 48  |     |      |

$^\dagger$  Full range is -40°C to 125°C.

**TLE2072-Q1 operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V**

| PARAMETER          |                                             | TEST CONDITIONS                                                                                               |                                                             | T <sub>A</sub> <sup>†</sup> | TLE2072-Q1 |     |        | TLE2072A-Q1 |        |     | UNIT |
|--------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-----------------------------|------------|-----|--------|-------------|--------|-----|------|
|                    |                                             |                                                                                                               |                                                             |                             | MIN        | TYP | MAX    | MIN         | TYP    | MAX |      |
| SR+                | Positive slew rate                          | V <sub>O(PP)</sub> = 10 V, A <sub>VD</sub> = −1, R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, See Figure 1 |                                                             | 25°C                        | 28         | 40  |        | 28          | 40     |     | V/μs |
|                    |                                             |                                                                                                               |                                                             | Full range                  | 20         |     | 20     |             |        |     |      |
| SR−                | Negative slew rate                          |                                                                                                               |                                                             | 25°C                        | 30         | 45  |        | 30          | 45     |     | V/μs |
|                    |                                             |                                                                                                               |                                                             | Full range                  | 20         |     | 20     |             |        |     |      |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1, 10-V step, R <sub>L</sub> = 1 kΩ, C <sub>L</sub> = 100 pF                               | To 10 mV                                                    | 25°C                        | 0.4        |     | 0.4    |             | μs     |     |      |
|                    |                                             |                                                                                                               | To 1 mV                                                     |                             | 1.5        |     | 1.5    |             |        |     |      |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω, See Figure 3                                                                           | f = 10 Hz                                                   | 25°C                        | 28         | 55  | 28     | 55          | nV/√Hz |     |      |
|                    |                                             |                                                                                                               | f = 10 kHz                                                  |                             | 11.6       | 17  | 11.6   | 17          |        |     |      |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage |                                                                                                               | f = 10 Hz to 10 kHz                                         | 25°C                        | 6          |     | 6      |             | μV     |     |      |
|                    |                                             |                                                                                                               | f = 0.1 Hz to 10 Hz                                         |                             | 0.6        |     | 0.6    |             |        |     |      |
| I <sub>n</sub>     | Equivalent input noise current              |                                                                                                               | V <sub>IC</sub> = 0, f = 10 kHz                             | 25°C                        | 2.8        |     | 2.8    |             | fA/√Hz |     |      |
| THD + N            | Total harmonic distortion plus noise        |                                                                                                               | V <sub>O(PP)</sub> = 20 V, f = 1 kHz, R <sub>S</sub> = 25 Ω | 25°C                        | 0.008%     |     | 0.008% |             |        |     |      |
| B <sub>1</sub>     | Unity-gain bandwidth                        | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF, R <sub>L</sub> = 2 kΩ, See Figure 2                           | 25°C                                                        | 8                           | 10         | 8   | 10     | MHz         |        |     |      |
| B <sub>OM</sub>    | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ, A <sub>VD</sub> = −1, C <sub>L</sub> = 25 pF                | 25°C                                                        | 478                         | 637        | 478 | 637    | kHz         |        |     |      |
| ϕ <sub>m</sub>     | Phase margin at unity gain                  | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF, R <sub>L</sub> = 2 kΩ, See Figure 2                           | 25°C                                                        | 57                          |            | 57  |        |             |        |     |      |

$^\dagger$  Full range is -40°C to 125°C.

# TLE207x-Q1, TLE207xA-Q1

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT OPERATIONAL AMPLIFIERS

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**TLE2074-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**

| PARAMETER        |                                                                       |              | TEST CONDITIONS                                                                   | T <sub>A</sub> <sup>†</sup> | TLE2074-Q1 |                  |         | TLE2074A-Q1 |                  |     | UNIT  |
|------------------|-----------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------|-----------------------------|------------|------------------|---------|-------------|------------------|-----|-------|
|                  |                                                                       |              |                                                                                   |                             | MIN        | TYP              | MAX     | MIN         | TYP              | MAX |       |
| V <sub>IO</sub>  | Input offset voltage                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0,<br>R <sub>S</sub> = 50Ω                  | 25°C                        | −1.6 7     |                  |         | −0.5 4      |                  |     | mV    |
|                  |                                                                       |              |                                                                                   | Full range                  | 11         |                  |         | 9           |                  |     |       |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                       |              |                                                                                   | Full range                  | 10.1       |                  |         | 10.1 30     |                  |     | μV/°C |
| I <sub>IO</sub>  | Input offset current                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0,<br>See Figure 4                          | 25°C                        | 15 100     |                  |         | 15 100      |                  |     | pA    |
|                  |                                                                       |              |                                                                                   | Full range                  | 20         |                  |         | 20          |                  |     | nA    |
| I <sub>IB</sub>  | Input bias current                                                    |              |                                                                                   | 25°C                        | 20 175     |                  |         | 20 175      |                  |     | pA    |
|                  |                                                                       |              |                                                                                   | Full range                  | 60         |                  |         | 60          |                  |     | nA    |
| V <sub>ICR</sub> | Common-mode input voltage range                                       |              | R <sub>S</sub> = 50 Ω                                                             | 25°C                        | 5 to −1    | 5 to −1.9        | 5 to −1 |             | 5 to −1.9        | V   |       |
|                  |                                                                       |              |                                                                                   | Full range                  | 5 to −0.8  | 5 to −0.8        |         |             |                  |     |       |
| V <sub>OM+</sub> | Maximum positive peak output voltage swing                            |              | I <sub>O</sub> = −200 μA                                                          | 25°C                        | 3.8        | 4.1              | 3.8     |             | 4.1              | V   |       |
|                  |                                                                       |              |                                                                                   | Full range                  | 3.6        |                  |         |             |                  |     |       |
|                  |                                                                       |              | I <sub>O</sub> = −2 mA                                                            | 25°C                        | 3.5        | 3.9              | 3.5     |             | 3.9              |     |       |
|                  |                                                                       |              |                                                                                   | Full range                  | 3.3        |                  |         |             |                  |     |       |
|                  |                                                                       |              | I <sub>O</sub> = −20 mA                                                           | 25°C                        | 1.5        | 2.3              | 1.5     |             | 2.3              |     |       |
|                  |                                                                       |              |                                                                                   | Full range                  | 1.4        |                  |         |             |                  |     |       |
| V <sub>OM−</sub> | Maximum negative peak output voltage swing                            |              | I <sub>O</sub> = 200 μA                                                           | 25°C                        | −3.8       | −4.2             | −3.8    |             | −4.2             | V   |       |
|                  |                                                                       |              |                                                                                   | Full range                  | −3.6       |                  |         |             |                  |     |       |
|                  |                                                                       |              | I <sub>O</sub> = 2 mA                                                             | 25°C                        | −3.5       | −4.1             | −3.5    |             | −4.1             |     |       |
|                  |                                                                       |              |                                                                                   | Full range                  | −3.3       |                  |         |             |                  |     |       |
|                  |                                                                       |              | I <sub>O</sub> = 20 mA                                                            | 25°C                        | −1.5       | −2.4             | −1.5    |             | −2.4             |     |       |
|                  |                                                                       |              |                                                                                   | Full range                  | −1.4       |                  |         |             |                  |     |       |
| A <sub>VD</sub>  | Large-signal differential voltage amplification                       |              | V <sub>O</sub> = ± 2.3 V                                                          | R <sub>L</sub> = 600 Ω      | 25°C       | 80               | 91      | 80          |                  | 91  | dB    |
|                  |                                                                       |              |                                                                                   |                             | Full range | 78               |         |             |                  |     |       |
|                  |                                                                       |              |                                                                                   | R <sub>L</sub> = 2 kΩ       | 25°C       | 90               | 100     | 90          |                  | 100 |       |
|                  |                                                                       |              |                                                                                   |                             | Full range | 88               |         |             |                  |     |       |
|                  |                                                                       |              |                                                                                   | R <sub>L</sub> = 10 kΩ      | 25°C       | 95               | 106     | 95          |                  | 106 |       |
|                  |                                                                       |              |                                                                                   |                             | Full range | 93               |         |             |                  |     |       |
| r <sub>i</sub>   | Input resistance                                                      |              | V <sub>IC</sub> = 0                                                               |                             | 25°C       | 10 <sup>12</sup> |         |             | 10 <sup>12</sup> |     | Ω     |
| c <sub>i</sub>   | Input capacitance                                                     | Common mode  | V <sub>IC</sub> = 0, See Figure 5                                                 |                             | 25°C       | 11               |         |             | 11               |     | pF    |
|                  |                                                                       | Differential |                                                                                   |                             | 25°C       | 2.5              |         |             | 2.5              |     |       |
| z <sub>o</sub>   | Open-loop output impedance                                            |              | f = 1 MHz                                                                         |                             | 25°C       | 80               |         |             | 80               |     | Ω     |
| CMRR             | Common-mode rejection ratio                                           |              | V <sub>IC</sub> = V <sub>ICRmin</sub> , V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω |                             | 25°C       | 70               | 89      | 70          |                  | 89  | dB    |
|                  |                                                                       |              |                                                                                   |                             | Full range | 68               |         |             | 68               |     |       |
| k <sub>SVR</sub> | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) |              | V <sub>CC±</sub> = ±5 V to ±15 V, V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω       |                             | 25°C       | 82               | 99      | 82          |                  | 99  | dB    |
|                  |                                                                       |              |                                                                                   |                             | Full range | 80               |         |             | 80               |     |       |

$^\dagger$  Full range is  $-40^\circ C$  to  $125^\circ C$ .

**TLE207x-Q1, TLE207xA-Q1**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
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**TLE2074-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted) (continued)**

| PARAMETER                                 | TEST CONDITIONS                     | $T_A^\dagger$   | TLE2074-Q1 |     |     | TLE2074A-Q1 |     |     | UNIT |
|-------------------------------------------|-------------------------------------|-----------------|------------|-----|-----|-------------|-----|-----|------|
|                                           |                                     |                 | MIN        | TYP | MAX | MIN         | TYP | MAX |      |
| $I_{CC}$ Supply current (four amplifiers) | $V_O = 0$ , No load                 | 25°C            | 5.2        | 6.3 | 7.5 | 5.2         | 6.3 | 7.5 | mA   |
|                                           |                                     | Full range      |            |     | 7.5 |             |     | 7.5 |      |
| Crosstalk attenuation                     | $V_{IC} = 0$ , $R_L = 2$ k $\Omega$ | 25°C            |            | 120 |     |             | 120 |     | dB   |
| $I_{OS}$ Short-circuit output current     | $V_O = 0$                           | $V_{ID} = 1$ V  |            | -35 |     |             | -35 |     | mA   |
|                                           |                                     | $V_{ID} = -1$ V |            | 45  |     |             | 45  |     |      |

$^\dagger$  Full range is -40°C to 125°C.

**TLE2074-Q1 operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V**

| PARAMETER          |                                             | TEST CONDITIONS                                                                                                               |                                                 | T <sub>A</sub> <sup>†</sup> | TLE2074-Q1   |     |     | TLE2074A-Q1  |     |     | UNIT   |
|--------------------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------|--------------|-----|-----|--------------|-----|-----|--------|
|                    |                                             |                                                                                                                               |                                                 |                             | MIN          | TYP | MAX | MIN          | TYP | MAX |        |
| SR+                | Positive slew rate                          | V <sub>O(PP)</sub> = ±2.3 V,<br>A <sub>VD</sub> = −1,<br>C <sub>L</sub> = 100 pF,      R <sub>L</sub> = 2 kΩ,<br>See Figure 1 |                                                 | 25°C                        | 35           |     |     | 35           |     |     | V/μs   |
|                    |                                             |                                                                                                                               |                                                 | Full range                  | 18           |     |     | 18           |     |     |        |
| SR−                | Negative slew rate                          |                                                                                                                               |                                                 | 25°C                        | 38           |     |     | 38           |     |     | V/μs   |
|                    |                                             |                                                                                                                               |                                                 | Full range                  | 18           |     |     | 18           |     |     |        |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1,<br>2-V step,<br>R <sub>L</sub> = 1 kΩ,<br>C <sub>L</sub> = 100 pF                                       | To 10 mV                                        | 25°C                        | 0.25         |     |     | 0.25         |     |     | μs     |
|                    |                                             |                                                                                                                               | To 1 mV                                         |                             | 0.4          |     |     | 0.4          |     |     |        |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω,<br>See Figure 3                                                                                        | f = 10 Hz                                       | 25°C                        | 28      55   |     |     | 28      55   |     |     | nV/√Hz |
|                    |                                             |                                                                                                                               | f = 10 kHz                                      |                             | 11.6      17 |     |     | 11.6      17 |     |     |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage |                                                                                                                               | f = 10 Hz to 10 kHz                             | 25°C                        | 6            |     |     | 6            |     |     | μV     |
|                    |                                             |                                                                                                                               | f = 0.1 Hz to 10 Hz                             |                             | 0.6          |     |     | 0.6          |     |     |        |
| I <sub>n</sub>     | Equivalent input noise current              | V <sub>IC</sub> = 0,                                                                                                          | f = 10 kHz                                      | 25°C                        | 2.8          |     |     | 2.8          |     |     | fA/√Hz |
| THD + N            | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 5 V,<br>f = 1 kHz,<br>R <sub>S</sub> = 25 Ω                                                              | A <sub>VD</sub> = 10,<br>R <sub>L</sub> = 2 kΩ, | 25°C                        | 0.013%       |     |     | 0.013%       |     |     |        |
| B <sub>1</sub>     | Unity-gain bandwidth                        | V <sub>I</sub> = 10 mV,<br>C <sub>L</sub> = 25 pF,                                                                            | R <sub>L</sub> = 2 kΩ,<br>See Figure 2          | 25°C                        | 9.4          |     |     | 9.4          |     |     | MHz    |
| B <sub>OM</sub>    | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 4 V,<br>R <sub>L</sub> = 2 kΩ,                                                                           | A <sub>VD</sub> = −1,<br>C <sub>L</sub> = 25 pF | 25°C                        | 2.8          |     |     | 2.8          |     |     | MHz    |
| f <sub>m</sub>     | Phase margin at unity gain                  | V <sub>I</sub> = 10 mV,<br>C <sub>L</sub> = 25 pF,                                                                            | R <sub>L</sub> = 2 kΩ,<br>See Figure 2          | 25°C                        | 56           |     |     | 56           |     |     |        |

$^\dagger$  Full range is -40°C to 125°C.

# TLE207x-Q1, TLE207xA-Q1

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT OPERATIONAL AMPLIFIERS

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**TLE2074-Q1 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> | TLE2074-Q1       |             |           | TLE2074A-Q1      |             |     | UNIT  |
|------------------|-----------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------|--|-----------------------------|------------------|-------------|-----------|------------------|-------------|-----|-------|
|                  |                                                                       |              |                                                                                   |  |                             | MIN              | TYP         | MAX       | MIN              | TYP         | MAX |       |
| V <sub>IO</sub>  | Input offset voltage                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0,<br>R <sub>S</sub> = 50 Ω                 |  | 25°C                        | −1.6             |             | 7         | −0.5             |             | 4   | mV    |
|                  |                                                                       |              |                                                                                   |  | Full range                  |                  |             | 11        |                  |             | 9   |       |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                       |              |                                                                                   |  | Full range                  | 10.1             |             | 10.1      |                  | 30          |     | μV/°C |
| I <sub>IO</sub>  | Input offset current                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0,<br>See Figure 4                          |  | 25°C                        | 15               |             | 100       | 15               |             | 100 | pA    |
|                  |                                                                       |              |                                                                                   |  | Full range                  | 20               |             | 20        |                  |             |     |       |
| I <sub>IB</sub>  | Input bias current                                                    |              |                                                                                   |  | 25°C                        | 25               |             | 175       | 25               |             | 175 | pA    |
|                  |                                                                       |              |                                                                                   |  | Full range                  | 60               |             | 60        |                  |             |     |       |
| V <sub>ICR</sub> | Common-mode input voltage range                                       |              | R <sub>S</sub> = 50 Ω                                                             |  | 25°C                        | 15 to −11        | 15 to −11.9 | 15 to −11 |                  | 15 to −11.9 | V   |       |
|                  |                                                                       |              |                                                                                   |  | Full range                  | 15 to −10.8      | 15 to −10.8 |           |                  |             |     |       |
| V <sub>OM+</sub> | Maximum positive peak output voltage swing                            |              | I <sub>O</sub> = −200 μA                                                          |  | 25°C                        | 13.8             | 14.1        | 13.8      |                  | 14.1        | V   |       |
|                  |                                                                       |              |                                                                                   |  | Full range                  | 13.6             | 13.6        |           |                  |             |     |       |
|                  |                                                                       |              | I <sub>O</sub> = −2 mA                                                            |  | 25°C                        | 13.5             | 13.9        | 13.5      |                  | 13.9        |     |       |
|                  |                                                                       |              |                                                                                   |  | Full range                  | 13.3             | 13.3        |           |                  |             |     |       |
|                  |                                                                       |              | I <sub>O</sub> = −20 mA                                                           |  | 25°C                        | 11.5             | 12.3        | 11.5      |                  | 12.3        |     |       |
|                  |                                                                       |              |                                                                                   |  | Full range                  | 11.4             | 11.4        |           |                  |             |     |       |
| V <sub>OM−</sub> | Maximum negative peak output voltage swing                            |              | I <sub>O</sub> = 200 μA                                                           |  | 25°C                        | −13.8            | −14.2       | −13.8     |                  | −14.2       | V   |       |
|                  |                                                                       |              |                                                                                   |  | Full range                  | −13.6            | −13.6       |           |                  |             |     |       |
|                  |                                                                       |              | I <sub>O</sub> = 2 mA                                                             |  | 25°C                        | −13.5            | −14         | −13.5     |                  | −14         |     |       |
|                  |                                                                       |              |                                                                                   |  | Full range                  | −13.3            | −13.3       |           |                  |             |     |       |
|                  |                                                                       |              | I <sub>O</sub> = 20 mA                                                            |  | 25°C                        | −11.5            | −12.4       | −11.5     |                  | −12.4       |     |       |
|                  |                                                                       |              |                                                                                   |  | Full range                  | −11.4            | −11.4       |           |                  |             |     |       |
| A <sub>VD</sub>  | Large-signal differential voltage amplification                       |              | V <sub>O</sub> = ±10 V                                                            |  | R <sub>L</sub> = 600 Ω      | 25°C             | 80          | 96        | 80               |             | 96  | dB    |
|                  |                                                                       |              |                                                                                   |  |                             | Full range       | 78          | 78        |                  |             |     |       |
|                  |                                                                       |              |                                                                                   |  | R <sub>L</sub> = 2 kΩ       | 25°C             | 90          | 109       | 90               |             | 109 |       |
|                  |                                                                       |              |                                                                                   |  |                             | Full range       | 88          | 88        |                  |             |     |       |
|                  |                                                                       |              |                                                                                   |  | R <sub>L</sub> = 10 kΩ      | 25°C             | 95          | 118       | 95               |             | 118 |       |
|                  |                                                                       |              |                                                                                   |  |                             | Full range       | 93          | 93        |                  |             |     |       |
| r <sub>i</sub>   | Input resistance                                                      |              | V <sub>IC</sub> = 0                                                               |  | 25°C                        | 10 <sup>12</sup> |             |           | 10 <sup>12</sup> |             | Ω   |       |
| c <sub>i</sub>   | Input capacitance                                                     | Common mode  | V <sub>IC</sub> = 0, See Figure 5                                                 |  | 25°C                        | 7.5              |             |           | 7.5              |             | pF  |       |
|                  |                                                                       | Differential |                                                                                   |  | 25°C                        | 2.5              |             |           | 2.5              |             |     |       |
| z <sub>o</sub>   | Open-loop output impedance                                            |              | f = 1 MHz                                                                         |  | 25°C                        | 80               |             |           | 80               |             | Ω   |       |
| CMRR             | Common-mode rejection ratio                                           |              | V <sub>IC</sub> = V <sub>ICRmin</sub> , V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω |  | 25°C                        | 80               | 98          | 80        |                  | 98          | dB  |       |
|                  |                                                                       |              |                                                                                   |  | Full range                  | 78               | 78          |           |                  |             |     |       |
| k <sub>SVR</sub> | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) |              | V <sub>CC±</sub> = ±5 V to ±15 V, V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω       |  | 25°C                        | 82               | 99          | 82        |                  | 99          | dB  |       |
|                  |                                                                       |              |                                                                                   |  | Full range                  | 80               | 80          |           |                  |             |     |       |

$^\dagger$  Full range is  $-40^\circ C$  to  $125^\circ C$ .

**TLE207x-Q1, TLE207xA-Q1**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT OPERATIONAL AMPLIFIERS**

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**TLE2074-Q1 electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted) (continued)**

| PARAMETER             |                                     | TEST CONDITIONS      |                        | T <sub>A</sub> <sup>†</sup> | TLE2074-Q1 |     |     | TLE2074A-Q1 |     |     | UNIT |
|-----------------------|-------------------------------------|----------------------|------------------------|-----------------------------|------------|-----|-----|-------------|-----|-----|------|
|                       |                                     |                      |                        |                             | MIN        | TYP | MAX | MIN         | TYP | MAX |      |
| I <sub>CC</sub>       | Supply current<br>(four amplifiers) | V <sub>O</sub> = 0,  | No load                | 25°C                        | 5.2        | 6.5 | 7.5 | 5.2         | 6.5 | 7.5 | mA   |
|                       |                                     |                      |                        | Full range                  | 7.5        |     |     | 7.5         |     |     |      |
| Crosstalk attenuation |                                     | V <sub>IC</sub> = 0, | R <sub>L</sub> = 2 kΩ  | 25°C                        | 120        |     |     | 120         |     |     | dB   |
| I <sub>OS</sub>       | Short-circuit output current        | V <sub>O</sub> = 0   | V <sub>ID</sub> = 1 V  | 25°C                        | -30        | -45 |     | -30         | -45 |     | mA   |
|                       |                                     |                      | V <sub>ID</sub> = -1 V |                             | 30         | 48  |     | 30          | 48  |     |      |

$^\dagger$  Full range is -40°C to 125°C.

**TLE2074-Q1 operating characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V**

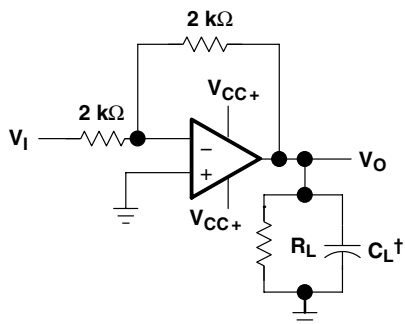
| PARAMETER          |                                             | TEST CONDITIONS                                                                                               |                                              | T <sub>A</sub> <sup>†</sup> | TLE2074-Q1 |     |        | TLE2074A-Q1 |        |        | UNIT |
|--------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------|------------|-----|--------|-------------|--------|--------|------|
|                    |                                             |                                                                                                               |                                              |                             | MIN        | TYP | MAX    | MIN         | TYP    | MAX    |      |
| SR +               | Positive slew rate                          | V <sub>O(PP)</sub> = 10 V, A <sub>VD</sub> = −1, R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, See Figure 1 |                                              | 25°C                        | 25         | 40  |        | 25          | 40     |        | V/μs |
|                    |                                             |                                                                                                               |                                              | Full range                  | 17         |     |        | 17          |        |        |      |
| SR −               | Negative slew rate                          |                                                                                                               |                                              | 25°C                        | 30         | 45  |        | 30          | 45     |        | V/μs |
|                    |                                             |                                                                                                               |                                              | Full range                  | 20         |     |        | 20          |        |        |      |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1, 10-V step, R <sub>L</sub> = 1 kΩ, C <sub>L</sub> = 100 pF                               | To 10 mV                                     | 25°C                        | 0.4        |     | 0.4    |             | μs     |        |      |
|                    |                                             |                                                                                                               | To 1 mV                                      |                             | 1.5        |     | 1.5    |             |        |        |      |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω, See Figure 3                                                                           | f = 10 Hz                                    | 25°C                        | 28         | 55  |        | 28          | 55     | nV/√Hz |      |
|                    |                                             |                                                                                                               | f = 10 kHz                                   |                             | 11.6       | 17  |        | 11.6        | 17     |        |      |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage |                                                                                                               | f = 10 Hz to 10 kHz                          | 25°C                        | 6          |     | 6      |             | μV     |        |      |
|                    |                                             |                                                                                                               | f = 0.1 Hz to 10 Hz                          |                             | 0.6        |     | 0.6    |             |        |        |      |
| I <sub>n</sub>     | Equivalent input noise current              | V <sub>IC</sub> = 0, f = 10 kHz                                                                               |                                              | 25°C                        | 2.8        |     | 2.8    |             | fA/√Hz |        |      |
| THD + N            | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 20 V, A <sub>VD</sub> = 10, f = 1 kHz, R <sub>L</sub> = 2 kΩ, R <sub>S</sub> = 25 Ω      |                                              | 25°C                        | 0.008%     |     | 0.008% |             |        |        |      |
| B <sub>1</sub>     | Unity-gain bandwidth                        | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF,                                                               | R <sub>L</sub> = 2 kΩ, See Figure 2          | 25°C                        | 8          | 10  |        | 8           | 10     | MHz    |      |
| B <sub>OM</sub>    | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ,                                                             | A <sub>VD</sub> = −1, C <sub>L</sub> = 25 pF | 25°C                        | 478        | 637 |        | 478         | 637    | kHz    |      |
| ϕ <sub>m</sub>     | Phase margin at unity gain                  | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF,                                                               | R <sub>L</sub> = 2 kΩ, See Figure 2          | 25°C                        | 57         |     | 57     |             |        |        |      |

$^\dagger$  Full range is -40°C to 125°C.

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

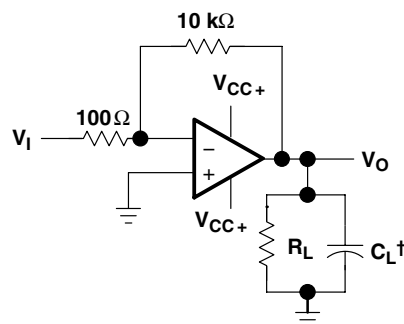
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## PARAMETER MEASUREMENT INFORMATION



† Includes fixture capacitance

Figure 1. Slew-Rate Test Circuit



† Includes fixture capacitance

Figure 2. Unity-Gain Bandwidth and Phase-Margin Test Circuit

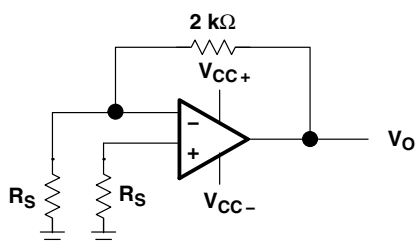


Figure 3. Noise-Voltage Test Circuit

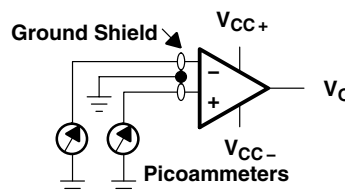


Figure 4. Input-Bias and Offset-Current Test Circuit

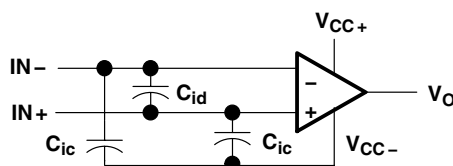


Figure 5. Internal Input Capacitance

## typical values

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

## input bias and offset current

At the picoampere bias current level typical of the TLE207x and TLE207xA, accurate measurement of the bias current becomes difficult. Not only does this measurement require a picoammeter but test socket leakages can easily exceed the actual device bias currents. To accurately measure these small currents, Texas Instruments uses a two-step process. The socket leakage is measured using picoammeters with bias voltages applied but with no device in the socket. The device is then inserted in the socket and a second test is performed that measures both the socket leakage and the device input bias current. The two measurements are then subtracted algebraically to determine the bias current of the device.

## TYPICAL CHARACTERISTICS

**Table of Graphs**

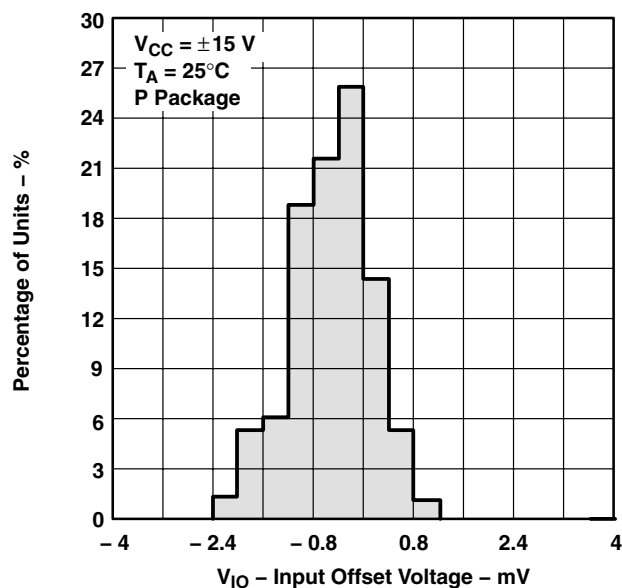
|                |                                                   |                                                                                | <b>FIGURE</b>                       |
|----------------|---------------------------------------------------|--------------------------------------------------------------------------------|-------------------------------------|
| $V_{IO}$       | Input offset voltage                              | Distribution                                                                   | 6, 7, 8                             |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage   | Distribution                                                                   | 9, 10, 11                           |
| $I_{IO}$       | Input offset current                              | vs Free-air temperature                                                        | 12, 13                              |
| $I_{IB}$       | Input bias current                                | vs Free-air temperature<br>vs Total supply voltage                             | 12, 13<br>14                        |
| $V_{ICR}$      | Common-mode input voltage range                   | vs Free-air temperature                                                        | 15                                  |
| $V_O$          | Output voltage                                    | vs Differential input voltage                                                  | 16, 17                              |
| $V_{OM+}$      | Maximum positive peak output voltage              | vs Output current                                                              | 18                                  |
| $V_{OM-}$      | Maximum negative peak output voltage              | vs Output current                                                              | 19                                  |
| $V_{OM}$       | Maximum peak output voltage                       | vs Free-air temperature<br>vs Supply voltage                                   | 20, 21<br>22                        |
| $V_{O(PP)}$    | Maximum peak-to-peak output voltage               | vs Frequency                                                                   | 23                                  |
| $V_O$          | Output voltage                                    | vs Settling time                                                               | 24                                  |
| $A_{VD}$       | Large-signal differential voltage amplification   | vs Load resistance<br>vs Free-air temperature                                  | 25<br>26, 27                        |
| $A_{VD}$       | Small-signal differential voltage amplification   | vs Frequency                                                                   | 28, 29                              |
| $CMRR$         | Common-mode rejection ratio                       | vs Frequency<br>vs Free-air temperature                                        | 30<br>31                            |
| $k_{SVR}$      | Supply-voltage rejection ratio                    | vs Frequency<br>vs Free-air temperature                                        | 32<br>33                            |
| $I_{CC}$       | Supply current                                    | vs Supply voltage<br>vs Free-air temperature<br>vs Differential input voltage  | 34, 35, 36<br>37, 38, 39<br>40 – 45 |
| $I_{OS}$       | Short-circuit output current                      | vs Supply voltage<br>vs Elapsed time<br>vs Free-air temperature                | 46<br>47<br>48                      |
| $SR$           | Slew rate                                         | vs Free-air temperature<br>vs Load resistance<br>vs Differential input voltage | 49, 50<br>51<br>52                  |
| $V_n$          | Equivalent Input noise voltage (spectral density) | vs Frequency                                                                   | 53                                  |
| $V_n$          | Input referred noise voltage                      | vs Noise bandwidth<br>Over a 10-second time interval                           | 54<br>55                            |
|                | Third-octave spectral noise density               | vs Frequency bands                                                             | 56                                  |
| $THD + N$      | Total harmonic distortion plus noise              | vs Frequency                                                                   | 57, 58                              |
| $B_1$          | Unity-gain bandwidth                              | vs Load capacitance                                                            | 59                                  |
|                | Gain-bandwidth product                            | vs Free-air temperature<br>vs Supply voltage                                   | 60<br>61                            |
|                | Gain margin                                       | vs Load capacitance                                                            | 62                                  |
| $\phi_m$       | Phase margin                                      | vs Free-air temperature<br>vs Supply voltage<br>vs Load capacitance            | 63<br>64<br>65                      |
|                | Phase shift                                       | vs Frequency                                                                   | 28, 29                              |
|                | Noninverting large-signal pulse response          | vs Time                                                                        | 66                                  |
|                | Small-signal pulse response                       | vs Time                                                                        | 67                                  |
| $z_o$          | Closed-loop output impedance                      | vs Frequency                                                                   | 68                                  |
|                | Crosstalk attenuation                             | vs Frequency                                                                   | 69                                  |

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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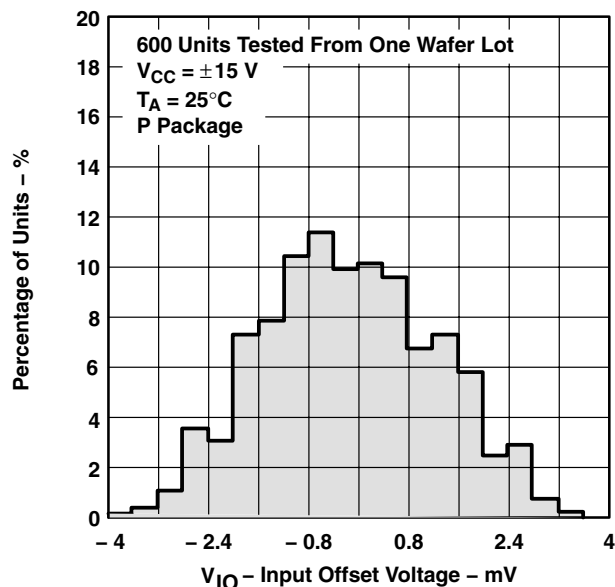
## TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLE2071  
INPUT OFFSET VOLTAGE**



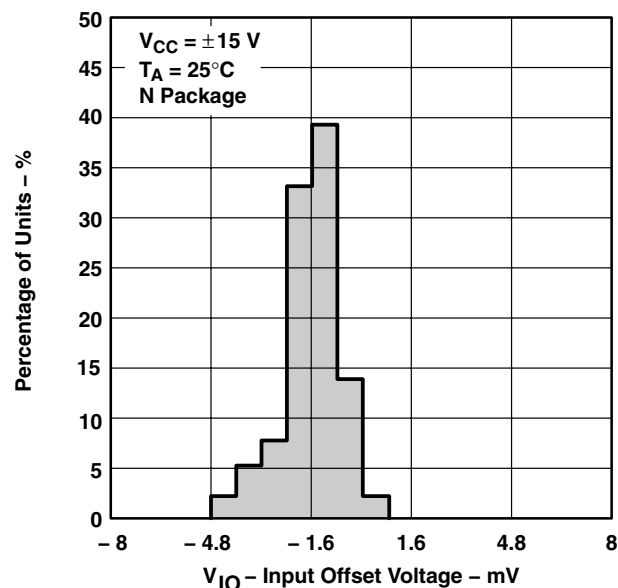
**Figure 6**

**DISTRIBUTION OF TLE2072  
INPUT OFFSET VOLTAGE**



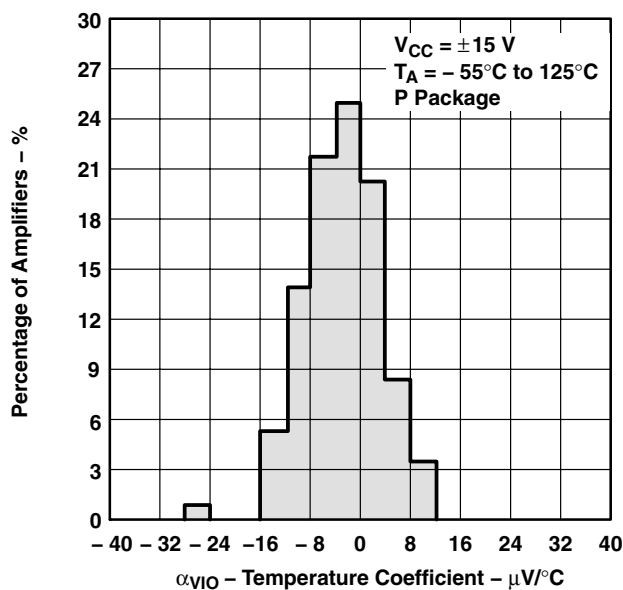
**Figure 7**

**DISTRIBUTION OF TLE2074  
INPUT OFFSET VOLTAGE**



**Figure 8**

**DISTRIBUTION OF TLE2071 INPUT OFFSET  
VOLTAGE TEMPERATURE COEFFICIENT**



**Figure 9**

## TYPICAL CHARACTERISTICS

**DISTRIBUTION OF TLE2072 INPUT OFFSET  
VOLTAGE TEMPERATURE COEFFICIENT**

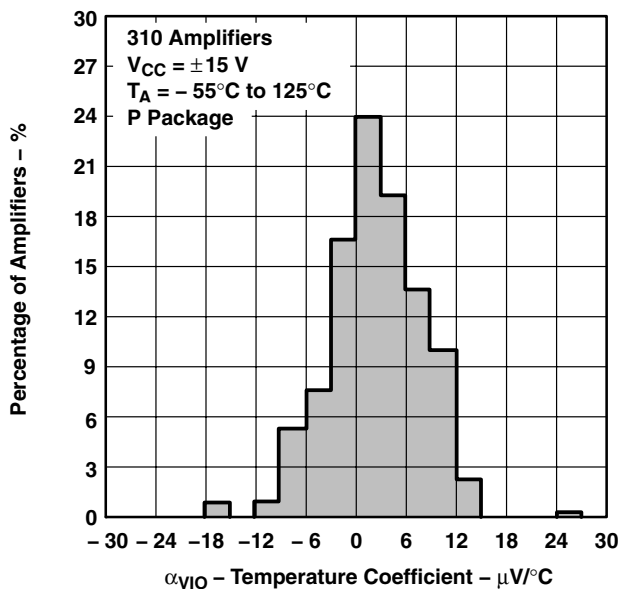


Figure 10

**DISTRIBUTION OF TLE2074 INPUT OFFSET  
VOLTAGE TEMPERATURE COEFFICIENT**

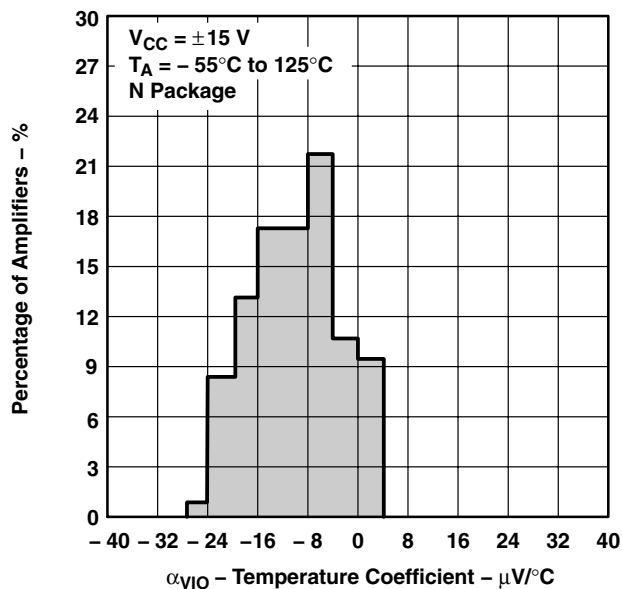


Figure 11

**INPUT BIAS CURRENT AND  
INPUT OFFSET CURRENT†  
vs  
FREE-AIR TEMPERATURE**

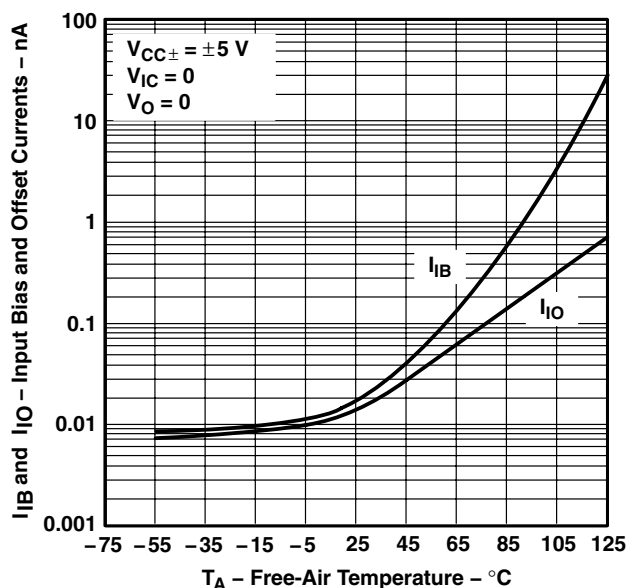


Figure 12

**INPUT BIAS CURRENT AND  
INPUT OFFSET CURRENT†  
vs  
FREE-AIR TEMPERATURE**

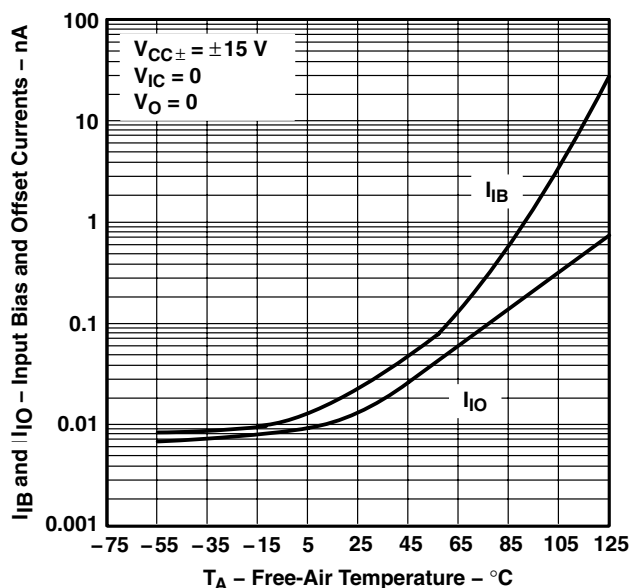


Figure 13

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

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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## TYPICAL CHARACTERISTICS

INPUT BIAS CURRENT  
vs  
TOTAL SUPPLY VOLTAGE

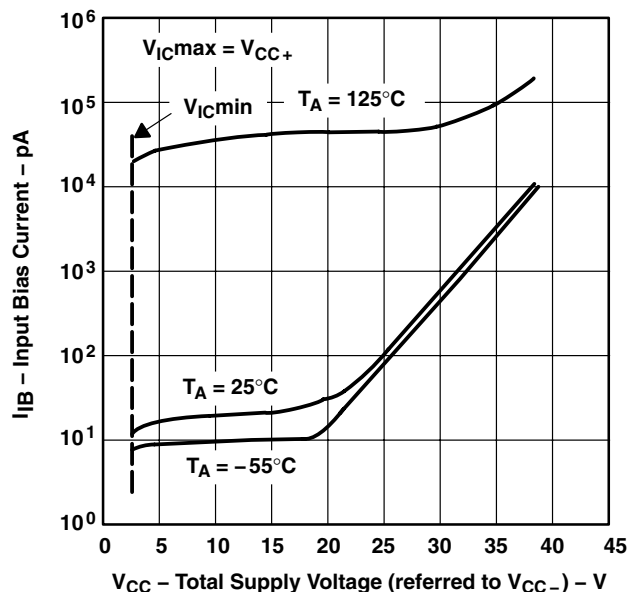


Figure 14

COMMON-MODE INPUT VOLTAGE RANGE†  
vs  
FREE-AIR TEMPERATURE

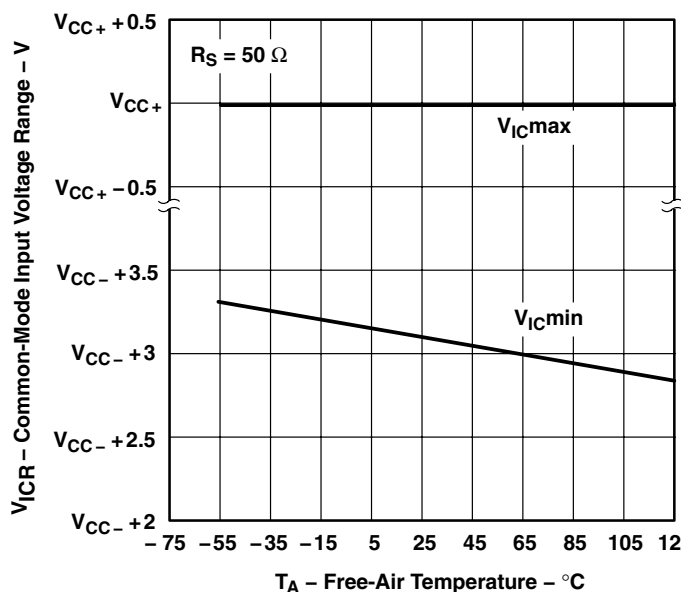


Figure 15

OUTPUT VOLTAGE  
vs  
DIFFERENTIAL INPUT VOLTAGE

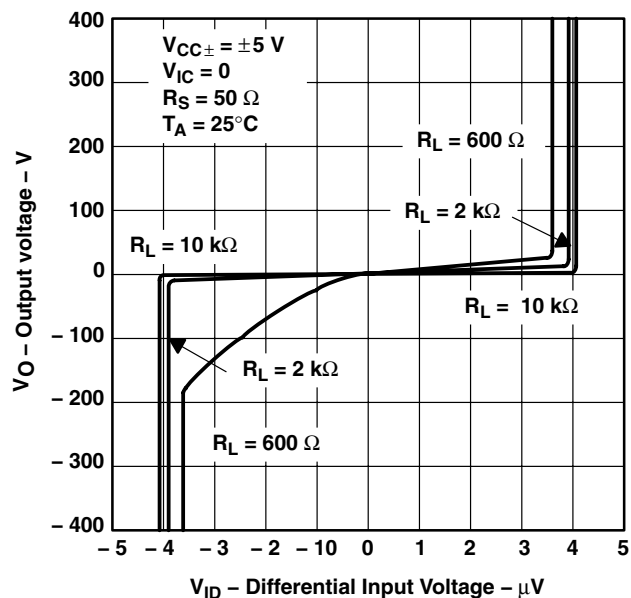


Figure 16

OUTPUT VOLTAGE  
vs  
DIFFERENTIAL INPUT VOLTAGE

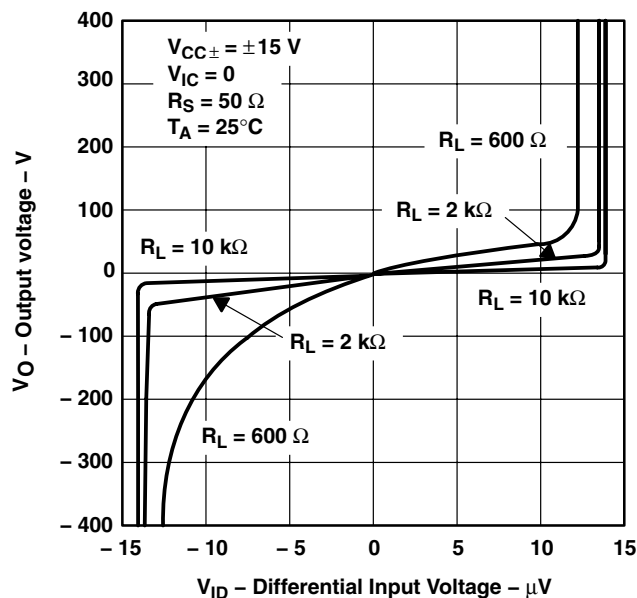


Figure 17

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

## TYPICAL CHARACTERISTICS

**MAXIMUM POSITIVE PEAK OUTPUT VOLTAGE†  
vs  
OUTPUT CURRENT**

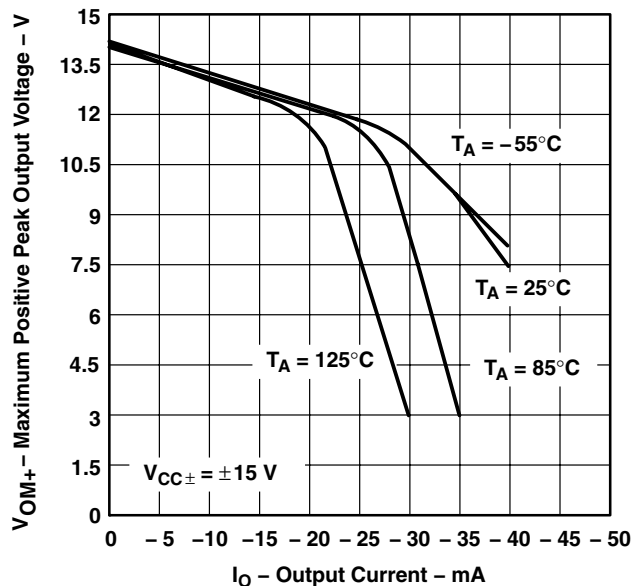


Figure 18

**MAXIMUM NEGATIVE PEAK OUTPUT VOLTAGE†  
vs  
OUTPUT CURRENT**

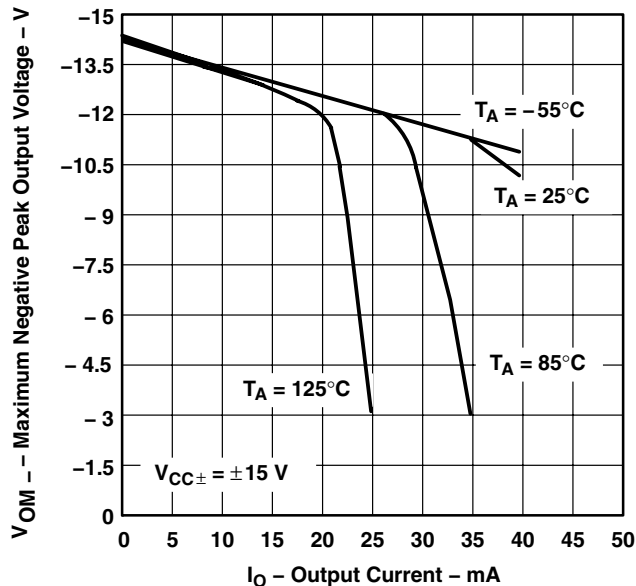


Figure 19

**MAXIMUM PEAK OUTPUT VOLTAGE†  
vs  
FREE-AIR TEMPERATURE**

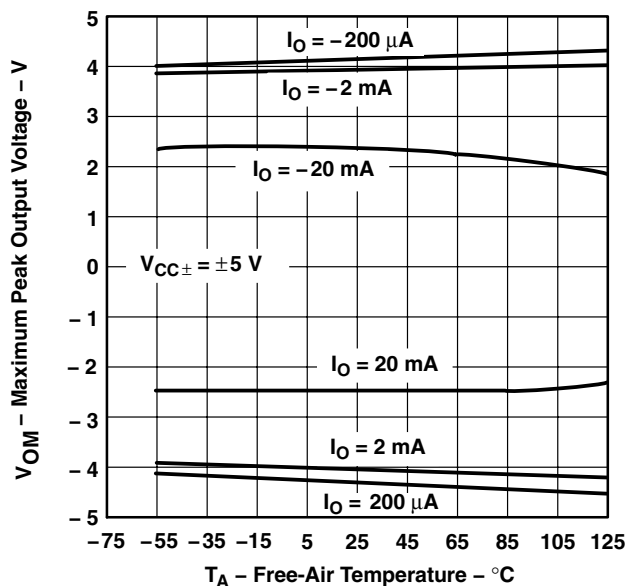


Figure 20

**MAXIMUM PEAK OUTPUT VOLTAGE†  
vs  
FREE-AIR TEMPERATURE**

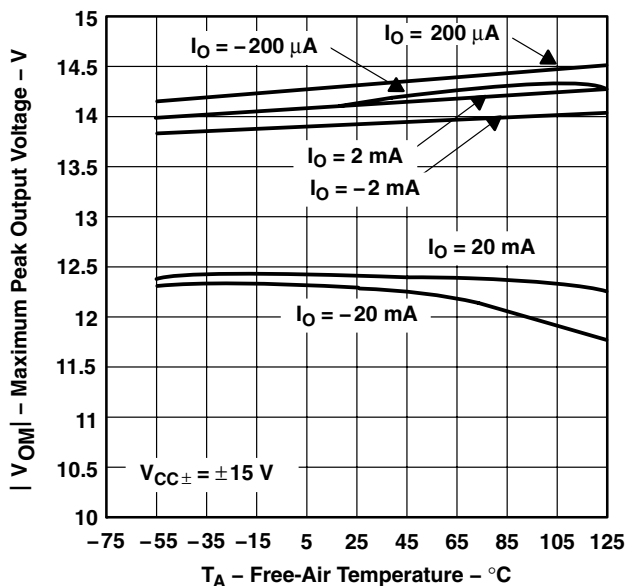


Figure 21

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

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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## TYPICAL CHARACTERISTICS

MAXIMUM PEAK OUTPUT VOLTAGE  
vs  
SUPPLY VOLTAGE

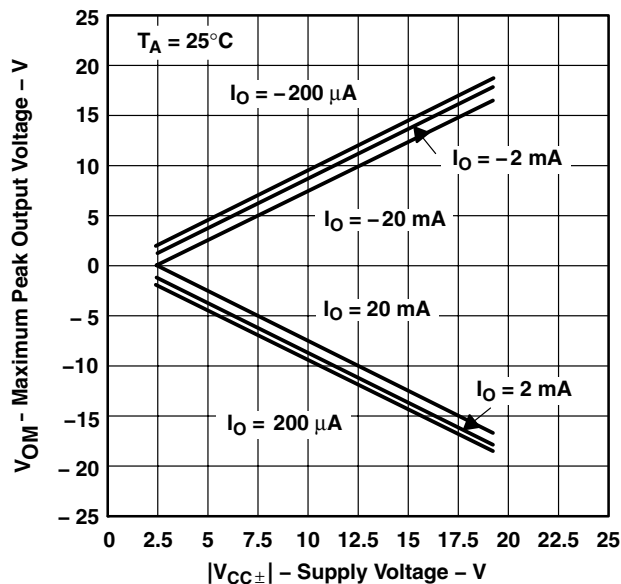


Figure 22

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE†  
vs  
FREQUENCY

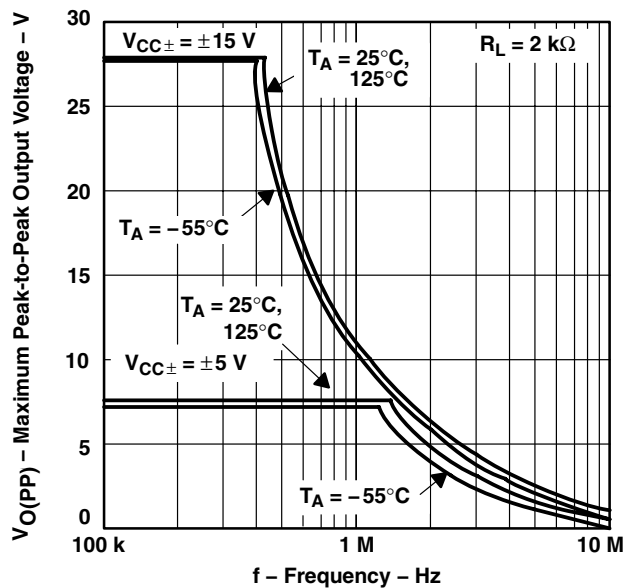


Figure 23

OUTPUT VOLTAGE  
vs  
SETTLING TIME

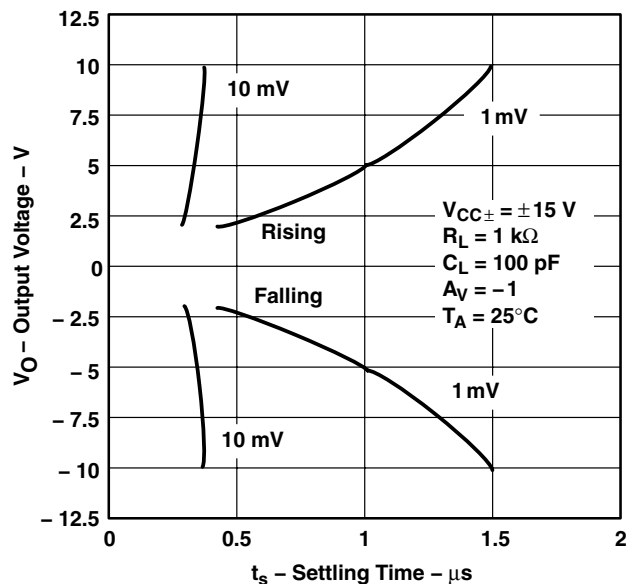


Figure 24

LARGE-SIGNAL DIFFERENTIAL  
VOLTAGE AMPLIFICATION  
vs  
LOAD RESISTANCE

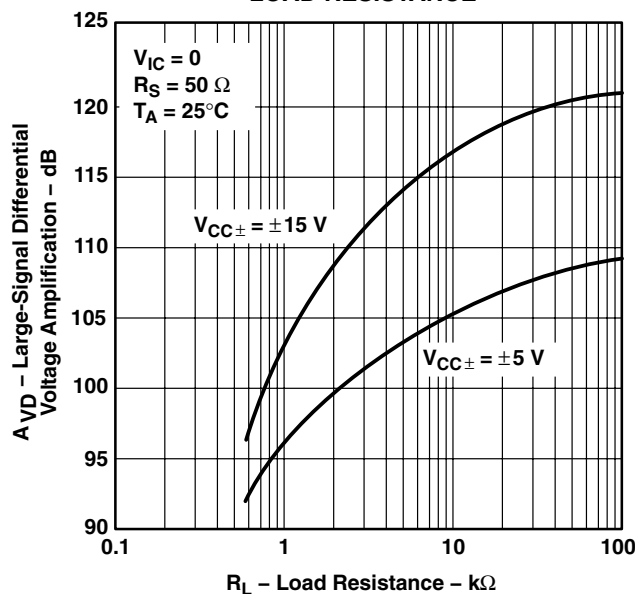


Figure 25

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

## TYPICAL CHARACTERISTICS

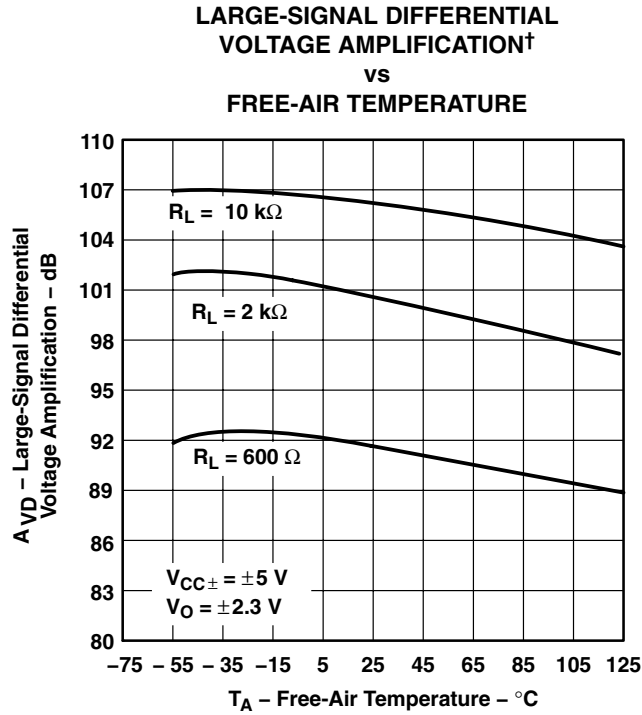


Figure 26

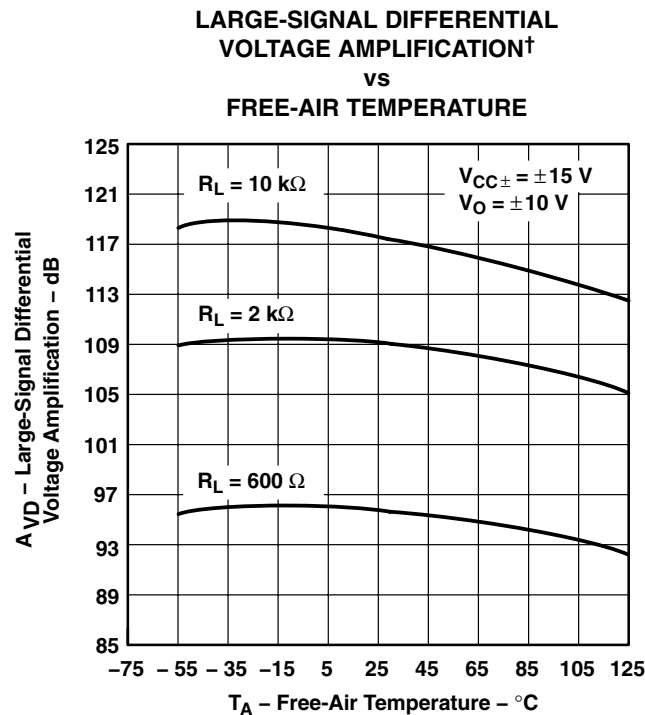


Figure 27

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

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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## TYPICAL CHARACTERISTICS

### SMALL-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT

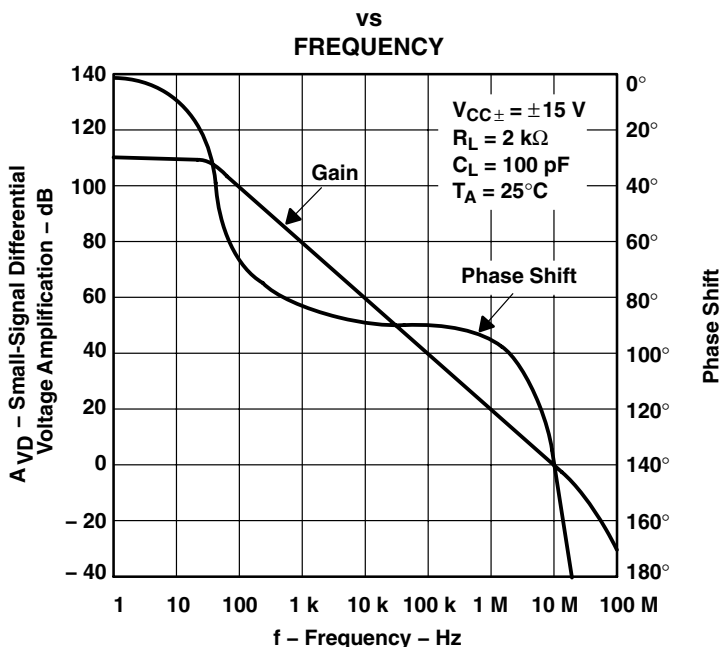


Figure 28

### SMALL-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT

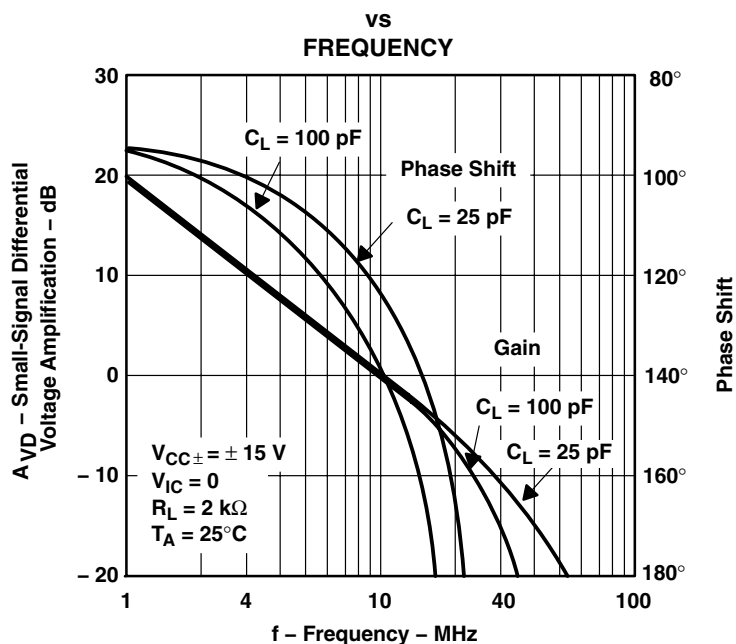


Figure 29

## TYPICAL CHARACTERISTICS

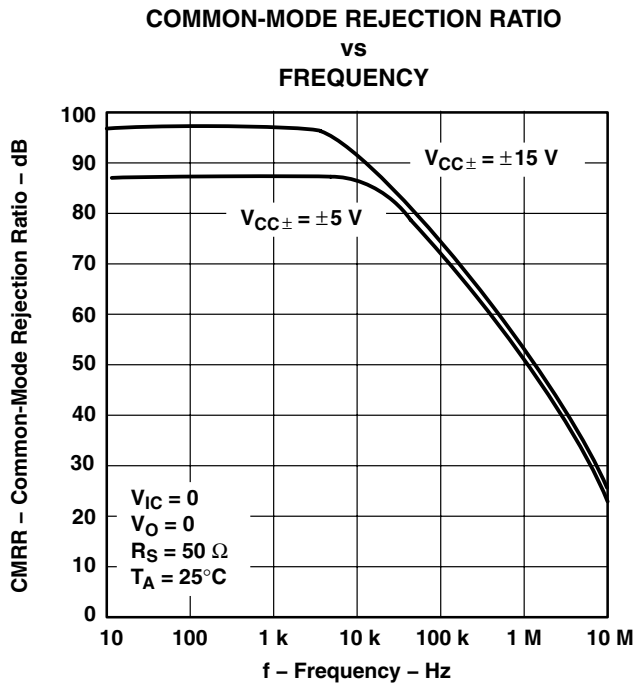


Figure 30

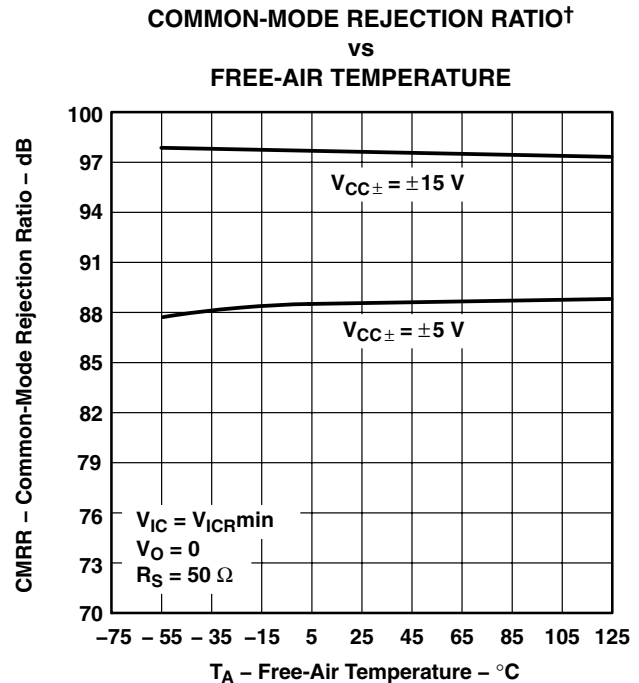


Figure 31

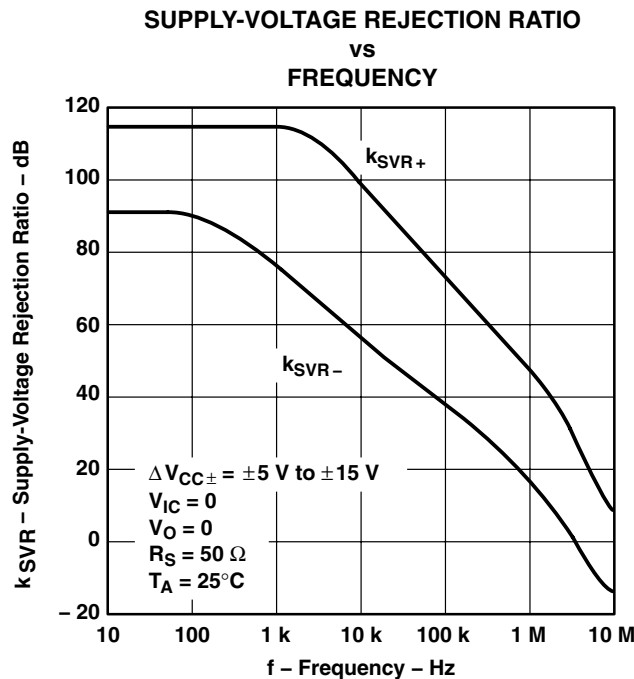


Figure 32

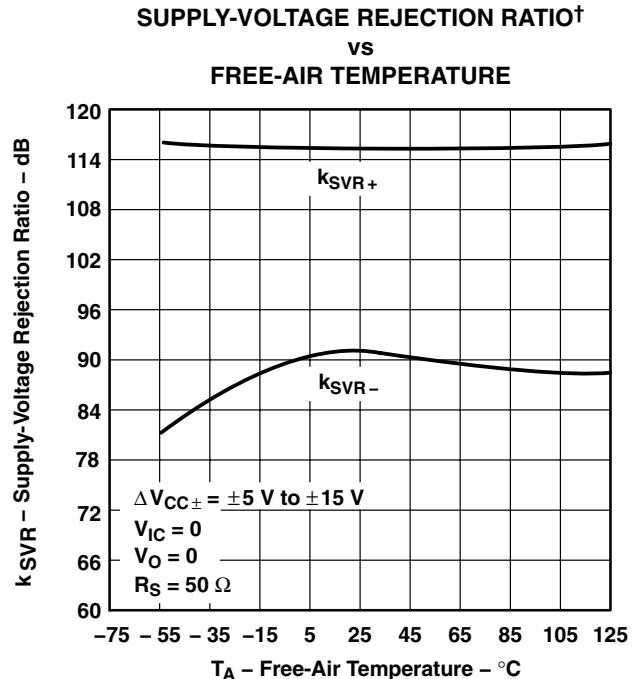


Figure 33

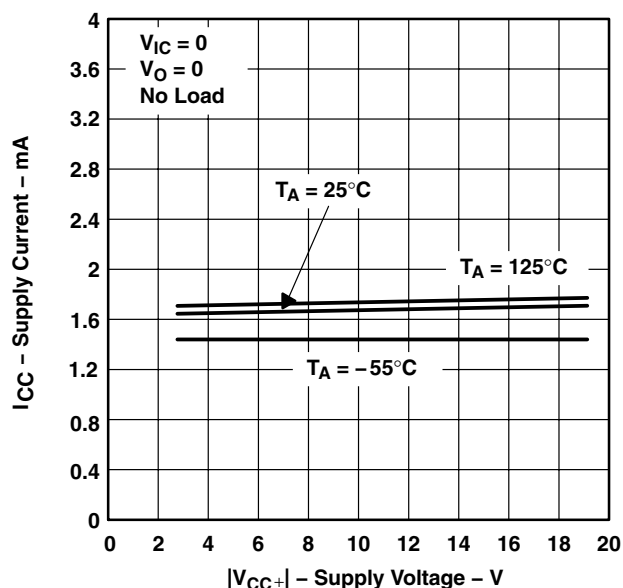
† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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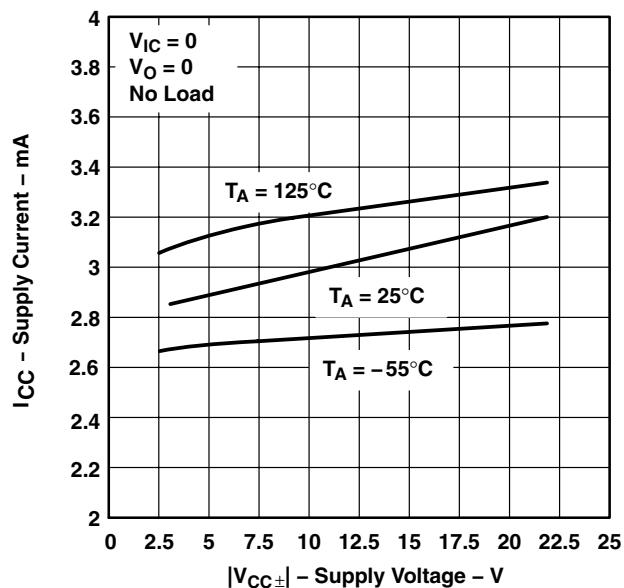
## TYPICAL CHARACTERISTICS

**TLE2071  
SUPPLY CURRENT  
vs  
SUPPLY VOLTAGE**



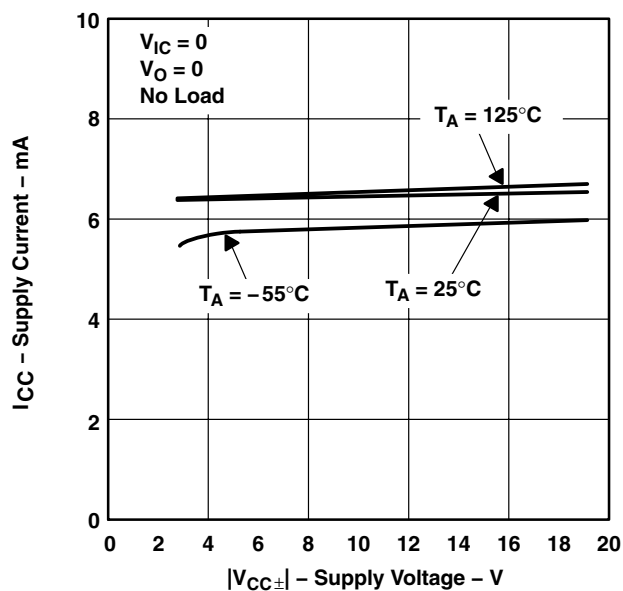
**Figure 34**

**TLE2072  
SUPPLY CURRENT  
vs  
SUPPLY VOLTAGE**



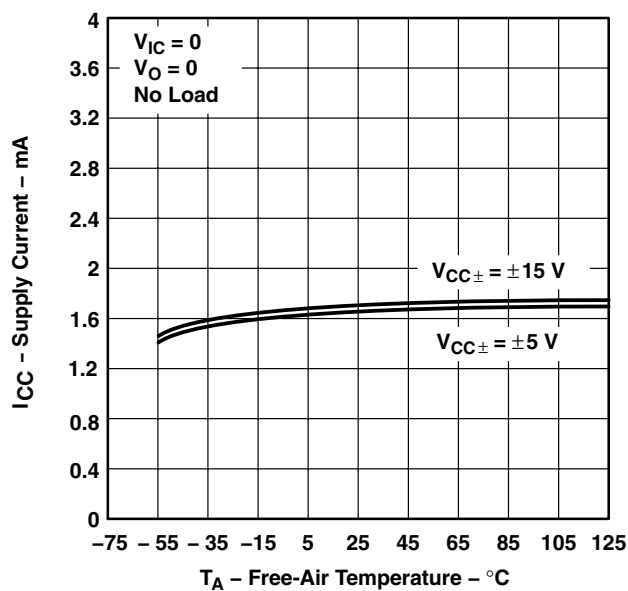
**Figure 35**

**TLE2074  
SUPPLY CURRENT  
vs  
SUPPLY VOLTAGE**



**Figure 36**

**TLE2071  
SUPPLY CURRENT†  
vs  
FREE-AIR TEMPERATURE**



**Figure 37**

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

## TYPICAL CHARACTERISTICS

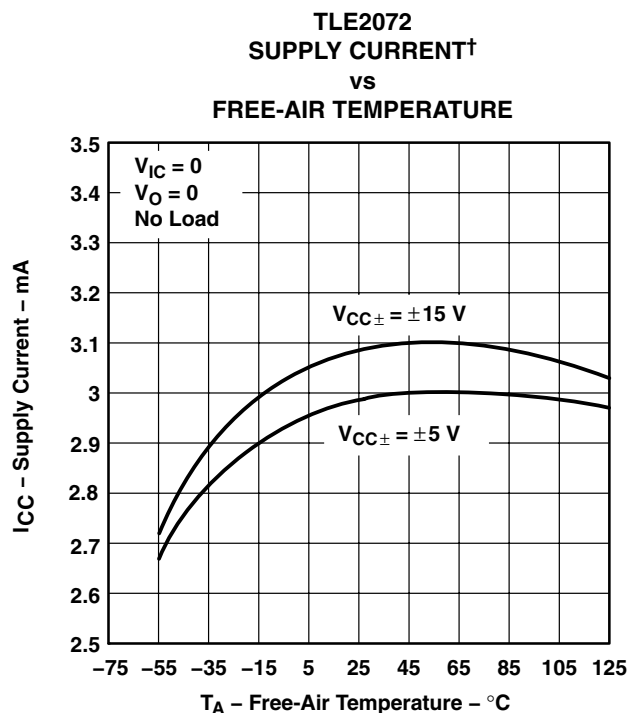


Figure 38

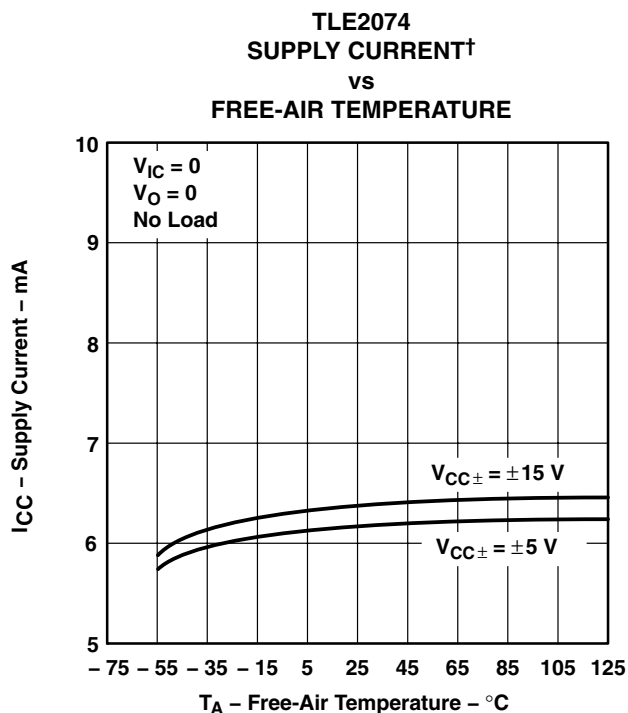


Figure 39

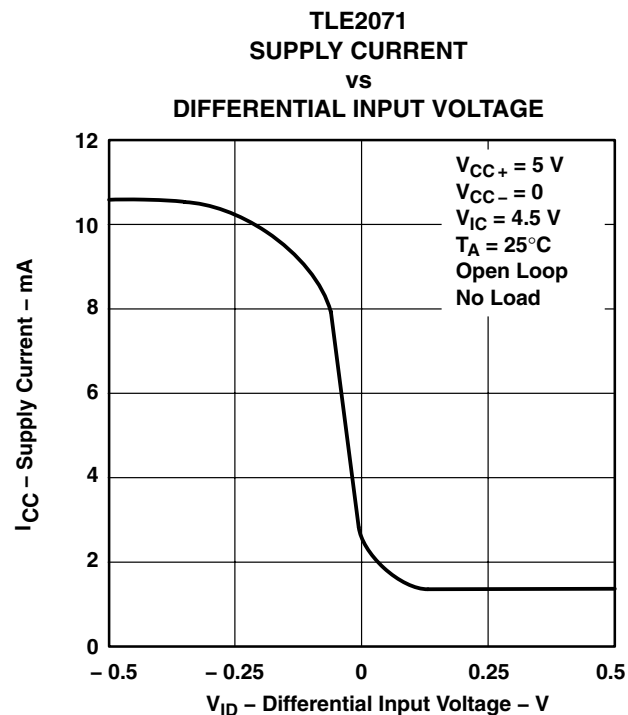


Figure 40

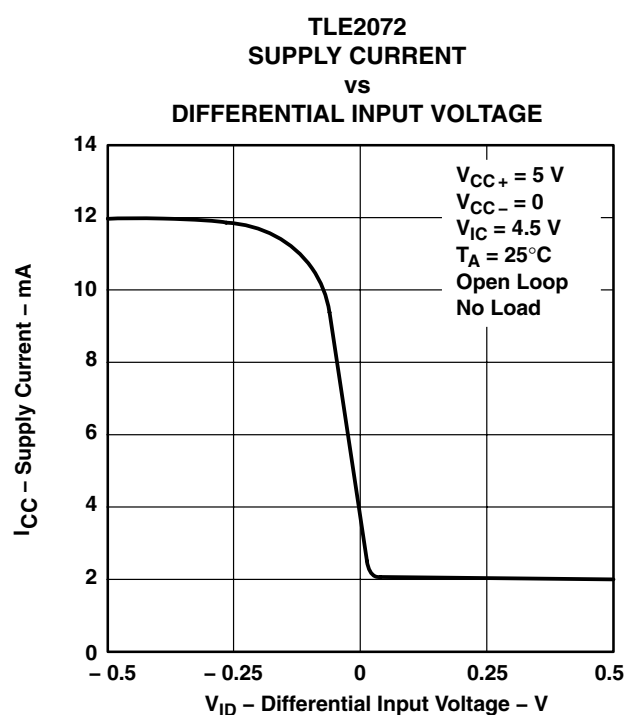


Figure 41

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

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

## TYPICAL CHARACTERISTICS

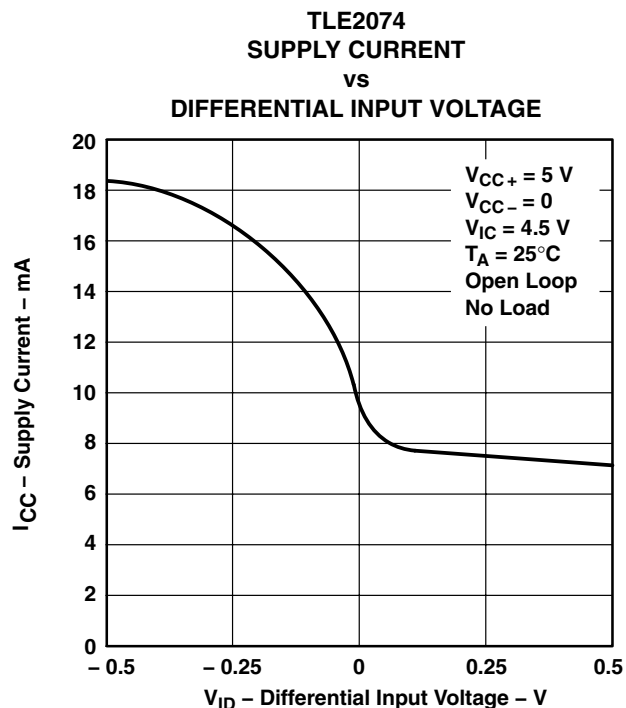


Figure 42

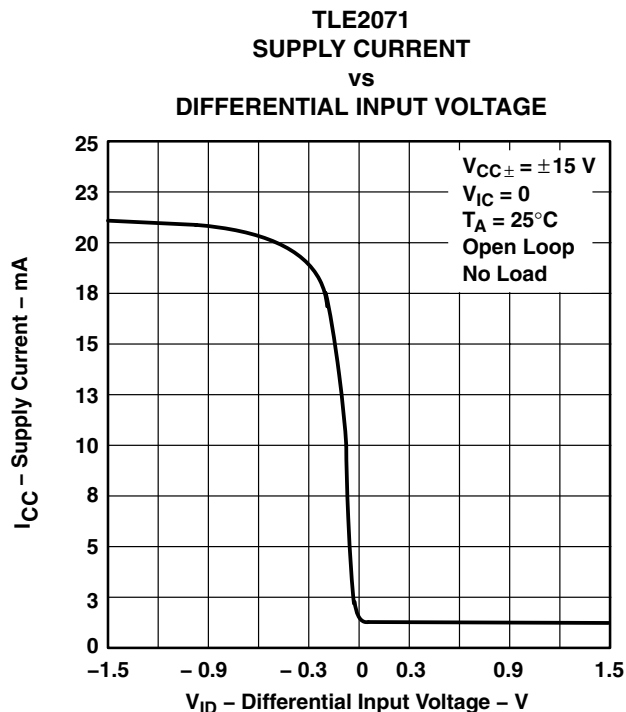


Figure 43

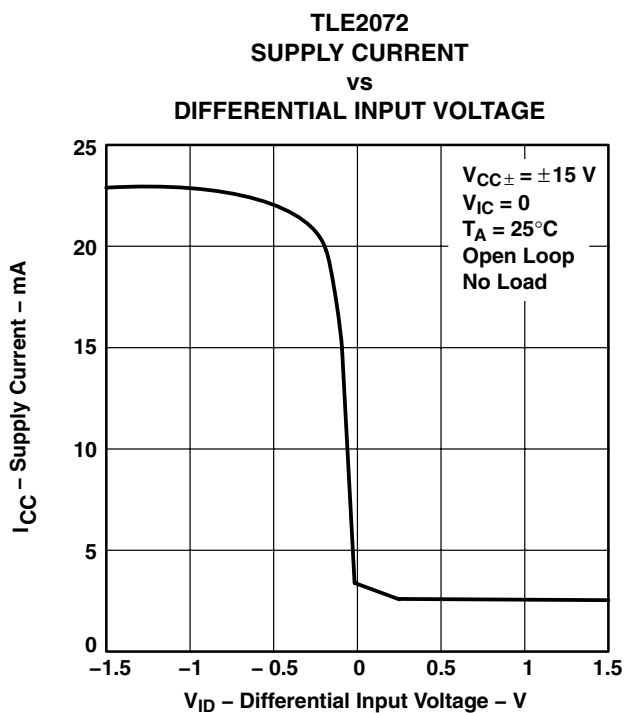


Figure 44

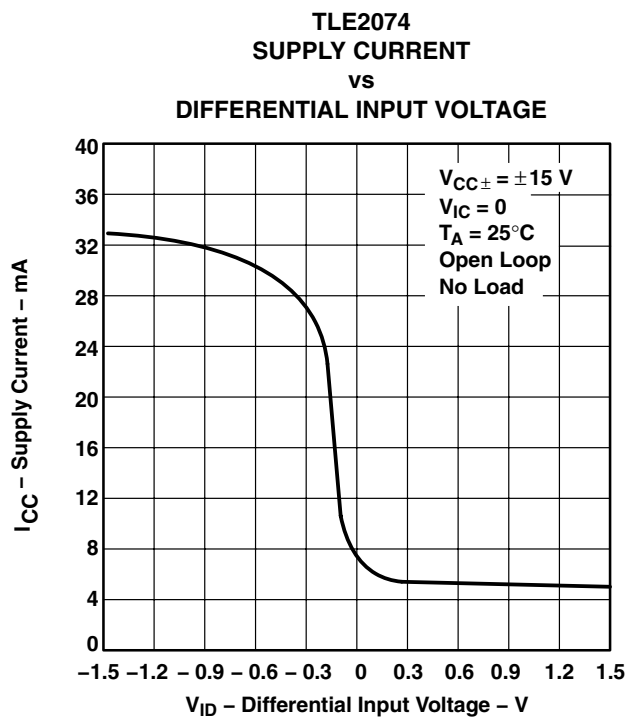
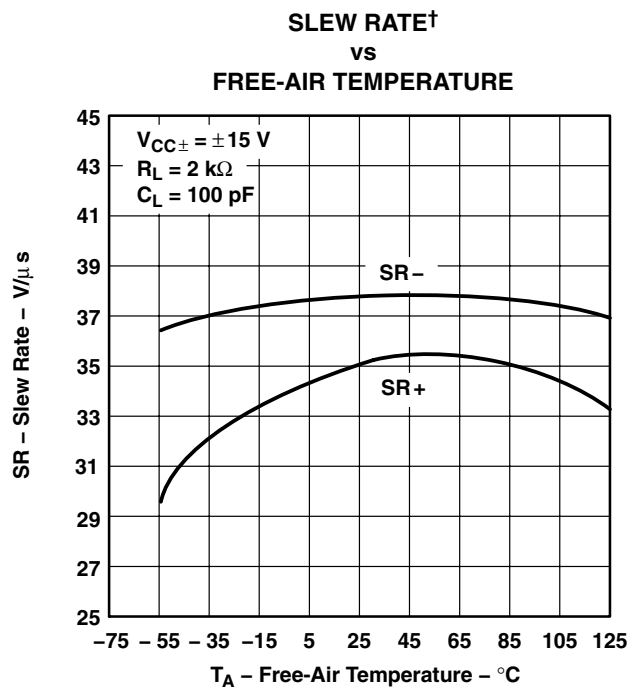
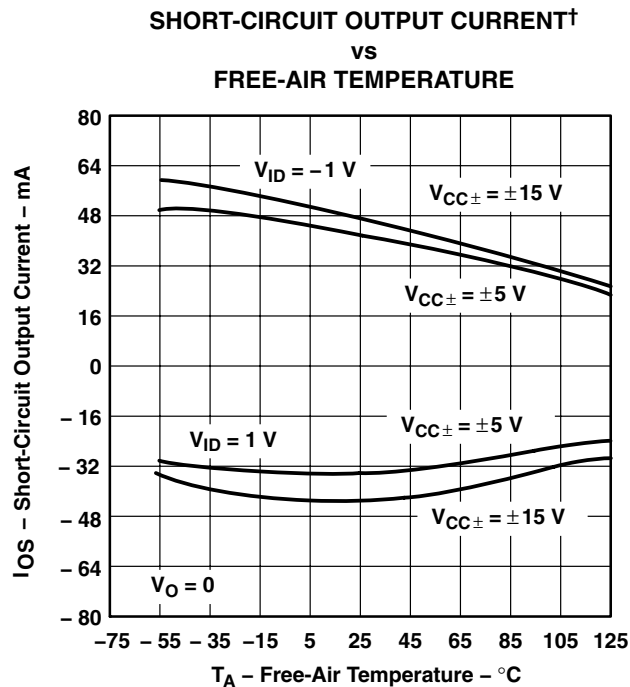
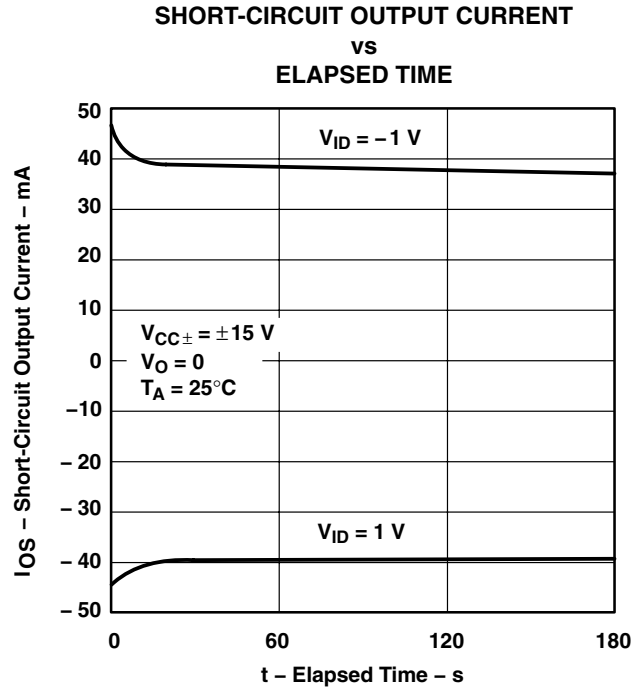
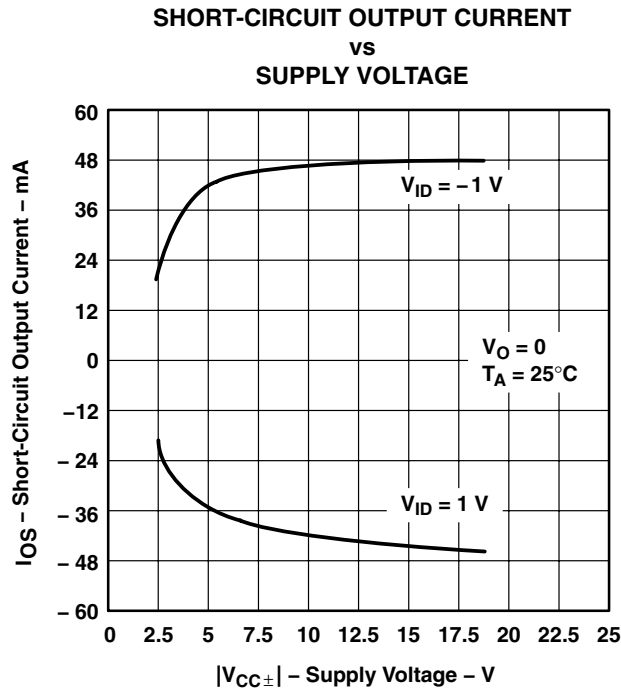


Figure 45

## TYPICAL CHARACTERISTICS



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

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

SGLS226A – DECEMBER 2003 – REVISED AUGUST 2004

## TYPICAL CHARACTERISTICS

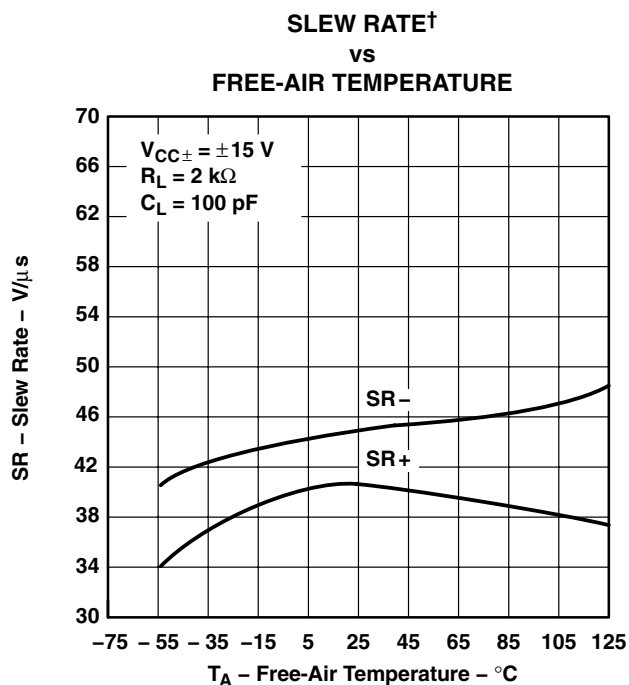


Figure 50

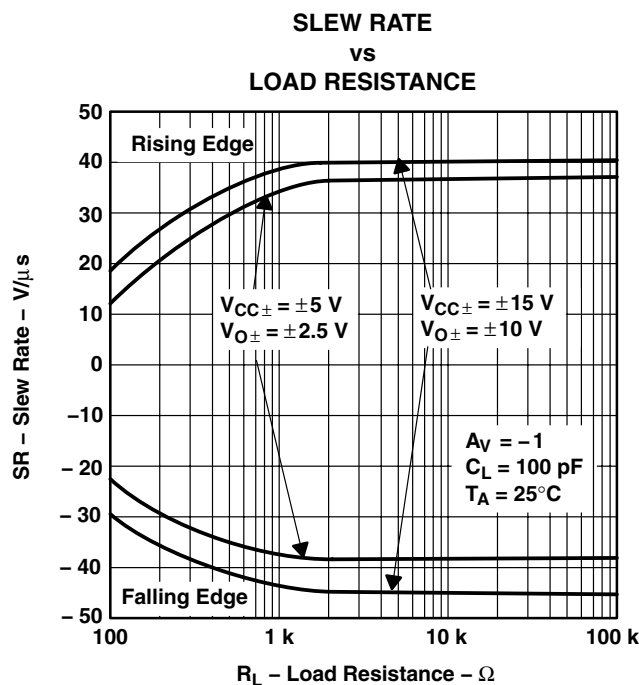


Figure 51

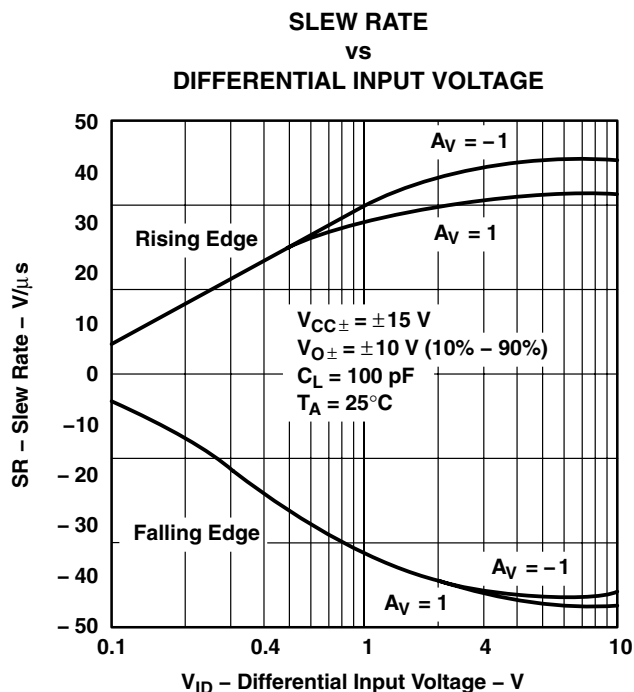


Figure 52

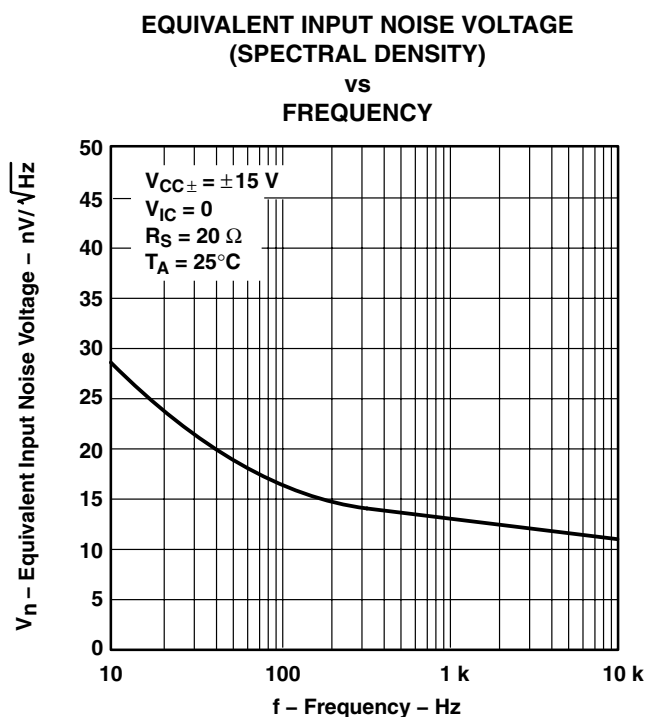
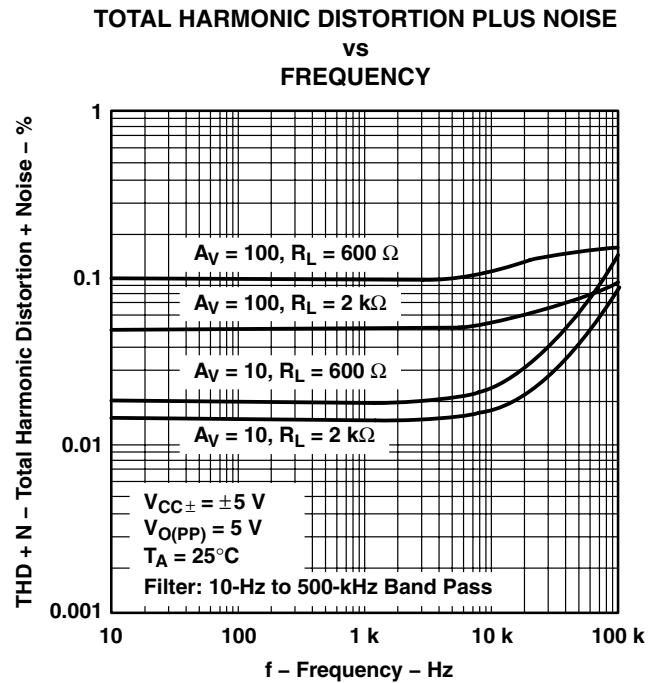
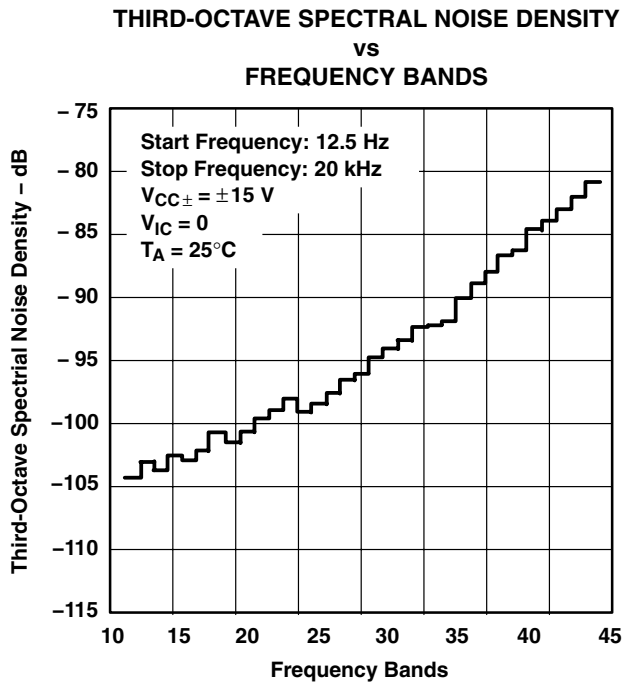
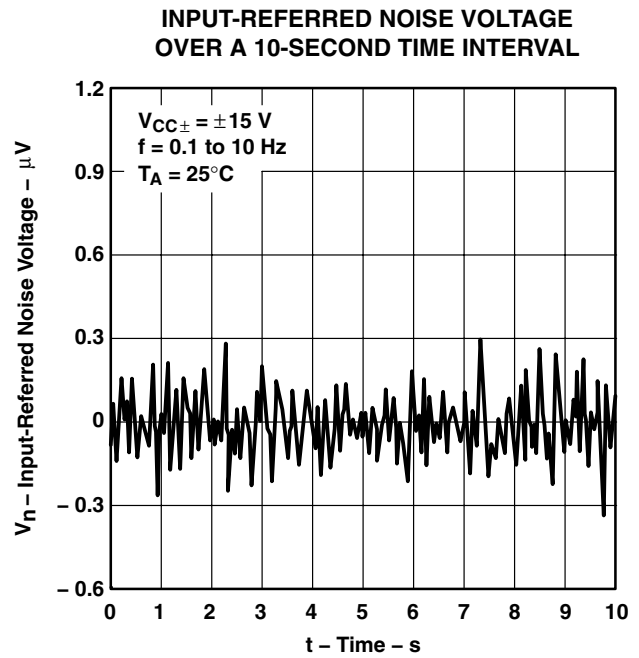
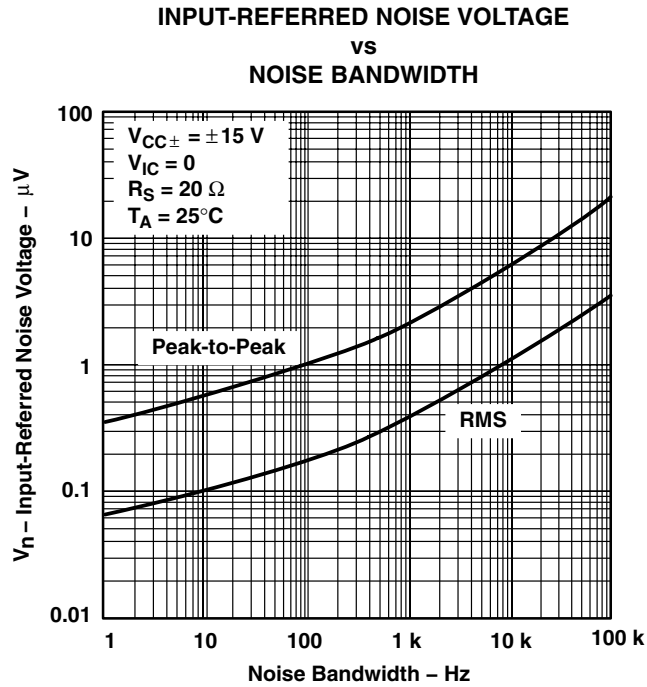


Figure 53

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

## TYPICAL CHARACTERISTICS



# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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## TYPICAL CHARACTERISTICS

**TOTAL HARMONIC DISTORTION PLUS NOISE  
vs  
FREQUENCY**

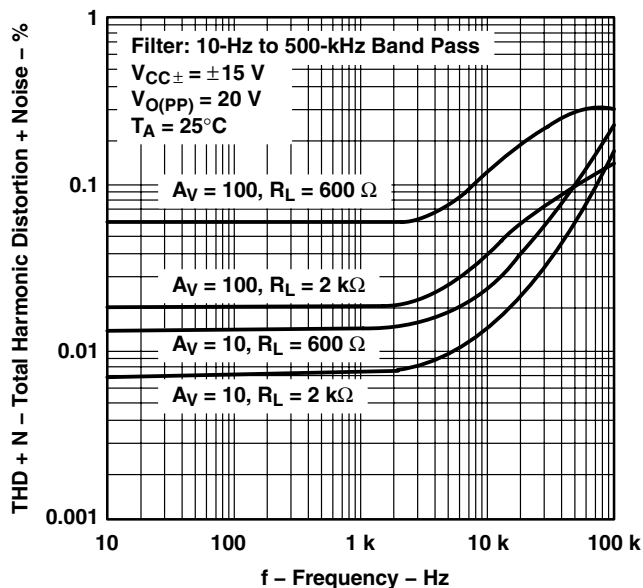


Figure 58

**UNITY-GAIN BANDWIDTH  
vs  
LOAD CAPACITANCE**

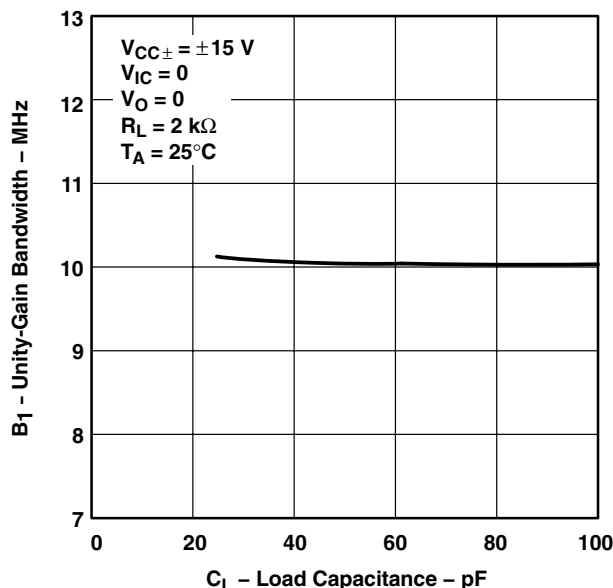


Figure 59

**GAIN-BANDWIDTH PRODUCT†  
vs  
FREE-AIR TEMPERATURE**

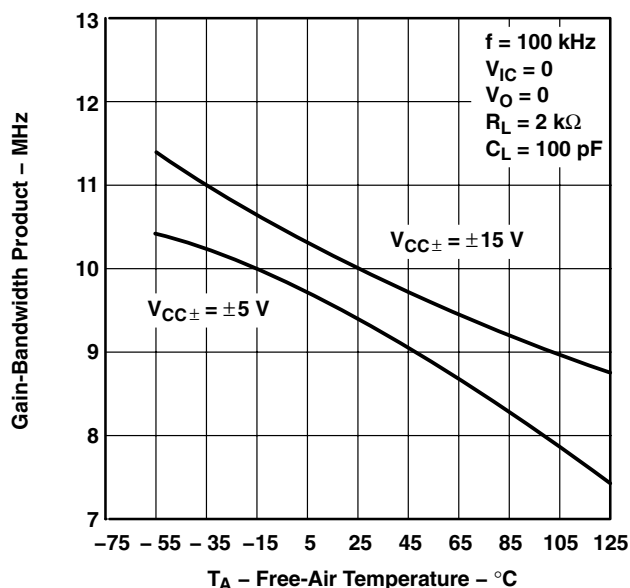


Figure 60

**GAIN-BANDWIDTH PRODUCT  
vs  
SUPPLY VOLTAGE**

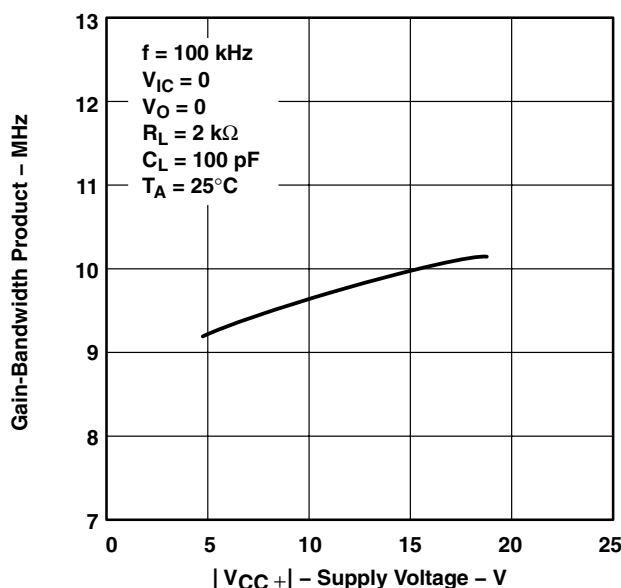


Figure 61

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

## TYPICAL CHARACTERISTICS

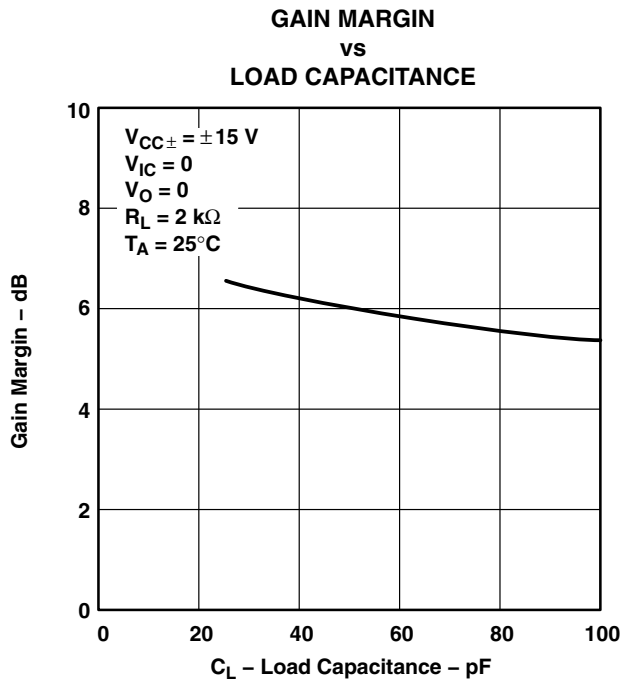


Figure 62

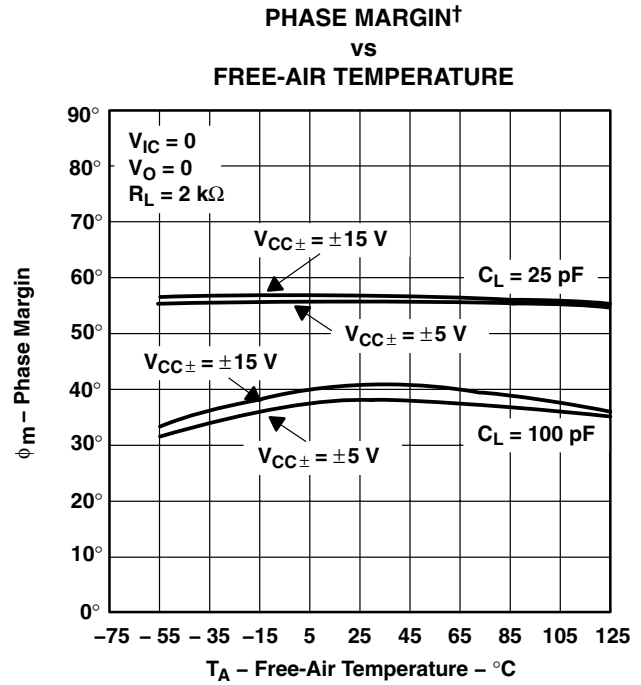


Figure 63

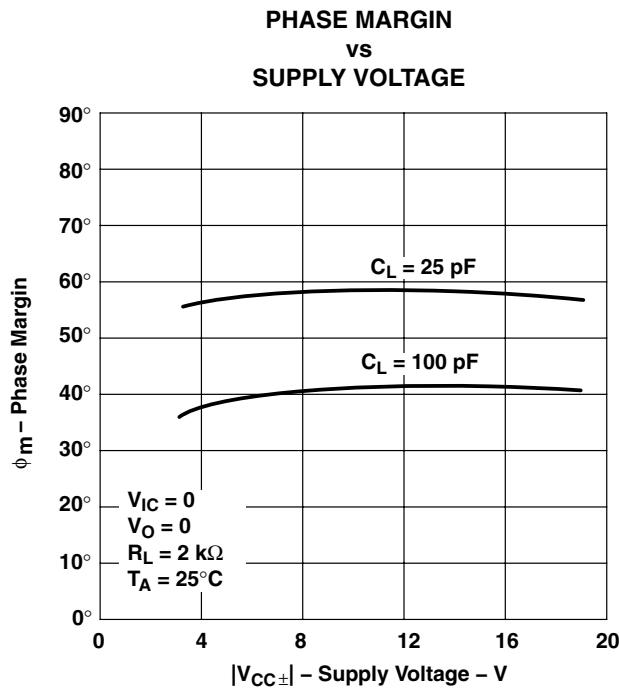


Figure 64

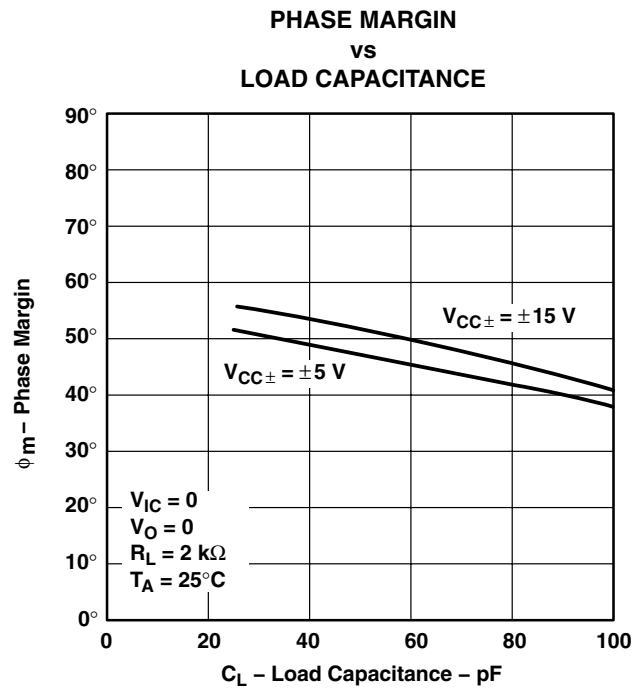


Figure 65

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

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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## TYPICAL CHARACTERISTICS

NONINVERTING LARGE-SIGNAL  
PULSE RESPONSE†

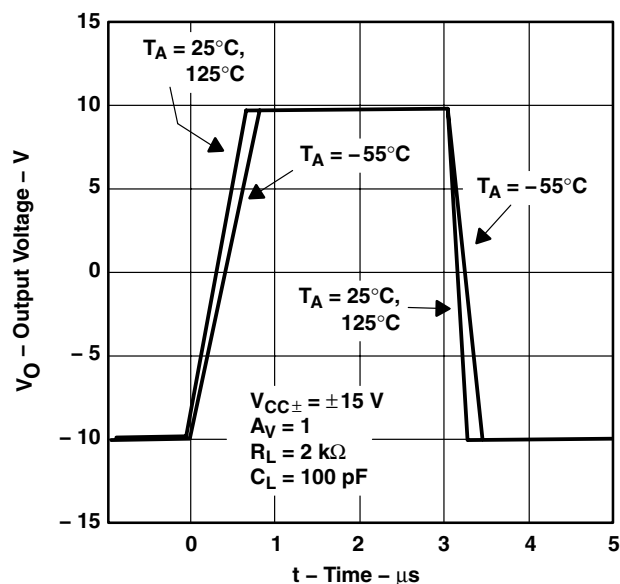


Figure 66

SMALL-SIGNAL PULSE RESPONSE

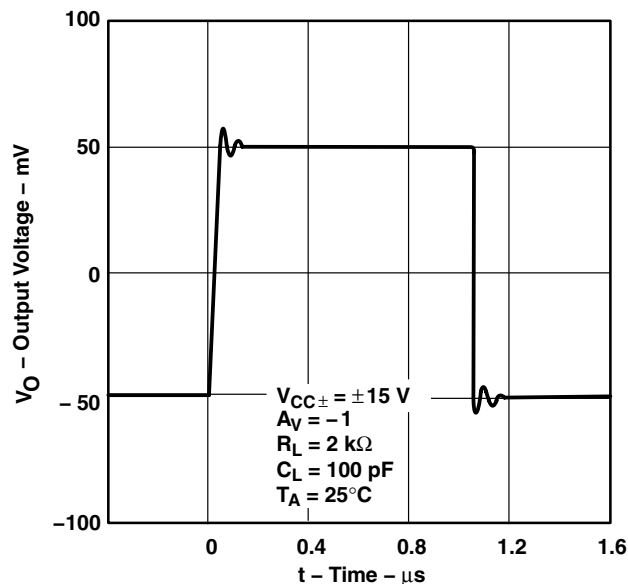


Figure 67

CLOSED-LOOP OUTPUT IMPEDANCE  
vs  
FREQUENCY

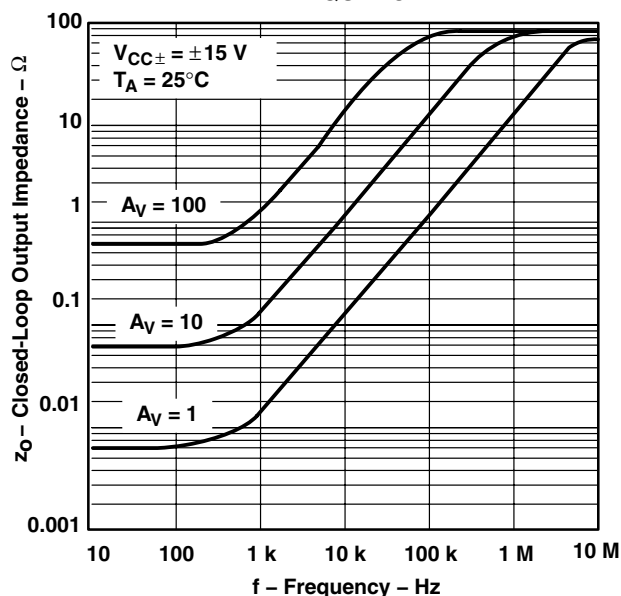


Figure 68

TLE2072 AND TLE2074  
CROSSTALK ATTENUATION  
vs  
FREQUENCY

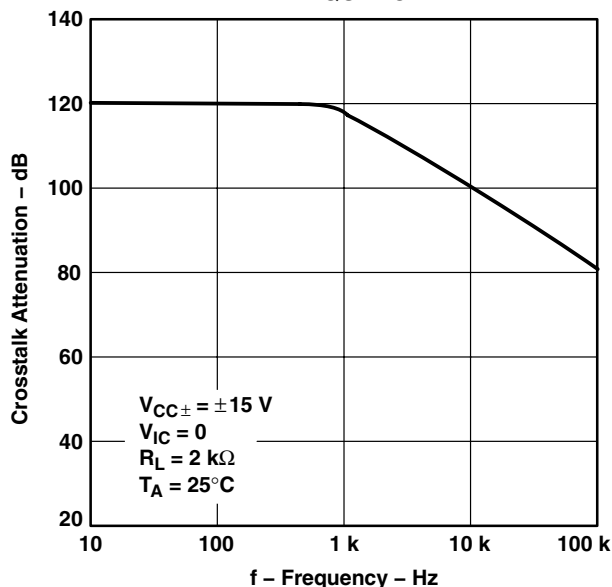


Figure 69

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

## APPLICATION INFORMATION

### input characteristics

The TLE207x, TLE207xA, and TLE207xB are specified with a minimum and a maximum input voltage that if exceeded at either input could cause the device to malfunction. Because of the extremely high input impedance and resulting low bias current requirements, the TLE207x, TLE207xA, and TLE207xB are well suited for low-level signal processing; however, leakage currents on printed-circuit boards and sockets can easily exceed bias current requirements and cause degradation in system performance. It is good practice to include guard rings around inputs (see Figure 70). These guards should be driven from a low-impedance source at the same voltage level as the common-mode input.

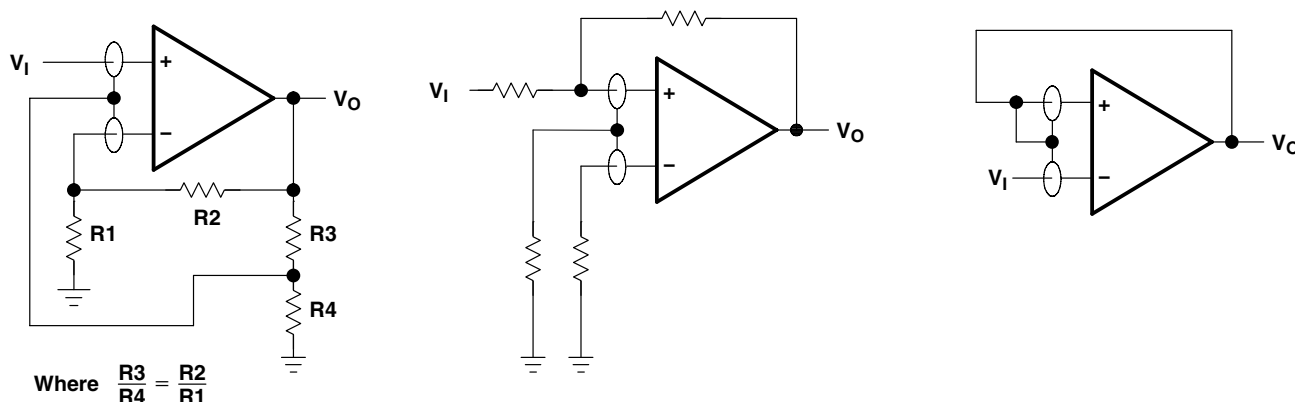


Figure 70. Use of Guard Rings

### TLE2071 input offset voltage nulling

The TLE2071 series offers external null pins that can be used to further reduce the input offset voltage. The circuit of Figure 71 can be connected as shown if the feature is desired. When external nulling is not needed, the null pins may be left unconnected.

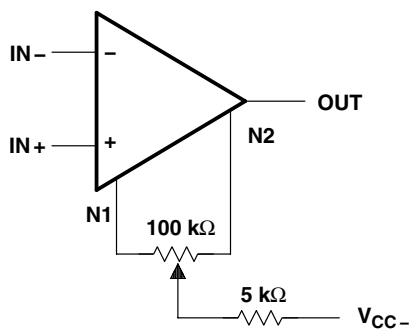


Figure 71. Input Offset Voltage Nulling

# TLE207x-Q1, TLE207xA-Q1 EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT OPERATIONAL AMPLIFIERS

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## APPLICATION INFORMATION

### macromodel information

Macromodel information provided was derived using *PSpice™ Parts™* model generation software. The Boyle macromodel (see Note 4) and subcircuit Figure 72 were generated using the TLE207x typical electrical and operating characteristics at  $T_A = 25^\circ\text{C}$ . Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

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

NOTE 4: G.R. Boyle, B.M. Cohn, D. O. Pederson, and J. E. Solomon, "Macromodeling of Integrated Circuit Operational Amplifiers", *IEEE Journal of Solid-State Circuits*, SC-9, 353 (1974).

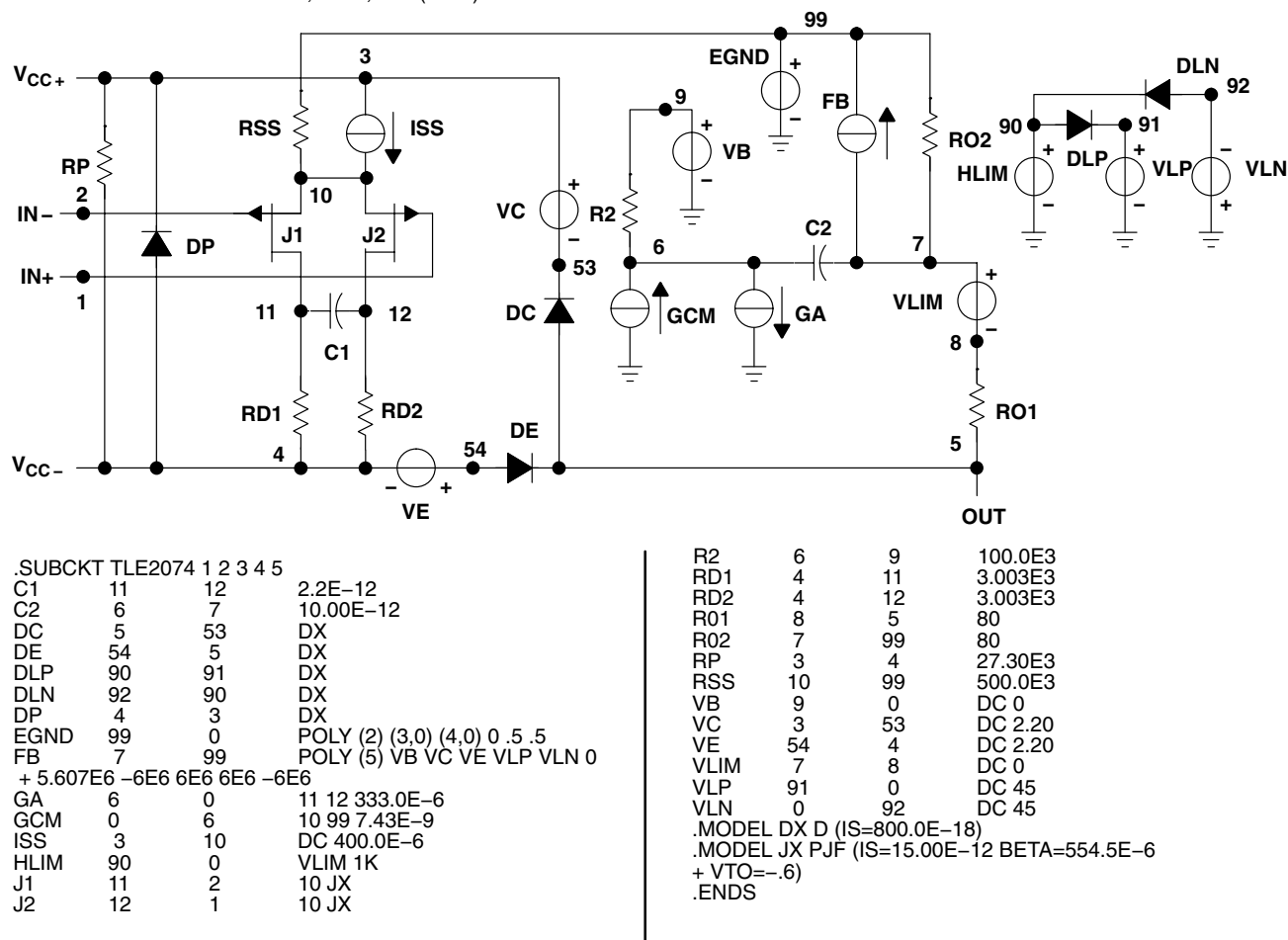


Figure 72. Boyle Macromodel and Subcircuit

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## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2)            | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| TLE2071AQDRG4Q1  | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | 2071AQ                  | <a href="#">Samples</a> |
| TLE2071AQDRQ1    | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | 2071AQ                  | <a href="#">Samples</a> |
| TLE2071QDRQ1     | OBSOLETE      | SOIC         | D                  | 8    |                | TBD                        | Call TI                 | Call TI              | -40 to 125   |                         |                         |
| TLE2072AQDRG4Q1  | ACTIVE        | SOIC         | D                  | 8    | 2500           | Green (RoHS<br>& no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | 2072AQ                  | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

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

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

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

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

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

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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

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

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

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**OTHER QUALIFIED VERSIONS OF TLE2071-Q1, TLE2071A-Q1, TLE2072A-Q1 :**

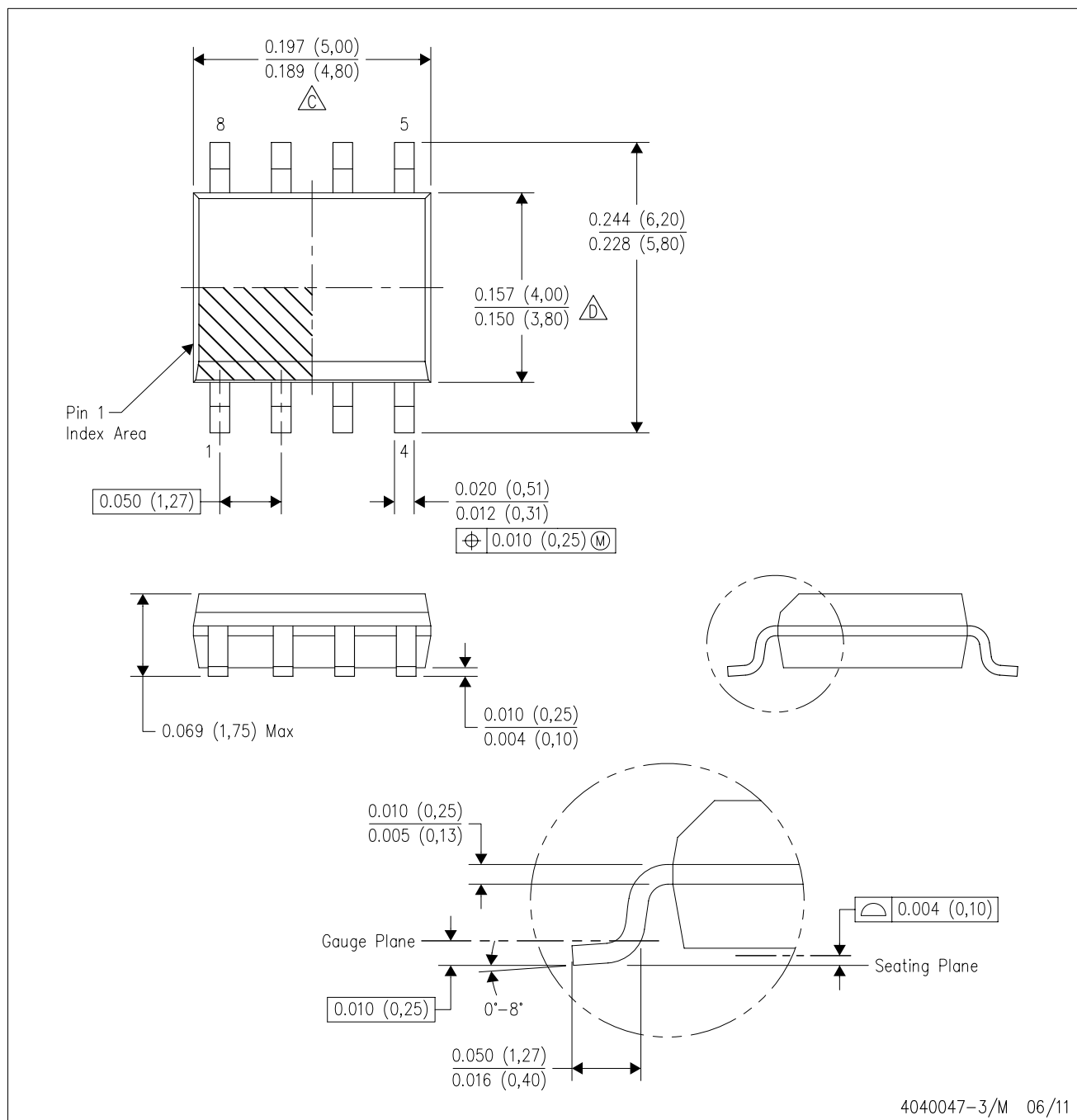
- Catalog: [TLE2071](#), [TLE2071A](#), [TLE2072A](#)
  
- Military: [TLE2071M](#), [TLE2071AM](#), [TLE2072AM](#)

NOTE: Qualified Version Definitions:

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

D (R-PDSO-G8)

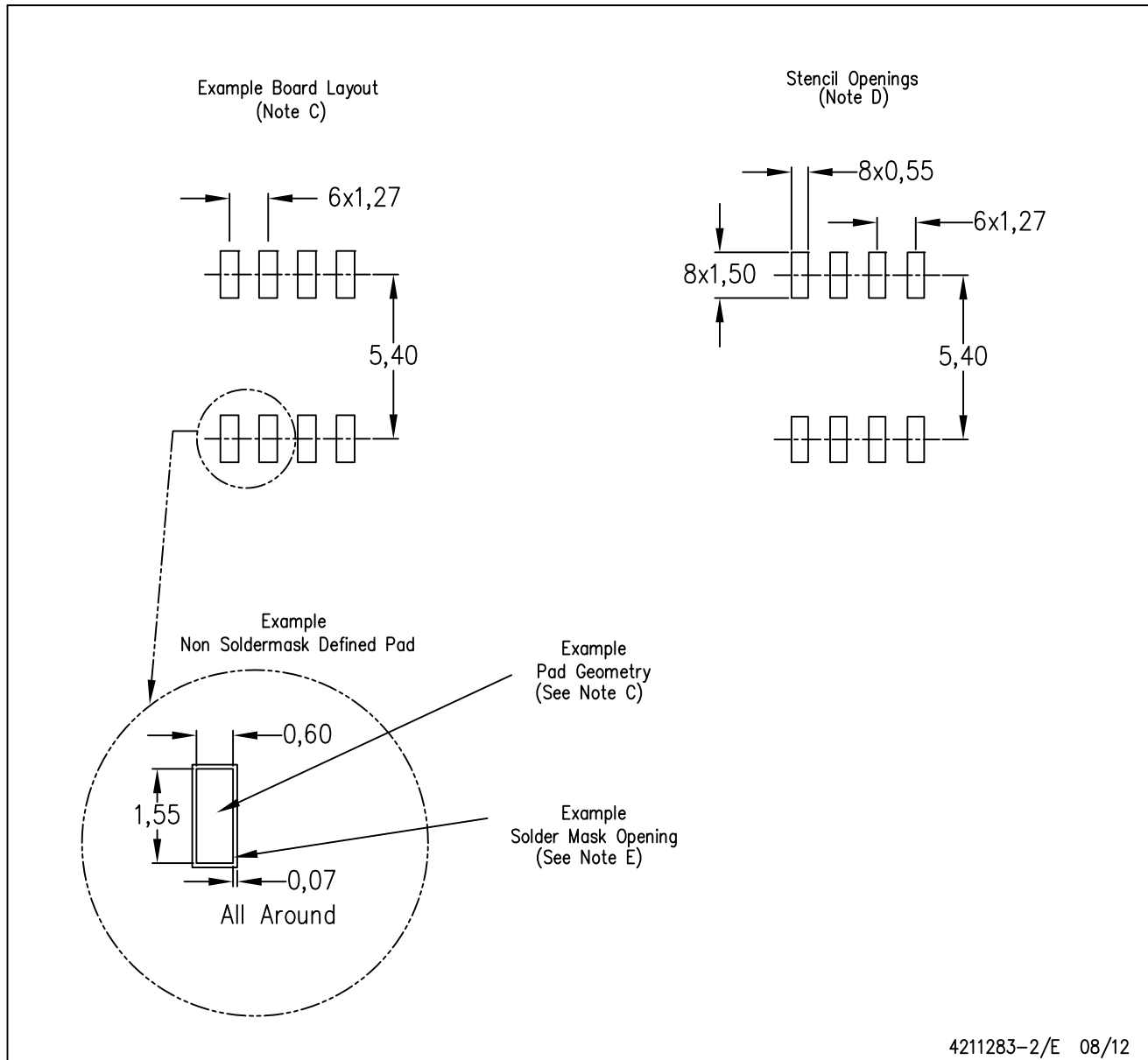
PLASTIC SMALL OUTLINE



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

D (R-PDSO-G8)

PLASTIC SMALL OUTLINE



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

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