

# TLE2074, TLE2074A, TLE2074Y EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

- 25-V/ $\mu$ s Slew Rate Min
- Low Noise  
17 nV/ $\sqrt{\text{Hz}}$  Max at  $f = 10 \text{ kHz}$   
11.6 nV/ $\sqrt{\text{Hz}}$  Typ at  $f = 10 \text{ kHz}$
- High Gain-Bandwidth Product . . . 10 MHz
- $\pm 30\text{-mA}$  Minimum Short-Circuit Output Current

- Wide Supply-Voltage Range  
 $\pm 2.25 \text{ V}$  to  $\pm 19 \text{ V}$
- Input Range Includes the Positive Supply
- Macromodel Included
- Fast Settling Time Using 10-V Step  
400 ns to 10 mV Typ  
1.5  $\mu$ s to 1 mV Typ

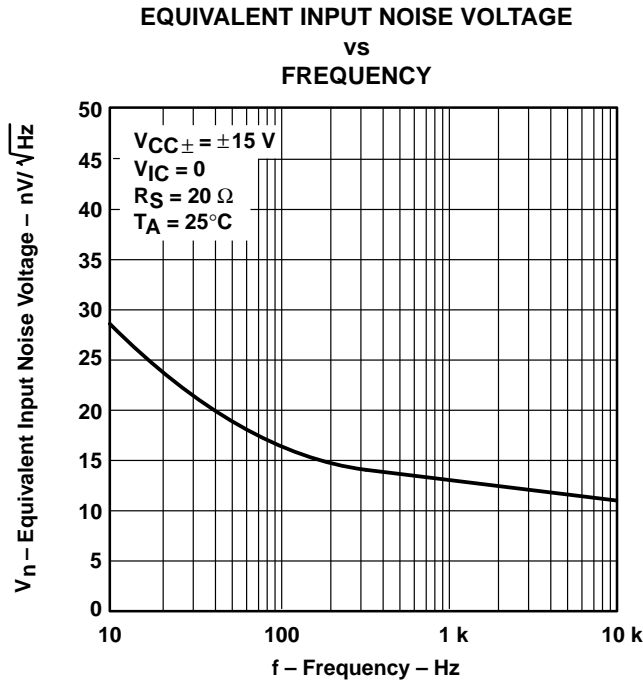


Figure 1

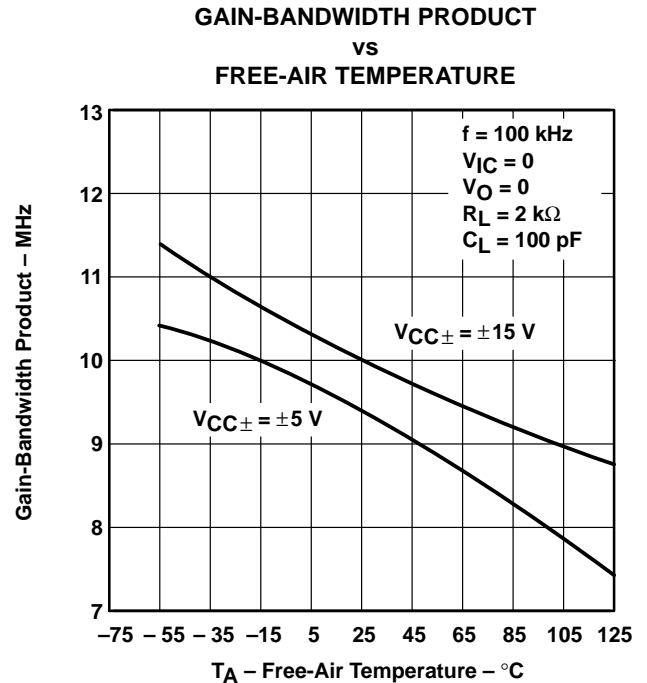


Figure 2

## description

The TLE2074 and TLE2074A are low-noise, high-performance, high-speed, internally compensated JFET-input quadruple operational amplifiers built using Texas Instruments complementary bipolar Excalibur process. These devices combine low noise (see Figure 1) with outstanding output drive capability, high slew rate, and wide bandwidth (see Figure 2).

### AVAILABLE OPTIONS

| $T_A$                                      | $V_{IOmax}$<br>AT $25^\circ\text{C}$ | PACKAGED DEVICES          |                           |                         |                         | CHIP<br>FORM<br>(Y)† |
|--|--------------------------------------|---------------------------|---------------------------|-------------------------|-------------------------|----------------------|
|  |                                      | SMALL<br>OUTLINE<br>(DW)† | CHIP<br>CARRIER<br>(FK)   | CERAMIC<br>DIP<br>(J)   | PLASTIC<br>DIP<br>(N)   |                      |
| $0^\circ\text{C}$ to $70^\circ\text{C}$    | 3 mV<br>5 mV                         | TLE2074ACDW<br>TLE2074CDW | —                         | —                       | TLE2074ACN<br>TLE2074CN | —<br>TLE2074Y        |
| $-40^\circ\text{C}$ to $85^\circ\text{C}$  | 3 mV<br>5 mV                         | TLE2074AIDW<br>TLE2074IDW | —                         | —                       | TLE2074AIN<br>TLE2074IN | —                    |
| $-55^\circ\text{C}$ to $125^\circ\text{C}$ | 3 mV<br>5 mV                         | —                         | TLE2074AMFK<br>TLE2074MFK | TLE2074AMJ<br>TLE2074MJ | —                       | —                    |

† The DW packages are available taped and reeled. Add R suffix to device type (e.g., TLE2074ACDWR).

‡ Chip-form versions are tested at  $T_A = 25^\circ\text{C}$ . For chip-form orders, contact your local TI sales office.

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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On products compliant to MIL-STD-883, Class B, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# TLE2074, TLE2074A, TLE2074Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

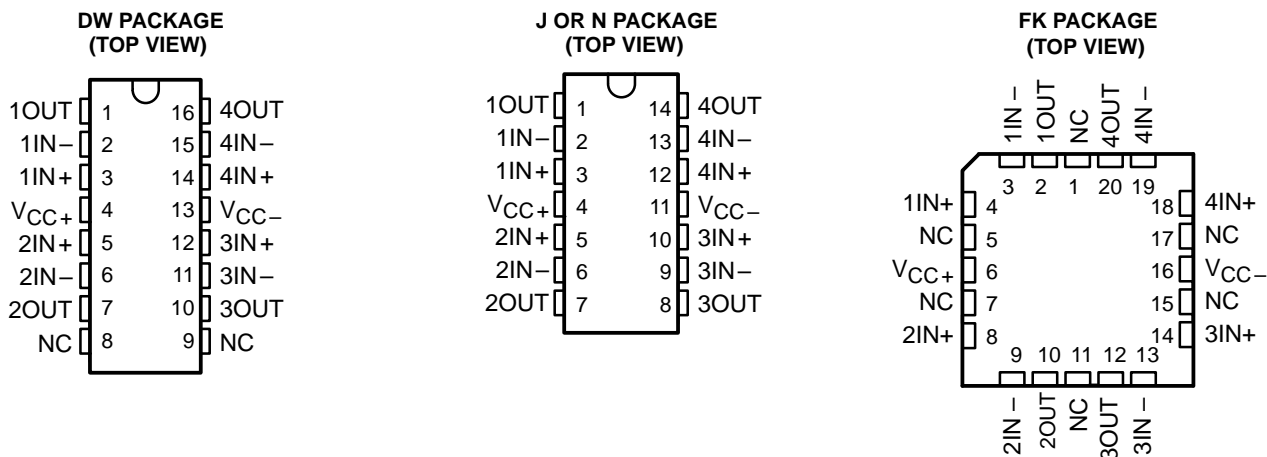
SLOS123A – JUNE 1993 – REVISED AUGUST 1994

#### description (continued)

The design features a low audio-band noise of  $11.6 \text{ nV}/\sqrt{\text{Hz}}$  typical at 10 kHz. This, coupled with a  $25\text{-V}/\mu\text{s}$  minimum slew rate, results in the low distortion and high-power bandwidth necessary for high-fidelity audio applications. Settling time to 0.1% of a 10-V step ( $1\text{-k}\Omega/100\text{-pF}$  load) is approximately 400 ns. Gain-bandwidth product is typically 10 MHz with an 8 MHz minimum. As such, the TLE2074 and TLE2074A offer significant speed and noise advantages at a low 1.6-mA typical supply current per channel.

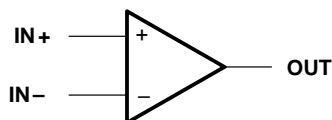
The input current characteristics traditionally associated with JFET-input amplifiers have been maintained. Input offset voltage is graded to a 7 mV and 4 mV maximum for the TLE2074 and TLE2074A, respectively. Typically, temperature coefficient of input offset voltage is  $10.1 \mu\text{V}/^\circ\text{C}$  and typical CMRR and  $k_{SVR}$  are 98 dB and 99 dB, respectively. Device performance is relatively independent of supply voltage over the wide  $\pm 2.25\text{-V}$  to  $\pm 19\text{-V}$  range. The input common-mode voltage range extends from the positive supply down to  $V_{CC-} + 4 \text{ V}$  without significant degradation to dynamic performance. Maximum peak output voltage swing is from  $V_{CC+} - 1 \text{ V}$  to  $V_{CC-} + 1 \text{ V}$  under light loading conditions. The output is capable of sourcing and sinking a minimum of 30 mA and can sustain shorts to either supply. Care must be taken to ensure that maximum power dissipation is not exceeded.

Both the TLE2074 and TLE2074A are available in a wide variety of packages, including both the industry-standard 16-pin wide-body SOIC and chip form for high-density system applications. The C-suffix devices are characterized for operation from  $0^\circ\text{C}$  to  $70^\circ\text{C}$ , the I-suffix devices over the  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  range, and the M-suffix devices over the full military temperature range of  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .



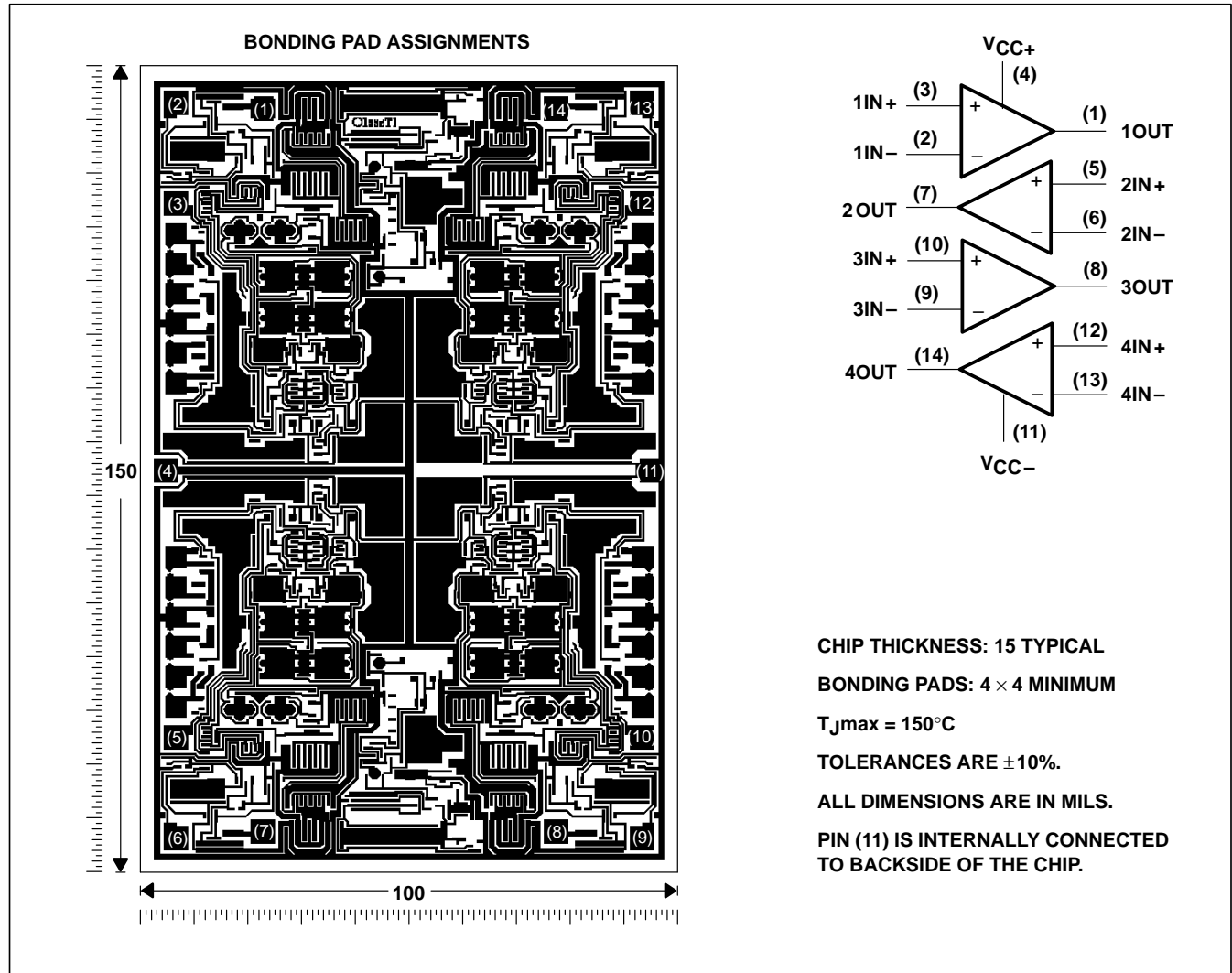
NC – No internal connection

#### symbol



## TLE2074Y chip information

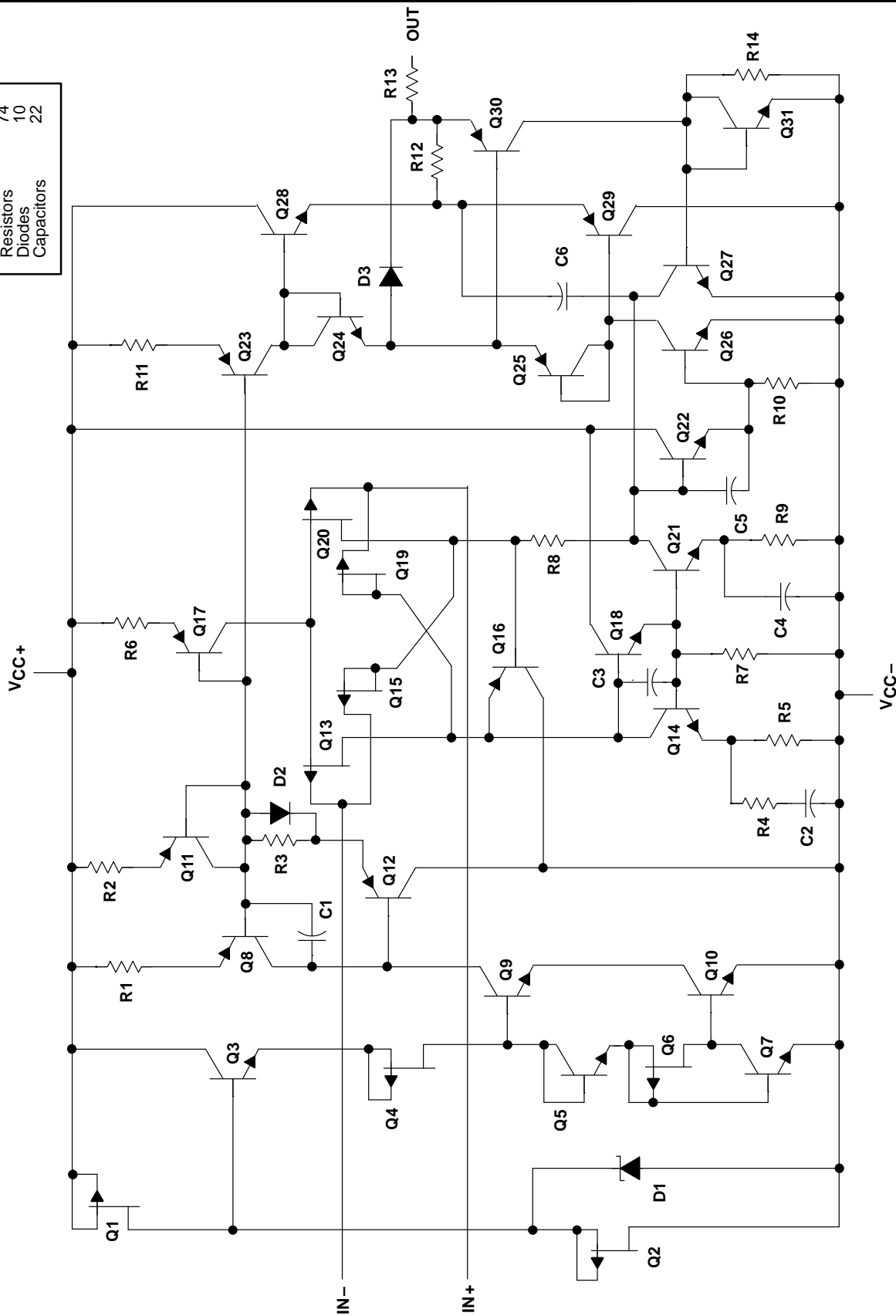
This chip, when properly assembled, displays characteristics similar to the TLE2074. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.



**TLE2074, TLE2074A, TLE2074Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT QUAD OPERATIONAL AMPLIFIERS**  
 SLOS123A – JUNE 1993 – REVISED AUGUST 1994

equivalent schematic (each channel)

| ACTUAL DEVICE<br>COMPONENT COUNT |     |
|----------------------------------|-----|
| Transistors                      | 114 |
| Resistors                        | 74  |
| Diodes                           | 10  |
| Capacitors                       | 22  |



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

|   |                              |
|---|------------------------------|
| Supply voltage, $V_{CC+}$ (see Note 1)  | 19 V                         |
| Supply voltage, $V_{CC-}$ (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)   | ±1 mA                        |
| Output current, $I_O$ (each output)   | ±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                    |
| Continuous total dissipation  | See Dissipation Rating Table |
| Operating free-air temperature range, $T_A$ : C suffix                        | 0°C to 70°C                  |
| I suffix  | –40°C to 85°C                |
| M suffix  | –55°C to 125°C               |
| Storage temperature range   | –65°C to 150°C               |
| Case temperature for 60 seconds: FK package                                   | 260°C                        |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: DW or N package | 260°C                        |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J package       | 300°C                        |

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

- NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .  
 2. Differential voltages are at 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.

**DISSIPATION RATING TABLE**

| PACKAGE | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | DERATING FACTOR<br>ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$<br>POWER RATING | $T_A = 85^\circ\text{C}$<br>POWER RATING | $T_A = 125^\circ\text{C}$<br>POWER RATING |
|---------|---|---|--|--|---|
| DW      | 1025 mW                                     | 8.2 mW/°C   | 656 mW                                   | 533 mW                                   | 205 mW                                    |
| FK      | 1375 mW                                     | 11.0 mW/°C  | 880 mW                                   | 715 mW                                   | 275 mW                                    |
| J       | 1375 mW                                     | 11.0 mW/°C  | 880 mW                                   | 715 mW                                   | 275 mW                                    |
| N       | 1150 mW                                     | 9.2 mW/°C   | 736 mW                                   | 598 mW                                   | 230 mW                                    |

**recommended operating conditions**

|                                       |                               | C SUFFIX |     | I SUFFIX |     | M SUFFIX |     | UNIT |
|---------------------------------------|-------------------------------|----------|-----|----------|-----|----------|-----|------|
|                                       |                               | MIN      | MAX | MIN      | MAX | MIN      | MAX |      |
| Supply voltage, $V_{CC\pm}$           |                               | ±2.25    | ±19 | ±2.25    | ±19 | ±2.25    | ±19 | V    |
| Common-mode input voltage, $V_{IC}$   | $V_{CC\pm} = \pm 5\text{ V}$  | –0.9     | 5   | –0.8     | 5   | –0.8     | 5   | V    |
|                                       | $V_{CC\pm} = \pm 15\text{ V}$ | –10.9    | 15  | –10.8    | 15  | –10.8    | 15  |      |
| Operating free-air temperature, $T_A$ |                               | 0        | 70  | –40      | 85  | –55      | 125 | °C   |

**TLE2074, TLE2074A, TLE2074Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT QUAD OPERATIONAL AMPLIFIERS**

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER        |   |              | TEST CONDITIONS   | T <sub>A</sub> †       | TLE2074C          |        |                   | TLE2074AC |       |     | 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 5            |        | −0.5 3            |           | mV    |     |      |
|                  |   |              |   | Full range             | 7.1               |        | 5.1               |           |       |     |      |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                       |              |   | Full range             | 10.1 30           |        | 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             | 1400              |        | 1400              |           |       |     |      |
| I <sub>IB</sub>  | Input bias current  |              |   | 25°C                   | 20 175            |        | 20 175            |           | pA    |     |      |
|                  |   |              |   | Full range             | 5000              |        | 5000              |           |       |     |      |
| 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 −0.9         |        | 5 to −0.9         |           |       |     |      |
| 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             | 3.7               |        | 3.7               |           |       |     |      |
|                  |   |              | I <sub>O</sub> = −2 mA  | 25°C                   | 3.5 3.9           |        | 3.5 3.9           |           |       |     |      |
|                  |   |              |   | Full range             | 3.4               |        | 3.4               |           |       |     |      |
|                  |   |              | I <sub>O</sub> = −20 mA   | 25°C                   | 1.5 2.3           |        | 1.5 2.3           |           |       |     |      |
|                  |   |              |   | Full range             | 1.5               |        | 1.5               |           |       |     |      |
| 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             | −3.7              |        | −3.7              |           |       |     |      |
|                  |   |              | I <sub>O</sub> = 2 mA   | 25°C                   | −3.5 −4.1         |        | −3.5 −4.1         |           |       |     |      |
|                  |   |              |   | Full range             | −3.4              |        | −3.4              |           |       |     |      |
|                  |   |              | I <sub>O</sub> = 20 mA  | 25°C                   | −1.5 −2.4         |        | −1.5 −2.4         |           |       |     |      |
|                  |   |              |   | Full range             | −1.5              |        | −1.5              |           |       |     |      |
| 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        | 79     |                   | 79        |       |     |      |
|                  |   |              |   | R <sub>L</sub> = 2 kΩ  | 25°C              | 90 100 |                   | 90 100    |       |     |      |
|                  |   |              |   |                        | Full range        | 89     |                   | 89        |       |     |      |
|                  |   |              |   | R <sub>L</sub> = 10 kΩ | 25°C              | 95 106 |                   | 95 106    |       |     |      |
|                  |   |              |   |                        | Full range        | 94     |                   | 94        |       |     |      |
| 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 0°C to 70°C.



**TLE2074, TLE2074A, TLE2074Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT QUAD OPERATIONAL AMPLIFIERS**  
SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER                                 | TEST CONDITIONS                     | $T_A$ †    | TLE2074C |                |     | TLE2074AC |                 |     | 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 |      |
| $a_x$ Crosstalk attenuation               | $V_{IC} = 0$ , $R_L = 2$ k $\Omega$ | 25°C       |          | 120            |     |           | 120             |     | dB   |
| $I_{OS}$ Short-circuit output current     | $V_O = 0$                           | 25°C       |          | –35            |     |           | –35             |     | mA   |
|   |                                     |            |          | $V_{ID} = 1$ V |     |           | $V_{ID} = -1$ V |     |      |
|   |                                     |            |          | 45             |     |           | 45              |     |      |

† Full range is 0°C to 70°C.

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

| PARAMETER          |   | TEST CONDITIONS   |  | T <sub>A</sub> † | TLE2074C |     |      | TLE2074AC |        |        | 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       | 22       |     |      | 22        |        |        |      |
| SR−                | Negative slew rate                          |   |  | 25°C             | 38       |     |      | 38        |        |        | V/μs |
|                    |   |   |  | Full range       | 22       |     |      | 22        |        |        |      |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1, 2-V step,<br>R <sub>L</sub> = 1 kΩ, 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, 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 = 0.1Hz 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°       |        |        |      |

† Full range is 0°C to 70°C.

# TLE2074, TLE2074A, TLE2074Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER      |   | TEST CONDITIONS  | $T_A^\dagger$              | TLE2074C    |             |     | TLE2074AC   |             |     | UNIT             |
|----------------|---|--|----------------------------|-------------|-------------|-----|-------------|-------------|-----|------------------|
|                |   |  |                            | MIN         | TYP         | MAX | MIN         | TYP         | MAX |                  |
| $V_{IO}$       | Input offset voltage  | $V_{IC} = 0, V_O = 0, R_S = 50 \Omega$                                       | 25°C                       | -1.6        | 5           |     | -0.5        | 3           |     | mV               |
|                |   |  | Full range                 |             | 7.1         |     |             | 5.1         |     |                  |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage                     |  | Full range                 | 10.1        | 30          |     | 10.1        | 30          |     | $\mu V/^\circ C$ |
| $I_{IO}$       | Input offset current  | $V_{IC} = 0, V_O = 0, \text{See Figure 4}$                                   | 25°C                       | 15          | 100         |     | 15          | 100         |     | pA               |
|                |   |  | Full range                 |             | 1400        |     |             | 1400        |     |                  |
| $I_{IB}$       | Input bias current  |  | 25°C                       | 25          | 175         |     | 25          | 175         |     | pA               |
|                |   |  | Full range                 |             | 5000        |     |             | 5000        |     |                  |
| $V_{ICR}$      | 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                 | 13.7        |             |     | 13.7        |             |     |                  |
|                |   | $I_O = -2 \text{ mA}$  | 25°C                       | 13.5        | 13.9        |     | 13.5        | 13.9        |     |                  |
|                |   |  | Full range                 | 13.4        |             |     | 13.4        |             |     |                  |
|                |   | $I_O = -20 \text{ mA}$   | 25°C                       | 11.5        | 12.3        |     | 11.5        | 12.3        |     |                  |
|                |   |  | Full range                 | 11.5        |             |     | 11.5        |             |     |                  |
| $V_{OM-}$      | Maximum negative peak output voltage swing                          | $I_O = 200 \mu A$  | 25°C                       | -13.8       | -14.2       |     | -13.8       | -14.2       |     | V                |
|                |   |  | Full range                 | -13.7       |             |     | -13.7       |             |     |                  |
|                |   | $I_O = 2 \text{ mA}$   | 25°C                       | -13.7       | -14         |     | -13.7       | -14         |     |                  |
|                |   |  | Full range                 | -13.6       |             |     | -13.6       |             |     |                  |
|                |   | $I_O = 20 \text{ mA}$  | 25°C                       | -11.5       | -12.4       |     | -11.5       | -12.4       |     |                  |
|                |   |  | Full range                 | -11.5       |             |     | -11.5       |             |     |                  |
| $A_{VD}$       | Large-signal differential voltage amplification                     | $V_O = \pm 10 \text{ V}$   | $R_L = 600 \Omega$         | 25°C        | 80          | 96  | 80          | 96          |     | dB               |
|                |   |  |                            | Full range  | 79          |     | 79          |             |     |                  |
|                |   |  | $R_L = 2 \text{ k}\Omega$  | 25°C        | 90          | 109 | 90          | 109         |     |                  |
|                |   |  |                            | Full range  | 89          |     | 89          |             |     |                  |
|                |   |  | $R_L = 10 \text{ k}\Omega$ | 25°C        | 95          | 118 | 95          | 118         |     |                  |
|                |   |  |                            | Full range  | 94          |     | 94          |             |     |                  |
| $r_i$          | Input resistance  | $V_{IC} = 0$   | 25°C                       |             | $10^{12}$   |     |             | $10^{12}$   |     | $\Omega$         |
| $c_i$          | Input capacitance   | 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                 | 79          |             |     | 79          |             |     |                  |
| $k_{SVR}$      | 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                 | 81          |             |     | 81          |             |     |                  |

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



**TLE2074, TLE2074A, TLE2074Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT QUAD OPERATIONAL AMPLIFIERS**  
SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER                                 | TEST CONDITIONS                     | $T_A$ †         | TLE2074C |     |     | TLE2074AC |     |     | UNIT |
|---|-------------------------------------|-----------------|----------|-----|-----|-----------|-----|-----|------|
|   |                                     |                 | MIN      | TYP | MAX | MIN       | TYP | MAX |      |
| $I_{CC}$ Supply current (four amplifiers) | $V_O = 0$ , 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                     | $V_{IC} = 0$ , $R_L = 2$ k $\Omega$ | 25°C            |          | 120 |     |           | 120 |     | dB   |
| $I_{OS}$ Short-circuit output current     | $V_O = 0$                           | $V_{ID} = 1$ V  | –30      | –45 |     | –30       | –45 |     | mA   |
|   |                                     | $V_{ID} = -1$ V | 30       | 48  |     | 30        | 48  |     |      |

† Full range is 0°C to 70°C.

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

| PARAMETER          |   | TEST CONDITIONS   |  | T <sub>A</sub> † | TLE2074C |     |     | TLE2074AC |      |     | UNIT   |        |
|--------------------|---|---|--|------------------|----------|-----|-----|-----------|------|-----|--------|--------|
|                    |   |   |  |                  | MIN      | TYP | MAX | MIN       | TYP  | MAX |        |        |
| SR +               | Positive slew rate                          | V <sub>O(PP)</sub> = 10 V, A <sub>VD</sub> = −1,<br>R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF,<br>See Figure 1 |  | 25°C             | 25       | 40  |     | 25        | 40   |     | V/μs   |        |
|                    |   |   |  | Full range       | 22       |     |     | 22        |      |     |        |        |
| SR −               | Negative slew rate                          |   |  | 25°C             | 30       | 45  |     | 30        | 45   |     | V/μs   |        |
|                    |   |   |  | Full range       | 25       |     |     | 25        |      |     |        |        |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1,<br>10-V step,<br>R <sub>L</sub> = 1 kΩ,<br>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,<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> = 20 V, A <sub>VD</sub> = 10,<br>f = 1 kHz, R <sub>L</sub> = 2 kΩ,<br>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,<br>C <sub>L</sub> = 25 pF,  | R <sub>L</sub> = 2 kΩ,<br>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, A <sub>VD</sub> = −1,<br>R <sub>L</sub> = 2 kΩ, 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,<br>C <sub>L</sub> = 25 pF,  | R <sub>L</sub> = 2 kΩ,<br>See Figure 2 | 25°C             | 57°      |     |     | 57°       |      |     |        |        |

† Full range is 0°C to 70°C.

**TLE2074, TLE2074A, TLE2074Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT QUAD OPERATIONAL AMPLIFIERS**

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER       |   | TEST CONDITIONS  | $T_A^\dagger$              | TLE2074I   |           |     | TLE2074AI |           |     | UNIT             |
|-----------------|---|--|----------------------------|------------|-----------|-----|-----------|-----------|-----|------------------|
|                 |   |  |                            | MIN        | TYP       | MAX | MIN       | TYP       | MAX |                  |
| $V_{IO}$        | Input offset voltage  | $V_{IC} = 0, V_O = 0, R_S = 50 \Omega$                                       | 25°C                       | -1.6       | 5         |     | -0.5      | 3         |     | mV               |
|                 |   |  | Full range                 |            |           | 9   |           |           | 7   |                  |
| $\alpha V_{IO}$ | Temperature coefficient of input offset voltage                     |  | Full range                 | 10.1       | 30        |     | 10.1      | 30        |     | $\mu V/^\circ C$ |
| $I_{IO}$        | Input offset current  | $V_{IC} = 0, V_O = 0, \text{See Figure 4}$                                   | 25°C                       | 15         | 100       |     | 15        | 100       |     | pA               |
|                 |   |  | Full range                 |            | 5         |     |           | 5         |     | nA               |
| $I_{IB}$        | Input bias current  |  | 25°C                       | 20         | 175       |     | 20        | 175       |     | pA               |
|                 |   |  | Full range                 |            | 10        |     |           | 10        |     | 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                 | 3.7        |           |     | 3.7       |           |     |                  |
|                 |   | $I_O = -2 \text{ mA}$  | 25°C                       | 3.5        | 3.9       |     | 3.5       | 3.9       |     |                  |
|                 |   |  | Full range                 | 3.4        |           |     | 3.4       |           |     |                  |
|                 |   | $I_O = -20 \text{ mA}$   | 25°C                       | 1.5        | 2.3       |     | 1.5       | 2.3       |     |                  |
|                 |   |  | Full range                 | 1.5        |           |     | 1.5       |           |     |                  |
| $V_{OM-}$       | Maximum negative peak output voltage swing                          | $I_O = 200 \mu A$  | 25°C                       | -3.8       | -4.2      |     | -3.8      | -4.2      |     | V                |
|                 |   |  | Full range                 | -3.7       |           |     | -3.7      |           |     |                  |
|                 |   | $I_O = 2 \text{ mA}$   | 25°C                       | -3.5       | -4.1      |     | -3.5      | -4.1      |     |                  |
|                 |   |  | Full range                 | -3.4       |           |     | -3.4      |           |     |                  |
|                 |   | $I_O = 20 \text{ mA}$  | 25°C                       | -1.5       | -2.4      |     | -1.5      | -2.4      |     |                  |
|                 |   |  | Full range                 | -1.5       |           |     | -1.5      |           |     |                  |
| $A_{VD}$        | 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 | 79        |     | 79        |           |     |                  |
|                 |   |  | $R_L = 2 \text{ k}\Omega$  | 25°C       | 90        | 100 | 90        | 100       |     |                  |
|                 |   |  |                            | Full range | 89        |     | 89        |           |     |                  |
|                 |   |  | $R_L = 10 \text{ k}\Omega$ | 25°C       | 95        | 106 | 95        | 106       |     |                  |
|                 |   |  |                            | Full range | 94        |     | 94        |           |     |                  |
| $r_i$           | Input resistance  | $V_{IC} = 0$   | 25°C                       |            | $10^{12}$ |     |           | $10^{12}$ |     | $\Omega$         |
| $c_i$           | Input capacitance   | 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   | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50 \Omega$                              | 25°C                       | 70         | 89        |     | 70        | 89        |     | dB               |
|                 |   |  | Full range                 | 68         |           |     | 68        |           |     |                  |
| $k_{SVR}$       | Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}, V_O = 0, R_S = 50 \Omega$ | 25°C                       | 82         | 99        |     | 82        | 99        |     | dB               |
|                 |   |  | Full range                 | 80         |           |     | 80        |           |     |                  |

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

**TLE2074, TLE2074A, TLE2074Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT QUAD OPERATIONAL AMPLIFIERS**  
 SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER                                 | TEST CONDITIONS                     | $T_A$ †         | TLE2074I |     |     | TLE2074AI |     |     | 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  |     |      |

† Full range is –40°C to 85°C.

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

| PARAMETER          |   | TEST CONDITIONS   |  | T <sub>A</sub> † | TLE2074I |     |     | TLE2074AI |     |        | 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, 2-V step,<br>R <sub>L</sub> = 1 kΩ, 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, 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°       |     |        |        |

† Full range is –40°C to 85°C.

# TLE2074, TLE2074A, TLE2074Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER      |   | TEST CONDITIONS  | $T_A^\dagger$                | TLE2074I    |             |     | TLE2074AI   |             |     | UNIT                         |
|----------------|---|--|------------------------------|-------------|-------------|-----|-------------|-------------|-----|------------------------------|
|                |   |  |                              | MIN         | TYP         | MAX | MIN         | TYP         | MAX |                              |
| $V_{IO}$       | Input offset voltage  | $V_{IC} = 0, \quad V_O = 0, \quad R_S = 50 \, \Omega$  | 25°C                         | -1.6        | 5           |     | -0.5        | 3           |     | mV                           |
|                |   |  | Full range                   |             |             | 9   |             |             | 7   |                              |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage                     |  | Full range                   | 10.1        | 30          |     | 10.1        | 30          |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$       | Input offset current  | $V_{IC} = 0, \quad V_O = 0, \quad \text{See Figure 4}$   | 25°C                         | 15          | 100         |     | 15          | 100         |     | pA                           |
|                |   |  | Full range                   |             | 5           |     |             | 5           |     | nA                           |
| $I_{IB}$       | Input bias current  |  | 25°C                         | 25          | 175         |     | 25          | 175         |     | pA                           |
|                |   |  | Full range                   |             | 10          |     |             | 10          |     | 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                          | $I_O = -200 \, \mu\text{A}$  | 25°C                         | 13.8        | 14.1        |     | 13.8        | 14.1        |     | V                            |
|                |   |  | Full range                   | 13.7        |             |     | 13.7        |             |     |                              |
|                |   | $I_O = -2 \, \text{mA}$  | 25°C                         | 13.5        | 13.9        |     | 13.5        | 13.9        |     |                              |
|                |   |  | Full range                   | 13.4        |             |     | 13.4        |             |     |                              |
|                |   | $I_O = -20 \, \text{mA}$   | 25°C                         | 11.5        | 12.3        |     | 11.5        | 12.3        |     |                              |
|                |   |  | Full range                   | 11.5        |             |     | 11.5        |             |     |                              |
| $V_{OM-}$      | Maximum negative peak output voltage swing                          | $I_O = 200 \, \mu\text{A}$   | 25°C                         | -13.8       | -14.2       |     | -13.8       | -14.2       |     | V                            |
|                |   |  | Full range                   | -13.7       |             |     | -13.7       |             |     |                              |
|                |   | $I_O = 2 \, \text{mA}$   | 25°C                         | -13.5       | -14         |     | -13.5       | -14         |     |                              |
|                |   |  | Full range                   | -13.4       |             |     | -13.4       |             |     |                              |
|                |   | $I_O = 20 \, \text{mA}$  | 25°C                         | -11.5       | -12.4       |     | -11.5       | -12.4       |     |                              |
|                |   |  | Full range                   | -11.5       |             |     | -11.5       |             |     |                              |
| $A_{VD}$       | Large-signal differential voltage amplification                     | $V_O = \pm 10 \, \text{V}$   | $R_L = 600 \, \Omega$        | 25°C        | 80          | 96  | 80          | 96          |     | dB                           |
|                |   |  |                              | Full range  | 79          |     | 79          |             |     |                              |
|                |   |  | $R_L = 2 \, \text{k}\Omega$  | 25°C        | 90          | 109 | 90          | 109         |     |                              |
|                |   |  |                              | Full range  | 89          |     | 89          |             |     |                              |
|                |   |  | $R_L = 10 \, \text{k}\Omega$ | 25°C        | 95          | 118 | 95          | 118         |     |                              |
|                |   |  |                              | Full range  | 94          |     | 94          |             |     |                              |
| $r_i$          | Input resistance  | $V_{IC} = 0$   | 25°C                         |             | $10^{12}$   |     |             | $10^{12}$   |     | $\Omega$                     |
| $c_i$          | Input capacitance   | 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   | $V_{IC} = V_{ICRmin}, \quad V_O = 0, \quad R_S = 50 \, \Omega$                                   | 25°C                         | 80          | 98          |     | 80          | 98          |     | dB                           |
|                |   |  | Full range                   | 79          |             |     | 79          |             |     |                              |
| $k_{SVR}$      | Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5 \, \text{V}$ to $\pm 15 \, \text{V}, \quad V_O = 0, \quad R_S = 50 \, \Omega$ | 25°C                         | 82          | 99          |     | 82          | 99          |     | dB                           |
|                |   |  | Full range                   | 80          |             |     | 80          |             |     |                              |

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



**TLE2074, TLE2074A, TLE2074Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT QUAD OPERATIONAL AMPLIFIERS**

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER                                 | TEST CONDITIONS                     | $T_A^\dagger$   | TLE2074I |     |     | TLE2074AI |     |     | UNIT |
|---|-------------------------------------|-----------------|----------|-----|-----|-----------|-----|-----|------|
|   |                                     |                 | MIN      | TYP | MAX | MIN       | TYP | MAX |      |
| $I_{CC}$ Supply current (four amplifiers) | $V_O = 0$ , 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                     | $V_{IC} = 0$ , $R_L = 2$ k $\Omega$ | 25°C            |          | 120 |     |           | 120 |     | dB   |
| $I_{OS}$ Short-circuit output current     | $V_O = 0$                           | $V_{ID} = 1$ V  | –30      | –45 |     | –30       | –45 |     | mA   |
|   |                                     | $V_{ID} = -1$ V | 30       | 48  |     | 30        | 48  |     |      |

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

| PARAMETER          |   | TEST CONDITIONS  |  | T <sub>A</sub> † | TLE2074I |     |     | TLE2074AI |     |        | UNIT   |
|--------------------|---|--|--|------------------|----------|-----|-----|-----------|-----|--------|--------|
|                    |   |  |  |                  | MIN      | TYP | MAX | MIN       | TYP | MAX    |        |
| SR+                | Positive slew rate                          | V <sub>O(PP)</sub> = ±10 V,<br>A <sub>VD</sub> = −1,<br>C <sub>L</sub> = 100 pF,<br>R <sub>L</sub> = 2 kΩ,<br>See Figure 1 |  | 25°C             | 25       | 40  |     | 25        | 40  |        | V/μs   |
|                    | Full range                                  |  |  | 19               |          |     | 19  |           |     |        |        |
| 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,<br>10-V step,<br>R <sub>L</sub> = 1 kΩ,<br>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,<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> = 20 V, A <sub>VD</sub> = 10,<br>f = 1 kHz, R <sub>L</sub> = 2 kΩ,<br>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,<br>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, A <sub>VD</sub> = −1,<br>R <sub>L</sub> = 2 kΩ, 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, R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 25 pF, See Figure 2                                     |  | 25°C             | 57°      |     |     | 57°       |     |        |        |

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

# TLE2074, TLE2074A, TLE2074Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER   | TEST CONDITIONS   | $T_A^\dagger$             | TLE2074M   |           |      | TLE2074AM |           |     | UNIT             |
|---|---|---------------------------|------------|-----------|------|-----------|-----------|-----|------------------|
|   |   |                           | MIN        | TYP       | MAX  | MIN       | TYP       | MAX |                  |
| $V_{IO}$ Input offset voltage   | $V_{IC} = 0, V_O = 0, R_S = 50\Omega$                                     | 25°C                      | -1.6       | 5         |      | -0.5      | 3         |     | mV               |
|   |   | Full range                |            |           | 10.5 |           |           | 8.5 |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                  |   | Full range                | 10.1       | 30*       |      | 10.1      | 30*       |     | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current   | $V_{IC} = 0, V_O = 0, \text{See Figure 4}$                                | 25°C                      | 15         | 100       |      | 15        | 100       |     | pA               |
|   |   | Full range                |            |           | 20   |           |           | 20  | nA               |
| $I_{IB}$ Input bias current   |   | 25°C                      | 20         | 175       |      | 20        | 175       |     | pA               |
|   |   | Full range                |            |           | 65   |           |           | 65  | 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   | 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  | $V_{IC} = V_{ICRmin}, V_O = 0, R_S = 50\Omega$                            | 25°C                      | 70         | 89        |      | 70        | 89        |     | dB               |
|   |   | Full range                | 68         |           |      | 68        |           |     |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5\text{ V to } \pm 15\text{ V}, V_O = 0, R_S = 50\Omega$ | 25°C                      | 82         | 99        |      | 82        | 99        |     | dB               |
|   |   | Full range                | 80         |           |      | 80        |           |     |                  |

\*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

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



**TLE2074, TLE2074A, TLE2074Y**  
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 SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER                                 | TEST CONDITIONS                     | $T_A$ †         | TLE2074M |     |     | TLE2074AM |     |     | 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  |     |      |

† Full range is –55°C to 125°C.

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

| PARAMETER           |   | TEST CONDITIONS  |   | T <sub>A</sub> † | TLE2074M |     |        | TLE2074AM |     |        | UNIT   |
|---------------------|---|--|---|------------------|----------|-----|--------|-----------|-----|--------|--------|
|                     |   |  |   |                  | MIN      | TYP | MAX    | MIN       | TYP | MAX    |        |
| SR+                 | Positive slew rate                          | V <sub>O</sub> (PP) = ±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       | 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, 2-V step,<br>R <sub>L</sub> = 1 kΩ, 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, 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</sub> (PP) | 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</sub> (PP) = 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</sub> (PP) = 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°    |           |     |        |        |

\*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

† Full range is –55°C to 125°C.

# TLE2074, TLE2074A, TLE2074Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER      |   | TEST CONDITIONS  | $T_A^\dagger$              | TLE2074M    |             |     | TLE2074AM   |             |     | UNIT             |
|----------------|---|--|----------------------------|-------------|-------------|-----|-------------|-------------|-----|------------------|
|                |   |  |                            | MIN         | TYP         | MAX | MIN         | TYP         | MAX |                  |
| $V_{IO}$       | Input offset voltage  | $V_{IC} = 0, \quad V_O = 0, \quad R_S = 50 \Omega$                                       | 25°C                       | -1.6        | 5           |     | -0.5        | 3           |     | mV               |
|                |   |  | Full range                 |             | 10.5        |     |             | 8.5         |     |                  |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage                       |  | Full range                 | 10.1        | 30*         |     | 10.1        | 30*         |     | $\mu V/^\circ C$ |
| $I_{IO}$       | Input offset current  | $V_{IC} = 0, \quad V_O = 0, \quad \text{See Figure 4}$                                   | 25°C                       | 15          | 100         |     | 15          | 100         |     | pA               |
|                |   |  | Full range                 |             | 20          |     |             | 20          |     | nA               |
| $I_{IB}$       | Input bias current  |  | 25°C                       | 25          | 175         |     | 25          | 175         |     | pA               |
|                |   |  | Full range                 |             | 65          |     |             | 65          |     | 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  | 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   | 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   | $V_{IC} = V_{ICRmin}, \quad V_O = 0, \quad R_S = 50 \Omega$                              | 25°C                       | 80          | 98          |     | 80          | 98          |     | dB               |
|                |   |  | Full range                 | 78          |             |     | 78          |             |     |                  |
| $k_{SVR}$      | Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5 \text{ V to } \pm 15 \text{ V}, \quad V_O = 0, \quad R_S = 50 \Omega$ | 25°C                       | 82          | 99          |     | 82          | 99          |     | dB               |
|                |   |  | Full range                 | 80          |             |     | 80          |             |     |                  |

\*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

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





**TLE2074, TLE2074A, TLE2074Y**  
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 SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

| PARAMETER                                 | TEST CONDITIONS                     | $T_A^\dagger$   | TLE2074M |     |     | TLE2074AM |     |     | UNIT |
|---|-------------------------------------|-----------------|----------|-----|-----|-----------|-----|-----|------|
|   |                                     |                 | MIN      | TYP | MAX | MIN       | TYP | MAX |      |
| $I_{CC}$ Supply current (four amplifiers) | $V_O = 0$ , 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                     | $V_{IC} = 0$ , $R_L = 2$ k $\Omega$ | 25°C            |          | 120 |     |           | 120 |     | dB   |
| $I_{OS}$ Short-circuit output current     | $V_O = 0$                           | $V_{ID} = 1$ V  | –30      | –45 |     | –30       | –45 |     | mA   |
|   |                                     | $V_{ID} = -1$ V | 30       | 48  |     | 30        | 48  |     |      |

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

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

| PARAMETER           |   | TEST CONDITIONS  |                     | T <sub>A</sub> † | TLE2074M |        |      | TLE2074AM |        |     | UNIT |
|---------------------|---|--|---------------------|------------------|----------|--------|------|-----------|--------|-----|------|
|                     |   |  |                     |                  | MIN      | TYP    | MAX  | MIN       | TYP    | MAX |      |
| SR +                | Positive slew rate                          | V <sub>O</sub> (PP) = 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</sub> (PP) | 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</sub> (PP) = 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</sub> (PP) = 20 V, A <sub>VD</sub> = −1, R <sub>L</sub> = 2 kΩ, 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°    |      |           |        |     |      |

\*On products compliant to MIL-STD-883, Class B, this parameter is not production tested.

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

# TLE2074, TLE2074A, TLE2074Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

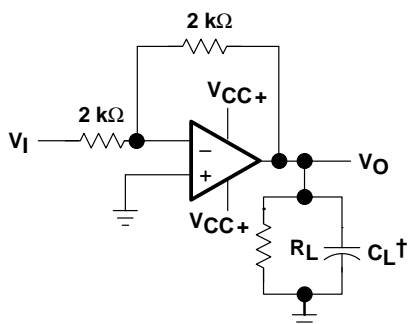
### JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

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

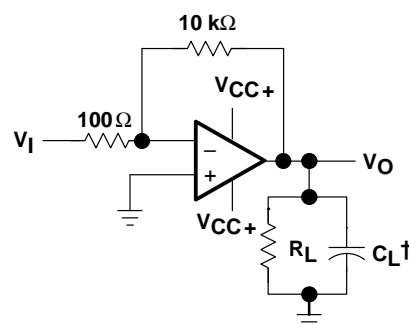
| PARAMETER |   | TEST CONDITIONS   |                             | TLE2074Y        |                  |     | UNIT     |
|-----------|---|---|-----------------------------|-----------------|------------------|-----|----------|
|           |   |   |                             | MIN             | TYP              | MAX |          |
| $V_{IO}$  | Input offset voltage  | $V_{IC} = 0$ ,<br>$R_S = 50\ \Omega$  | $V_O = 0$ ,                 |                 |                  | 5   | mV       |
| $I_{IO}$  | Input offset current  | $V_{IC} = 0$ ,<br>See Figure 4  | $V_O = 0$ ,                 |                 | 15               | 100 | pA       |
| $I_{IB}$  | Input bias current  |   |                             |                 | 25               | 175 | pA       |
| $V_{ICR}$ | Common-mode input voltage range                                     | $R_S = 50\ \Omega$  |                             | 15<br>to<br>-11 | 15<br>to<br>11.9 |     | V        |
| $V_{OM+}$ | Maximum positive peak output voltage swing                          | $I_O = -200\ \mu\text{A}$   |                             | 13.8            | 14.1             |     | V        |
|           |   | $I_O = -2\text{ mA}$  |                             | 13.5            | 13.9             |     |          |
|           |   | $I_O = -20\text{ mA}$   |                             | 11.5            | 12.3             |     |          |
| $V_{OM-}$ | Maximum negative peak output voltage swing                          | $I_O = 200\ \mu\text{A}$  |                             | -13.8           | -14.2            |     | V        |
|           |   | $I_O = 2\text{ mA}$   |                             | -13.5           | -14              |     |          |
|           |   | $I_O = 20\text{ mA}$  |                             | -11.5           | -12.4            |     |          |
| $A_{VD}$  | Large-signal differential voltage amplification                     | $V_O = \pm 10\text{ V}$   | $R_L = 600\ \Omega$         | 80              | 96               |     | dB       |
|           |   |   | $R_L = 2\text{ k}\Omega$    | 90              | 109              |     |          |
|           |   |   | $R_L = 10\text{ k}\Omega$   | 95              | 118              |     |          |
| $r_i$     | Input resistance  | $V_{IC} = 0$  |                             |                 | $10^{12}$        |     | $\Omega$ |
| $c_i$     | Input capacitance   | Common mode   | $V_O = 0$ ,<br>See Figure 5 |                 | 7.5              |     | pF       |
|           |   | Differential  |                             |                 | 2.5              |     |          |
| $z_o$     | Open-loop output impedance  | $f = 1\text{ MHz}$  |                             |                 | 80               |     | $\Omega$ |
| CMRR      | Common-mode rejection ratio   | $V_{IC} = V_{ICRmin}$ ,<br>$R_S = 50\ \Omega$   | $V_O = 0$ ,                 | 80              | 98               |     | dB       |
| kSVR      | Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5\text{ V to } \pm 15\text{ V}$ ,<br>$V_O = 0$ ,<br>$R_S = 50\ \Omega$ |                             | 82              | 99               |     | dB       |
| $I_{CC}$  | Supply current (four amplifiers)                                    | $V_O = 0$ ,<br>No load  |                             | 5.2             | 6.5              | 7.5 | mA       |
| $I_{OS}$  | Short-circuit output current  | $V_O = 0$   | $V_{ID} = 1\text{ V}$       | -30             | -45              |     | mA       |
|           |   |   | $V_{ID} = -1\text{ V}$      | 30              | 48               |     |          |

## PARAMETER MEASUREMENT INFORMATION



† Includes fixture capacitance

Figure 3. Slew-Rate Test Circuit



† Includes fixture capacitance

Figure 4. Unity-Gain Bandwidth and Phase-Margin Test Circuit

## PARAMETER MEASUREMENT INFORMATION

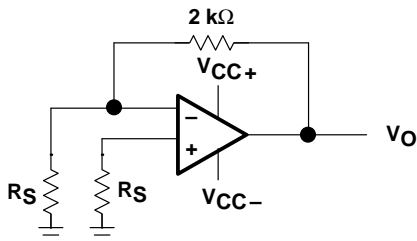


Figure 5. Noise-Voltage Test Circuit

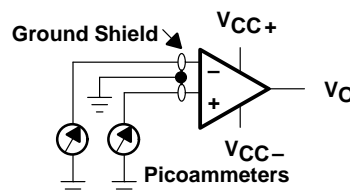


Figure 6. Input-Bias and Offset-Current Test Circuit

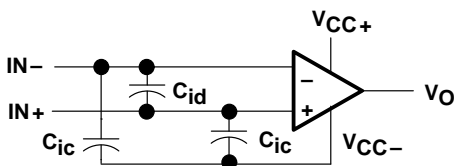


Figure 7. Internal Input Capacitance

### 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 TLE2074 and TLE2074A, 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.

**TLE2074, TLE2074A, TLE2074Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT QUAD OPERATIONAL AMPLIFIERS**

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

**TYPICAL CHARACTERISTICS**

**Table of Graphs**

|                |   |  | <b>FIGURE</b>          |
|----------------|---|--|------------------------|
| $V_{IO}$       | Input offset voltage                            | Distribution   | 8                      |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage | Distribution   | 9                      |
| $I_{IO}$       | Input offset current                            | vs Free-air temperature  | 10, 11                 |
| $I_{IB}$       | Input bias current                              | vs Free-air temperature<br>vs Supply voltage                                   | 10, 11<br>12           |
| $V_{ICR}$      | Common-mode input voltage range                 | vs Free-air temperature  | 13                     |
| $V_O$          | Output voltage                                  | vs Differential input voltage  | 14, 15                 |
| $V_{OM+}$      | Maximum positive peak output voltage            | vs Output current<br>vs Free-air temperature<br>vs Supply voltage              | 16<br>18, 19<br>20     |
| $V_{OM-}$      | Maximum negative peak output voltage            | vs Output current<br>vs Free-air temperature<br>vs Supply voltage              | 17<br>18, 19<br>20     |
| $V_{O(PP)}$    | Maximum peak-to-peak output voltage             | vs Frequency   | 21                     |
| $V_O$          | Output voltage                                  | vs Settling time   | 22                     |
| $A_{VD}$       | Large-signal differential voltage amplification | vs Load resistance<br>vs Free-air temperature<br>vs Frequency                  | 23<br>24, 25<br>26, 27 |
| $CMRR$         | Common-mode rejection ratio                     | vs Frequency<br>vs Free-air temperature  | 28<br>29               |
| $k_{SVR}$      | Supply-voltage rejection ratio                  | vs Frequency<br>vs Free-air temperature  | 30<br>31               |
| $I_{CC}$       | Supply current                                  | vs Supply voltage<br>vs Free-air temperature<br>vs Differential input voltage  | 32<br>33<br>34, 35     |
| $I_{OS}$       | Short-circuit output current                    | vs Supply voltage<br>vs Time<br>vs Free-air temperature                        | 36<br>37<br>38         |
| $SR$           | Slew rate                                       | vs Free-air temperature<br>vs Load resistance<br>vs Differential input voltage | 39, 40<br>41<br>42     |
| $V_n$          | Equivalent Input noise voltage                  | vs Frequency   | 43                     |
| $V_n$          | Input referred noise voltage                    | vs Noise bandwidth<br>Over a 10-second time interval                           | 44<br>45               |
|                | Third-octave spectral noise density             | vs Frequency   | 46                     |
| $THD + N$      | Total harmonic distortion plus noise            | vs Frequency   | 47, 48                 |
| $B_1$          | Unity-gain bandwidth                            | vs Load capacitance  | 49                     |
|                | Gain-bandwidth product                          | vs Free-air temperature<br>vs Supply voltage                                   | 50<br>51               |
| $A_m$          | Gain margin                                     | vs Load capacitance  | 52                     |
| $\phi_m$       | Phase margin                                    | vs Free-air temperature<br>vs Supply voltage<br>vs Load capacitance            | 53<br>54<br>55         |
|                | Phase shift                                     | vs Frequency   | 26                     |
|                | Noninverting large-signal pulse response        | vs Time  | 56                     |
|                | Small-signal pulse response                     | vs Time  | 57                     |
| $z_o$          | Closed-loop output impedance                    | vs Frequency   | 58                     |
|                | Crosstalk attenuation                           | vs Frequency   | 59                     |

## TYPICAL CHARACTERISTICS†

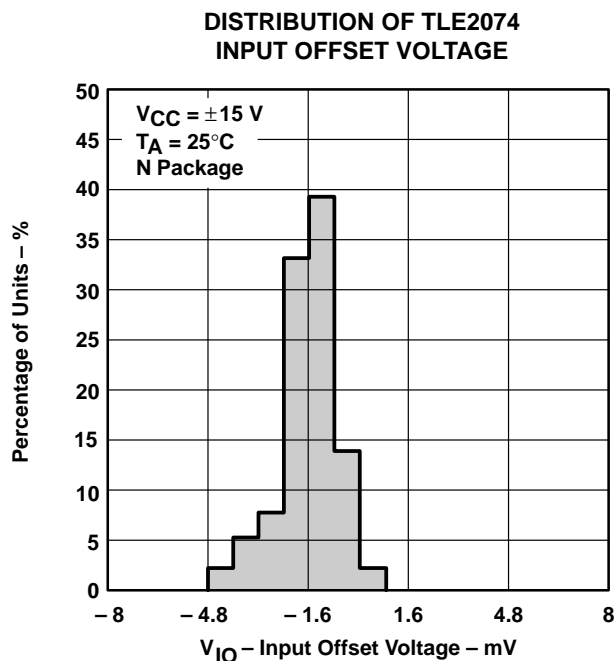


Figure 8

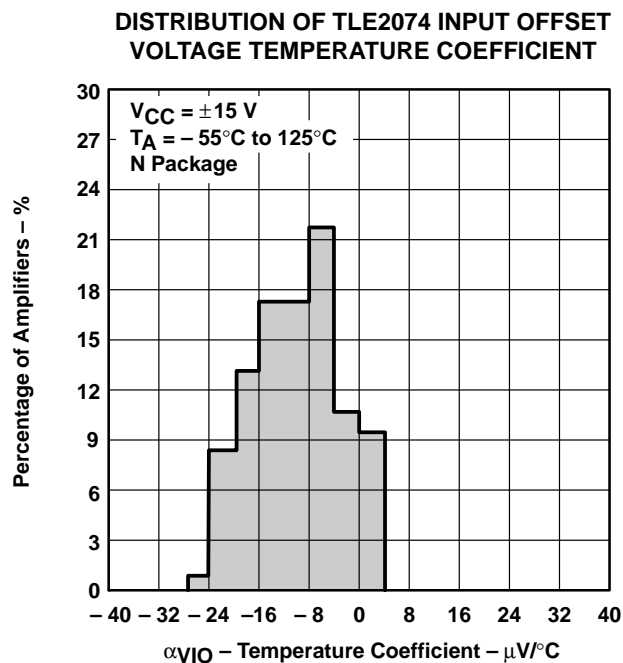


Figure 9

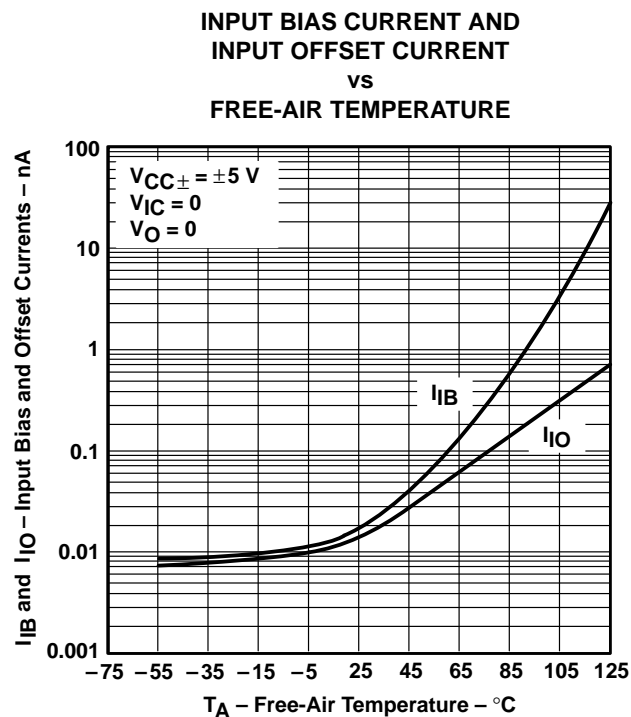


Figure 10

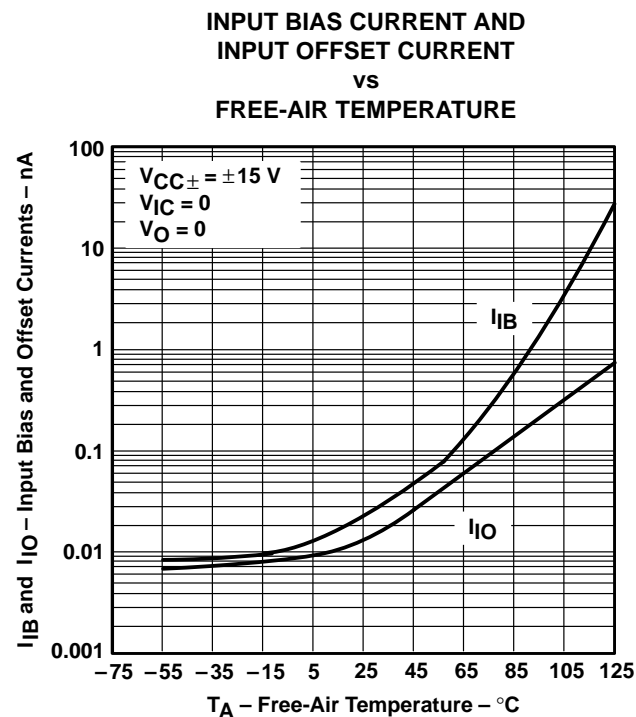


Figure 11

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

# TLE2074, TLE2074A, TLE2074Y EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

## TYPICAL CHARACTERISTICS†

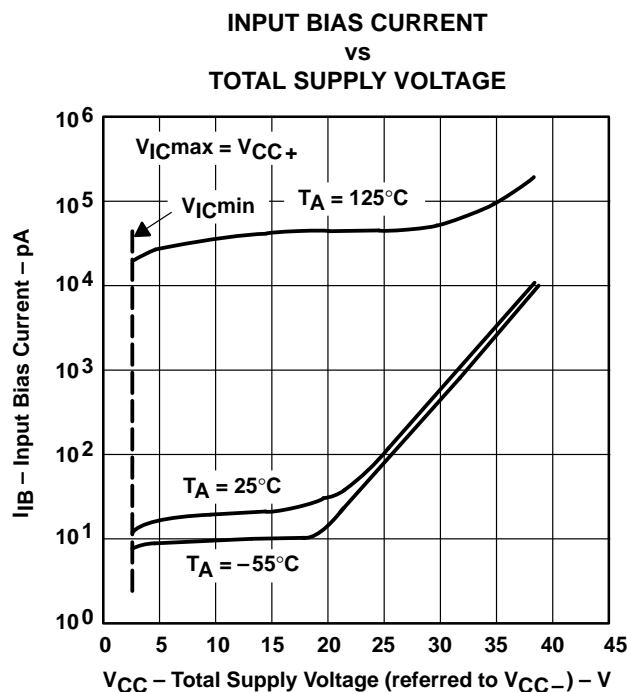


Figure 12

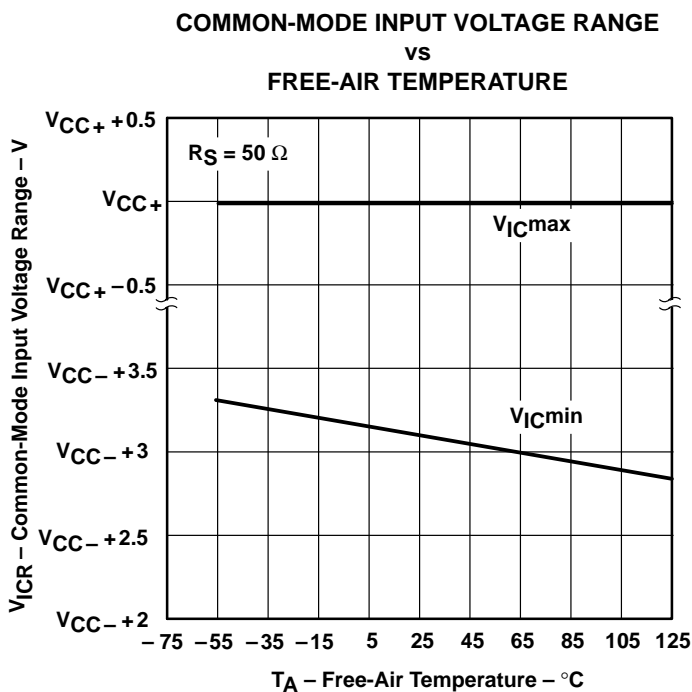


Figure 13

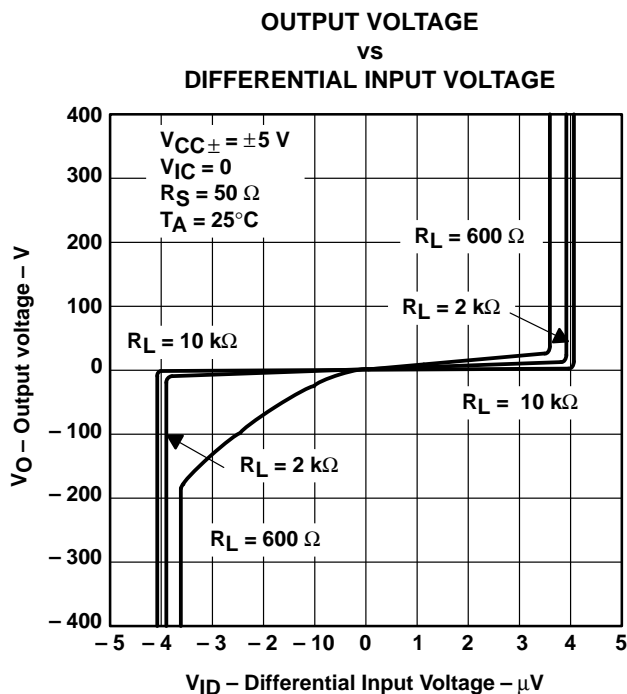


Figure 14

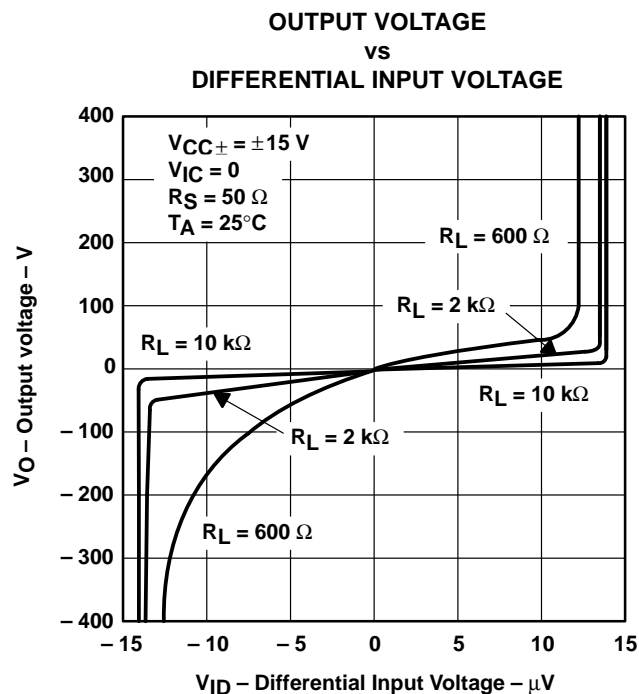


Figure 15

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

### TYPICAL CHARACTERISTICS†

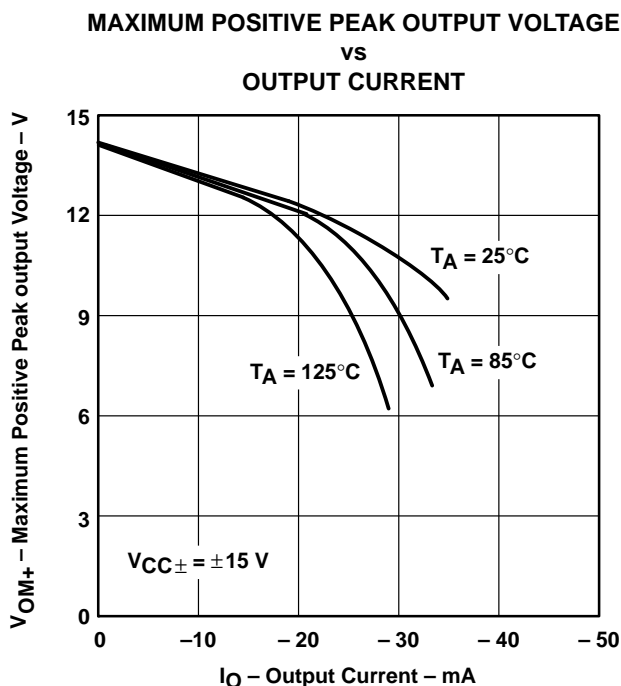


Figure 16

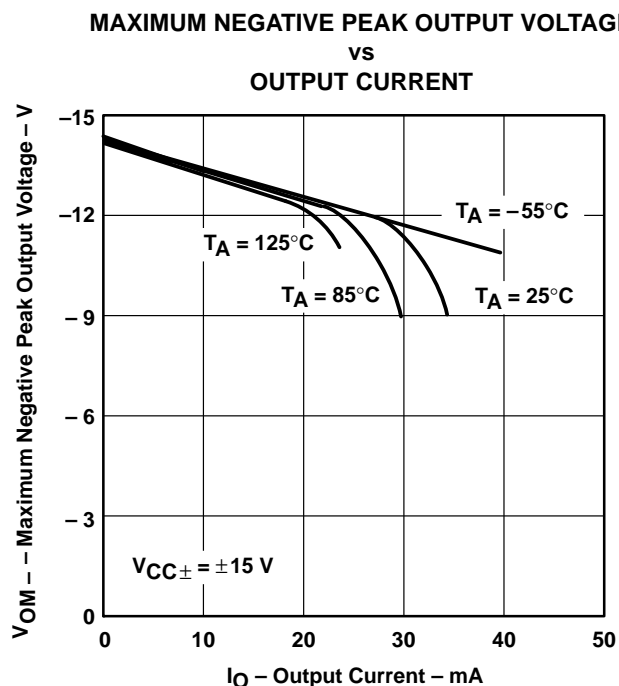


Figure 17

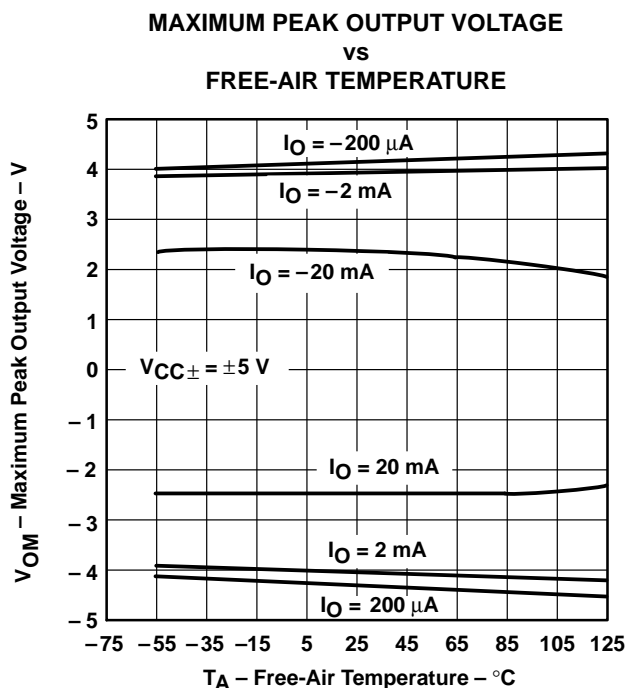


Figure 18

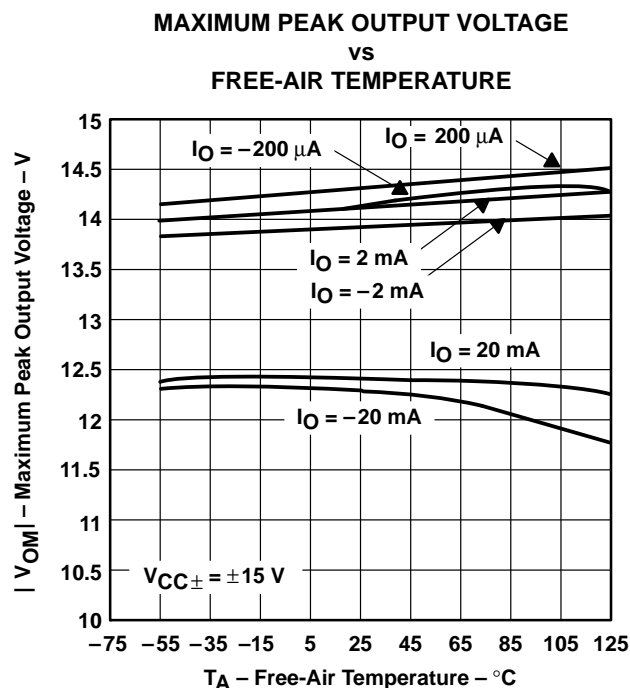


Figure 19

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

# TYPICAL CHARACTERISTICS†

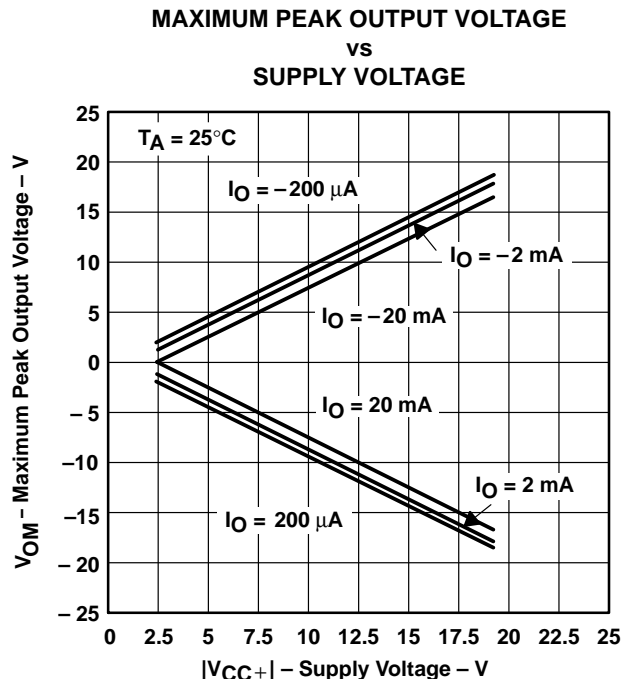


Figure 20

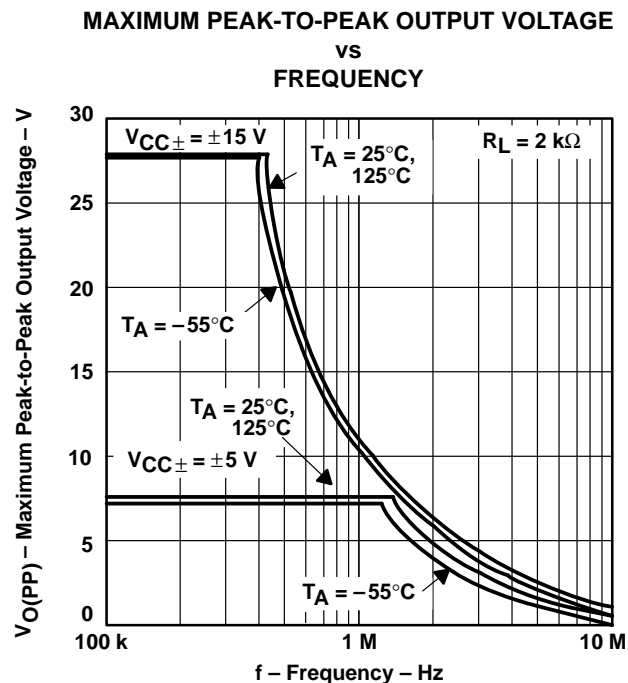


Figure 21

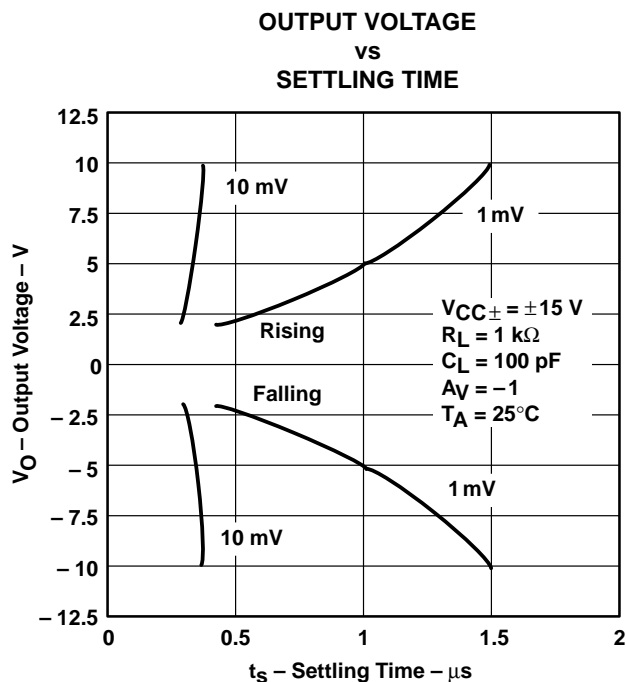


Figure 22

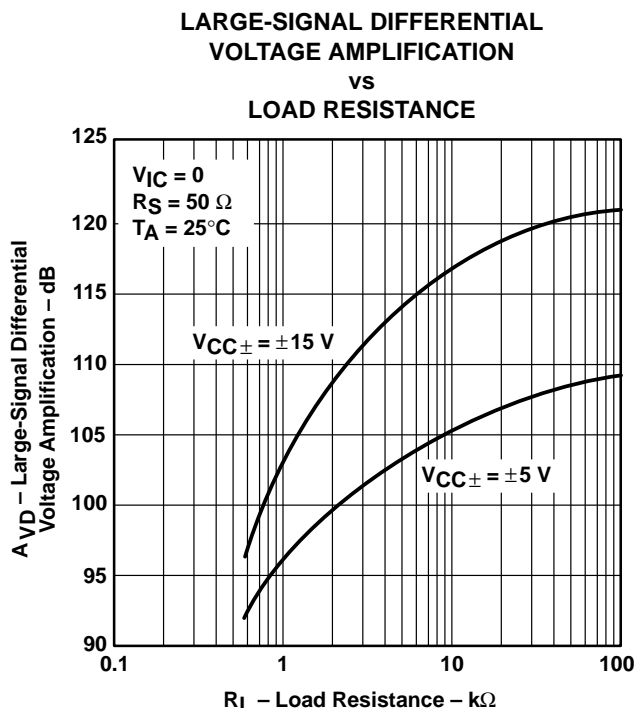


Figure 23

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



## TYPICAL CHARACTERISTICS†

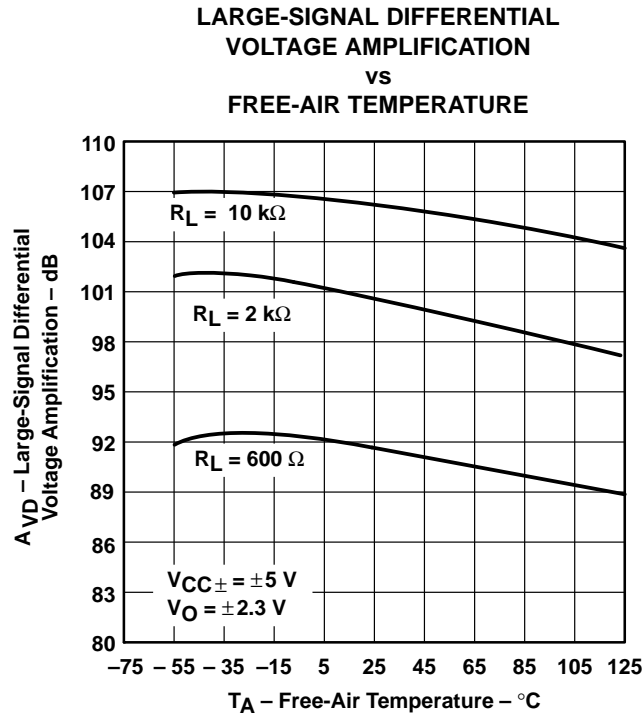


Figure 24

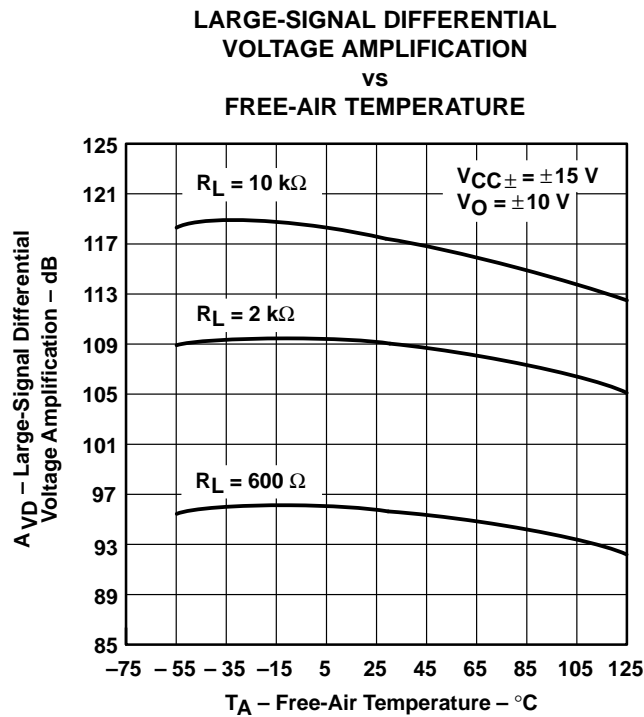


Figure 25

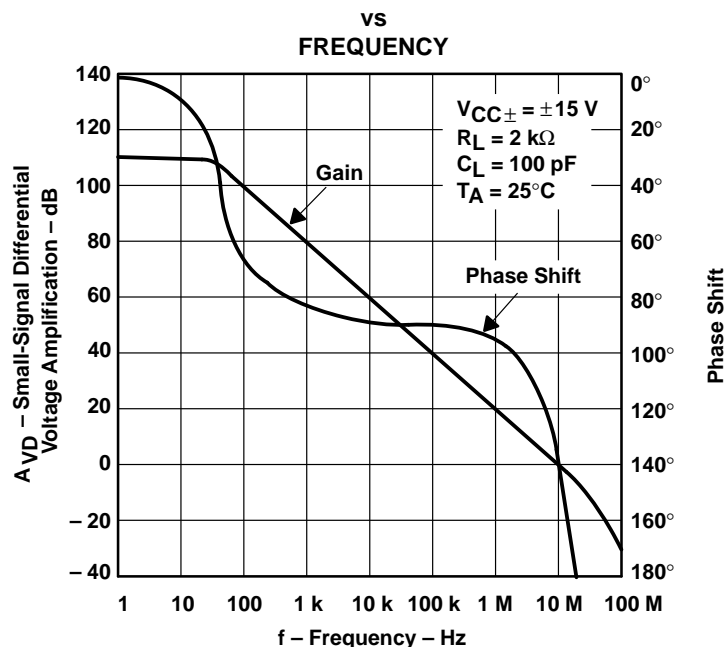
† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

**TLE2074, TLE2074A, TLE2074Y**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**JFET-INPUT QUAD OPERATIONAL AMPLIFIERS**

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

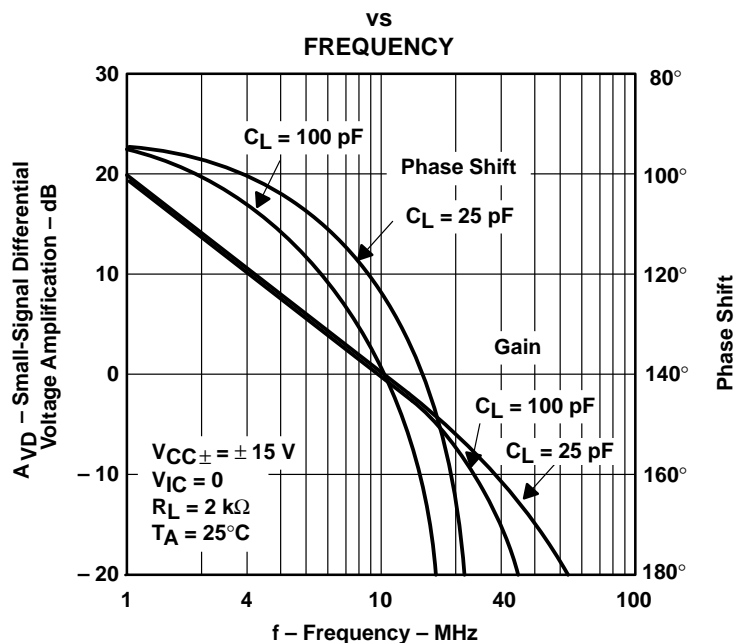
**TYPICAL CHARACTERISTICS†**

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



**Figure 26**

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



**Figure 27**

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

## TYPICAL CHARACTERISTICS†

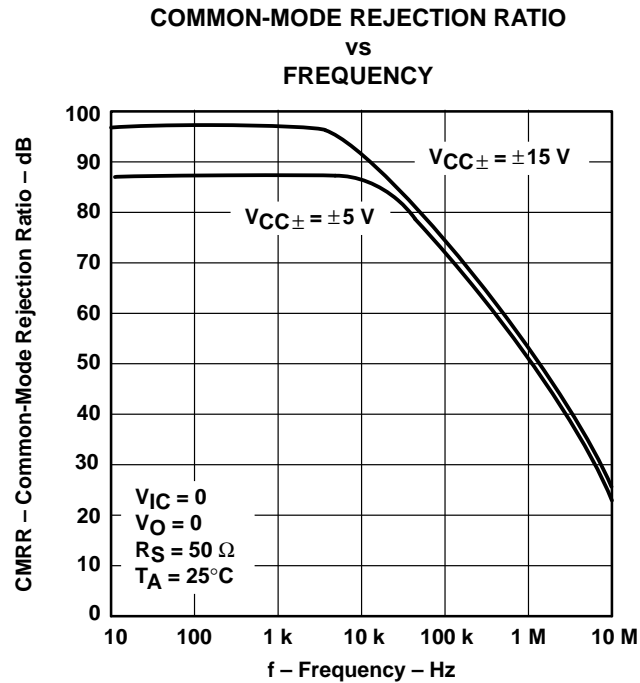


Figure 28

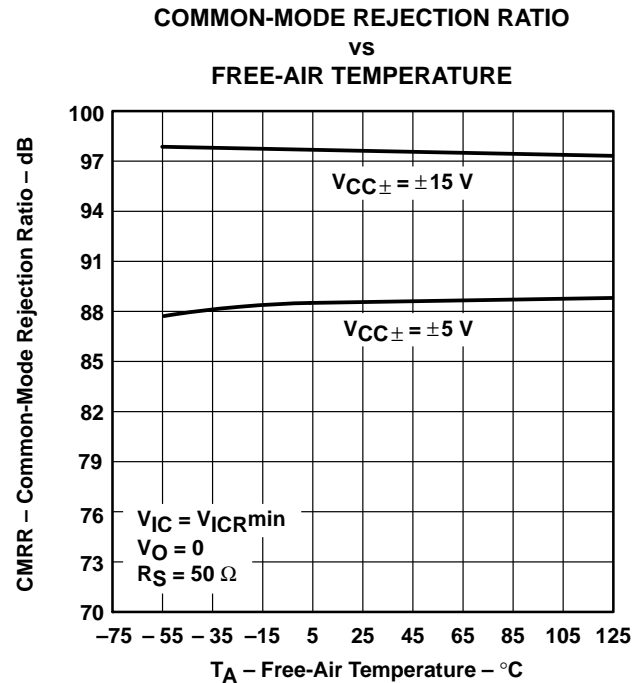


Figure 29

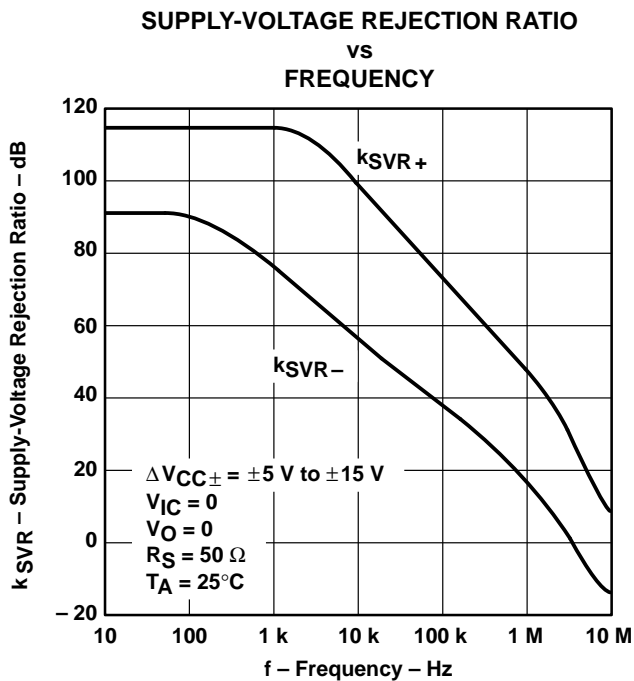


Figure 30

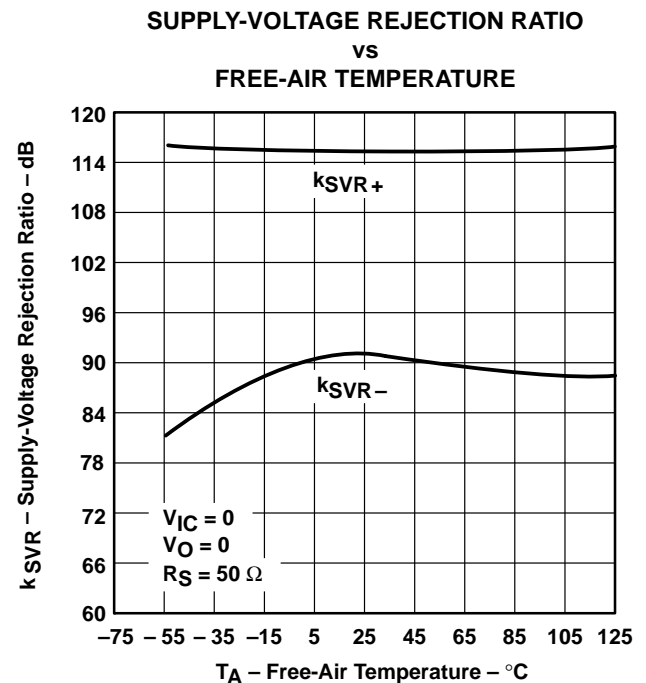


Figure 31

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

# TLE2074, TLE2074A, TLE2074Y EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

## TYPICAL CHARACTERISTICS†

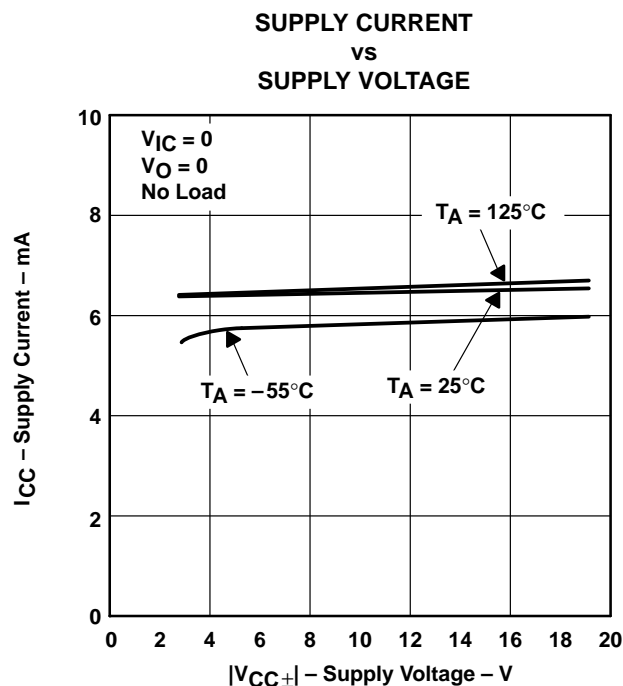


Figure 32

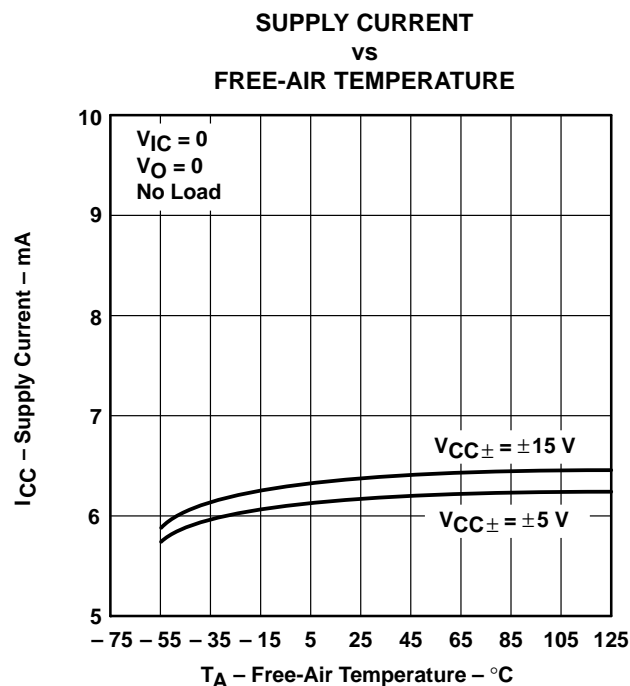


Figure 33

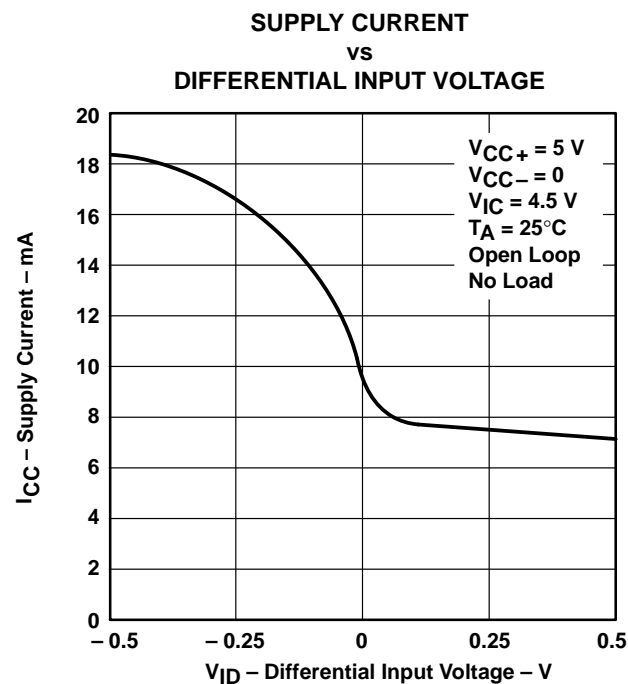


Figure 34

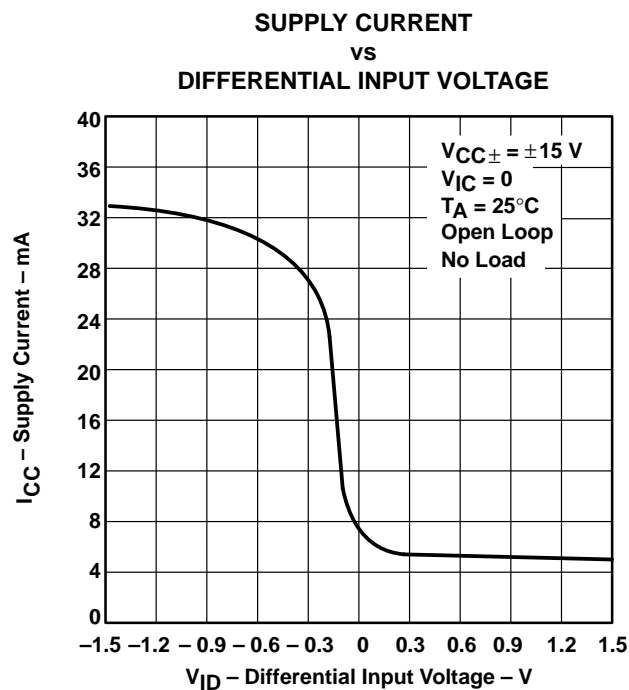
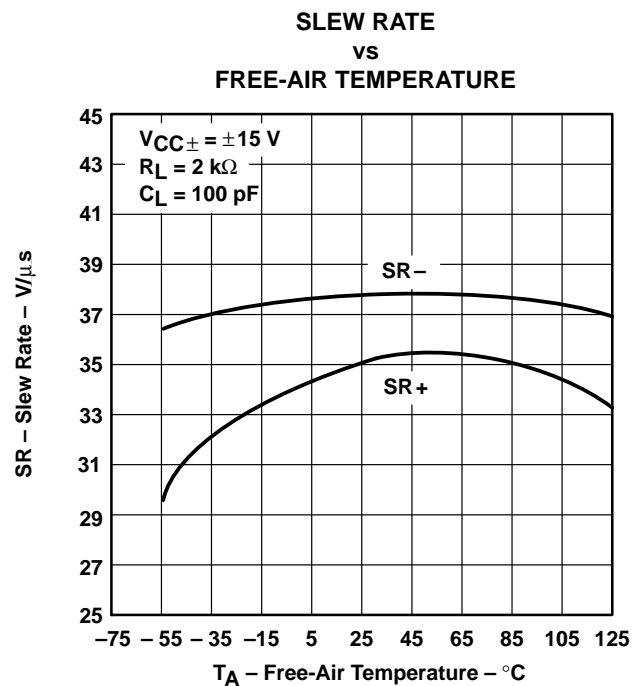
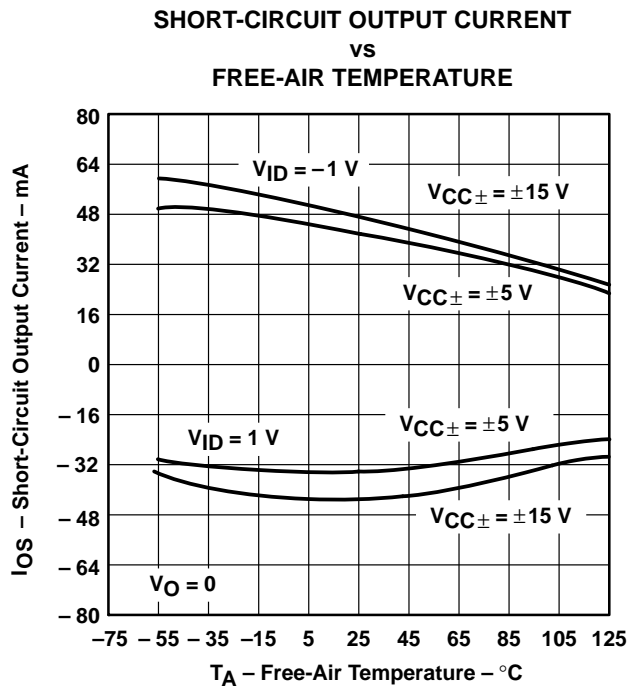
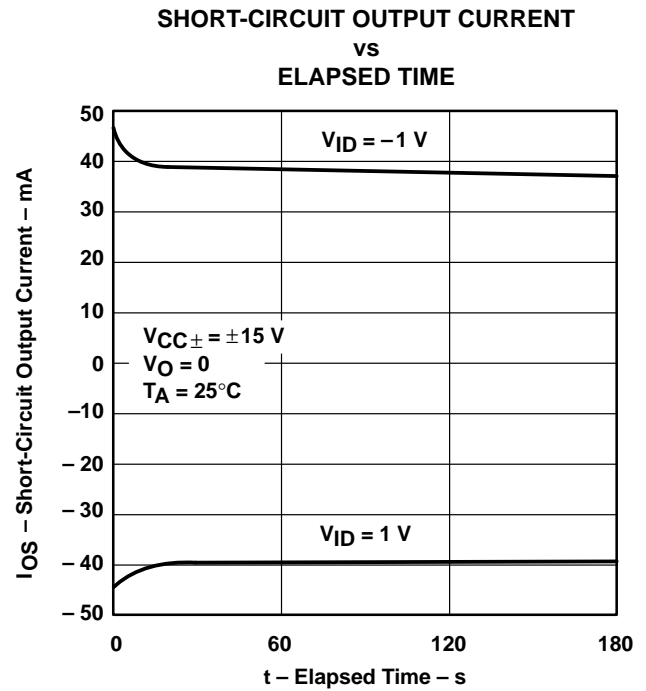
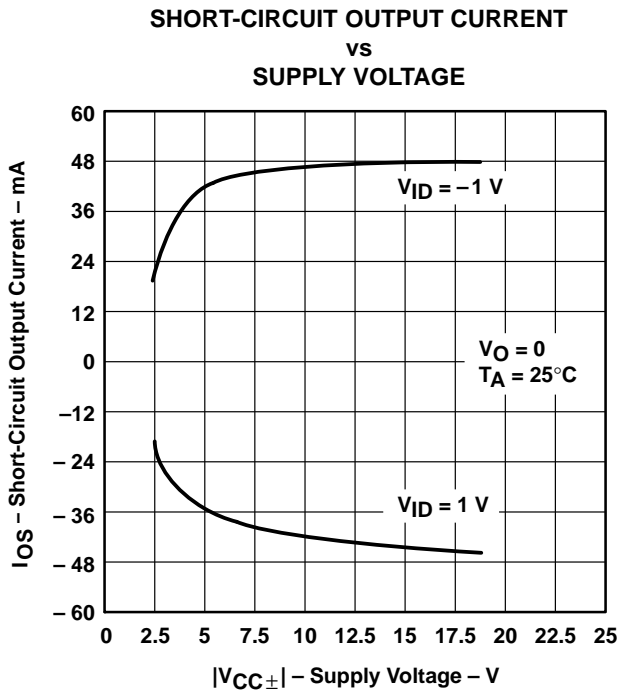


Figure 35

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

## TYPICAL CHARACTERISTICS†



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

# TLE2074, TLE2074A, TLE2074Y EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

## TYPICAL CHARACTERISTICS†

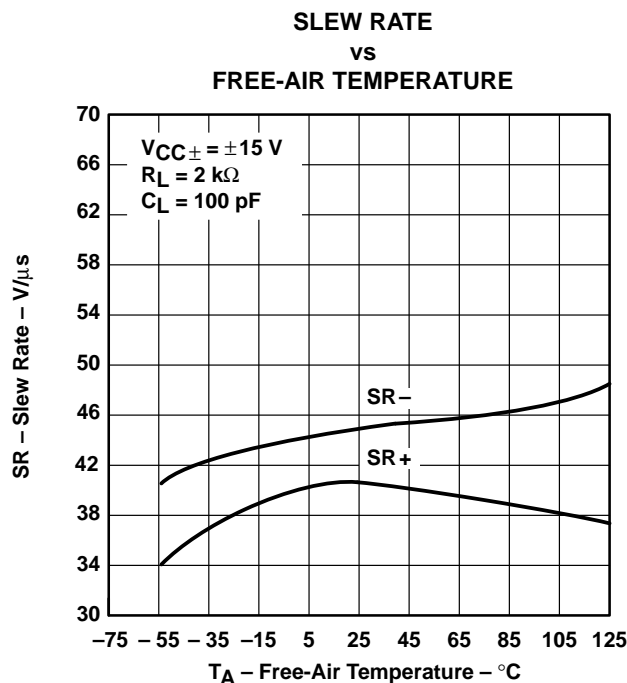


Figure 40

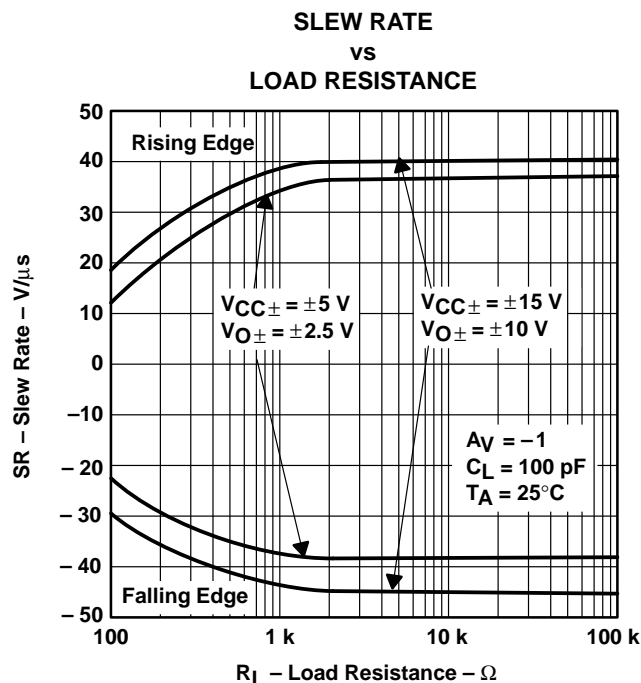


Figure 41

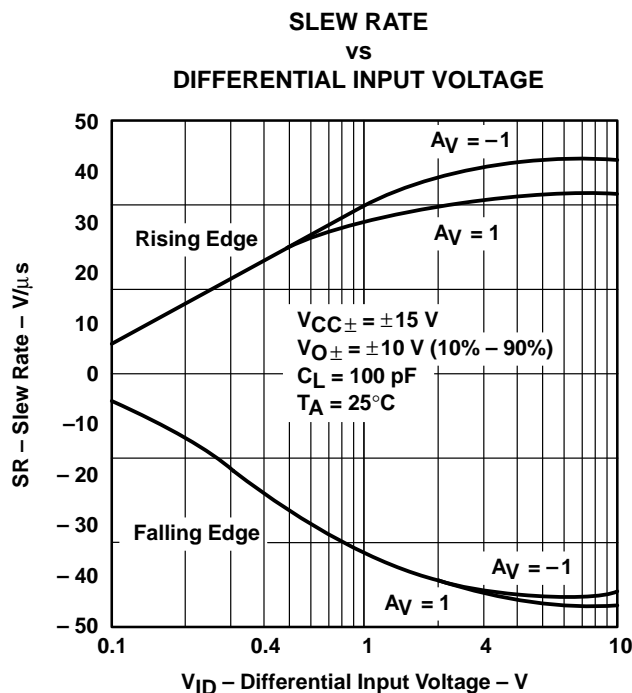


Figure 42

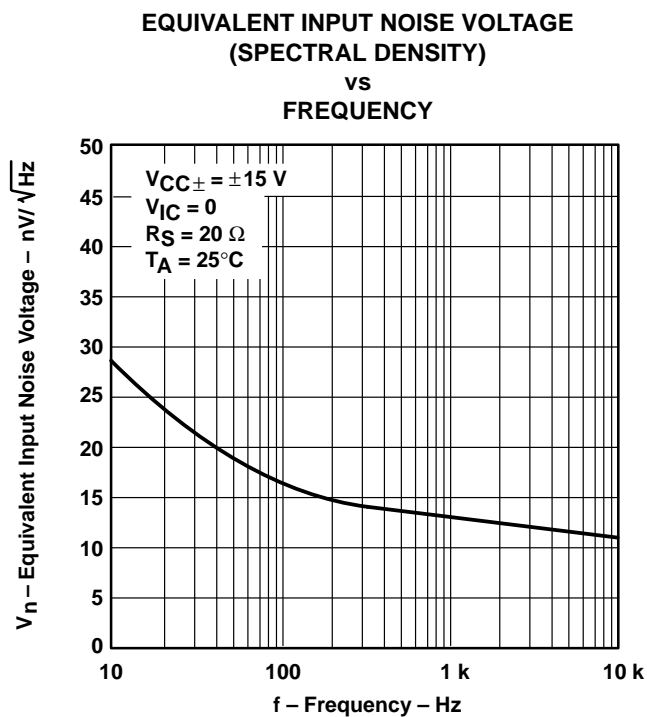


Figure 43

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

## TYPICAL CHARACTERISTICS

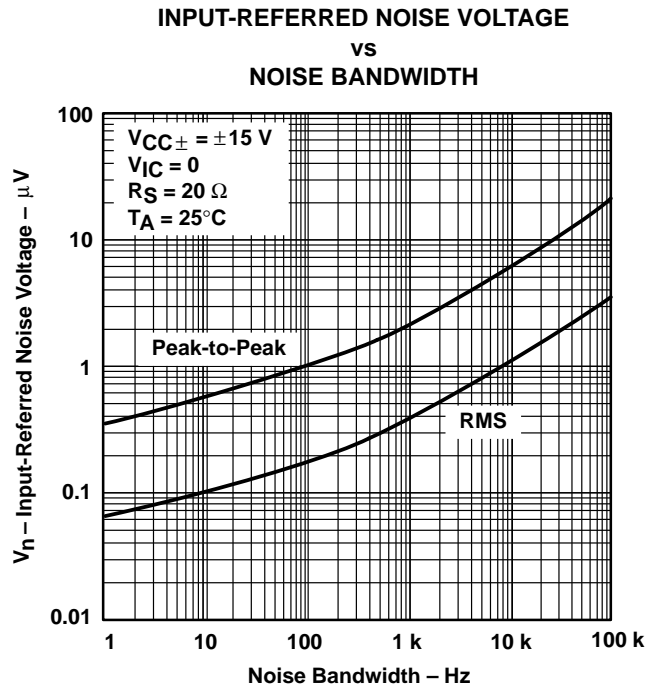


Figure 44

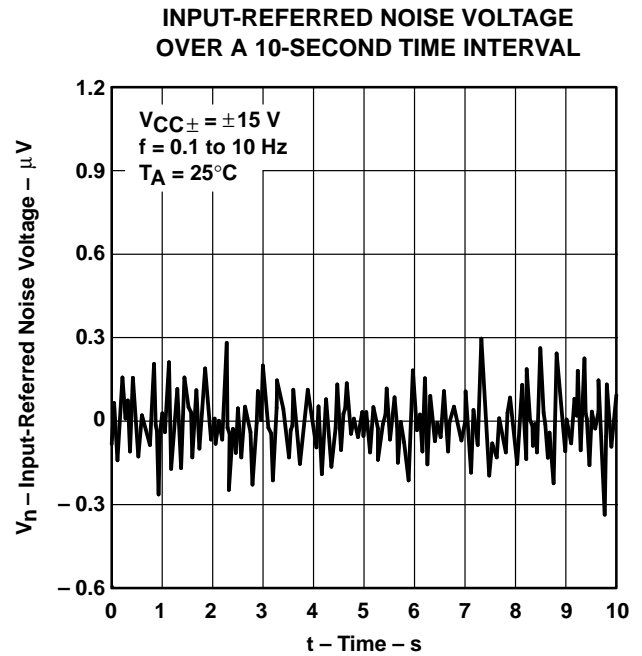


Figure 45

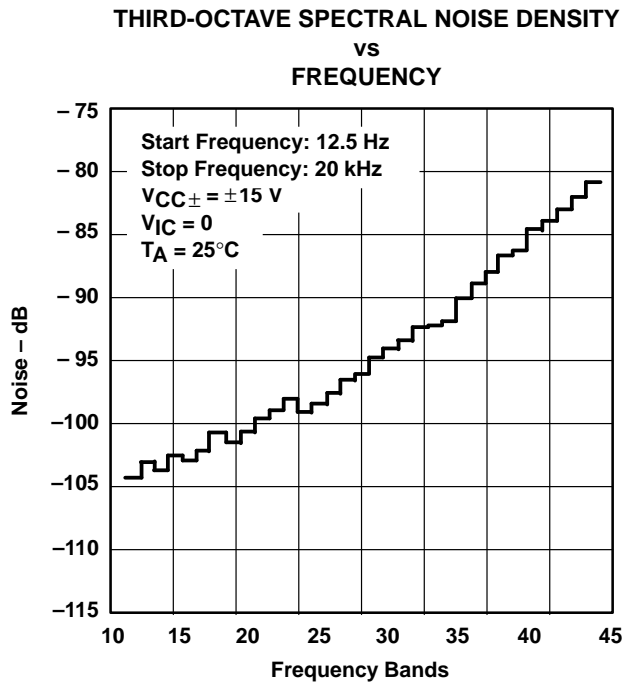


Figure 46

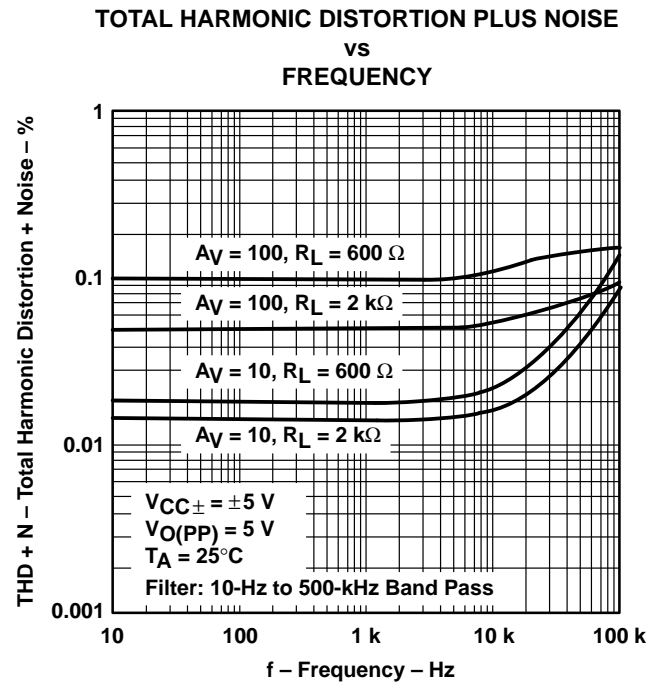


Figure 47

# TLE2074, TLE2074A, TLE2074Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

### JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

#### TYPICAL CHARACTERISTICS†

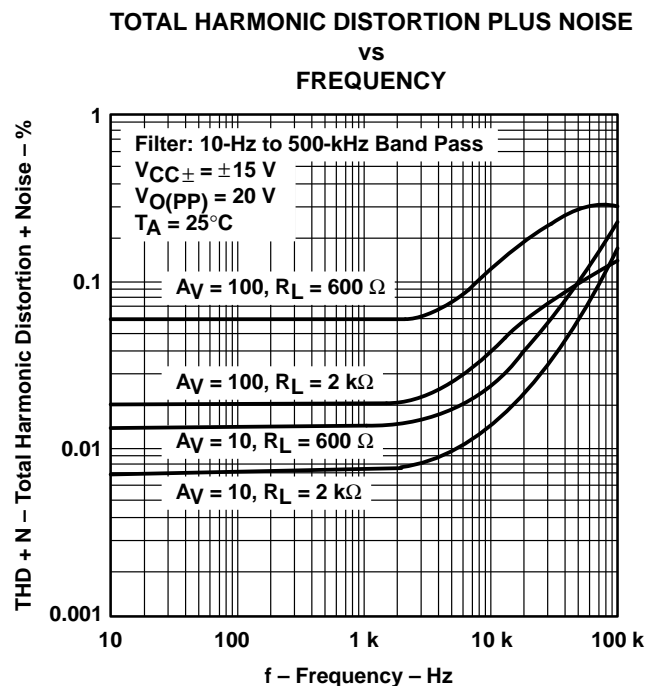


Figure 48

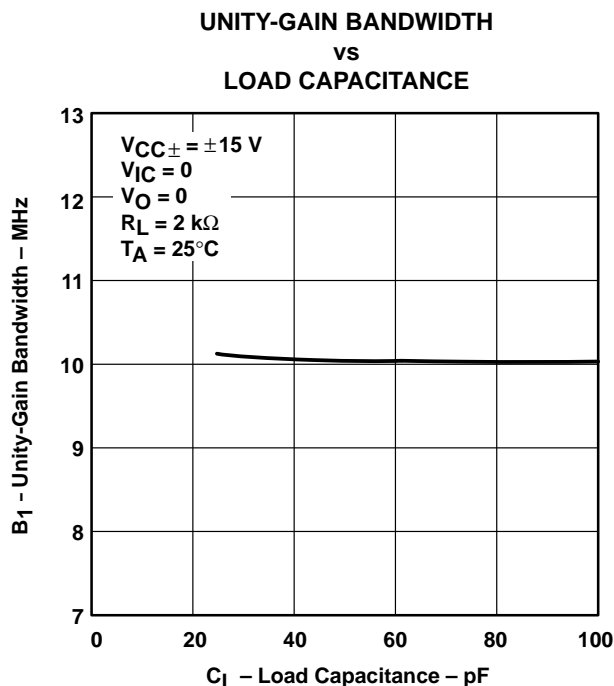


Figure 49

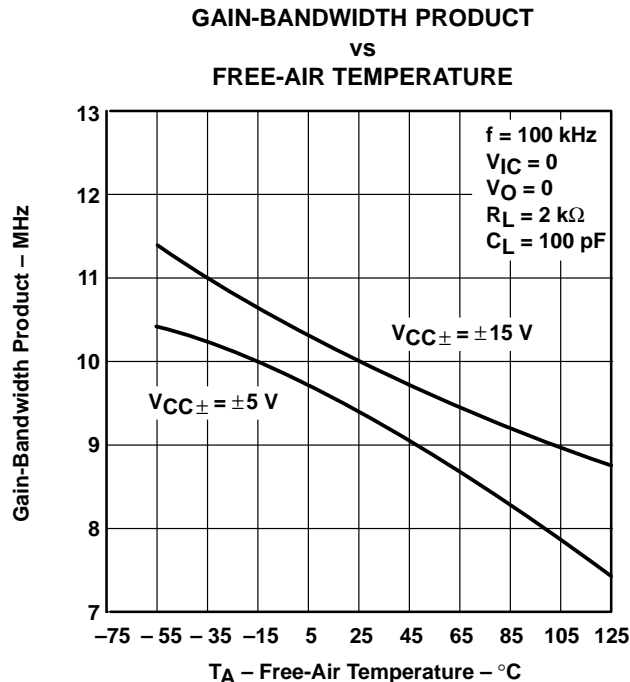


Figure 50

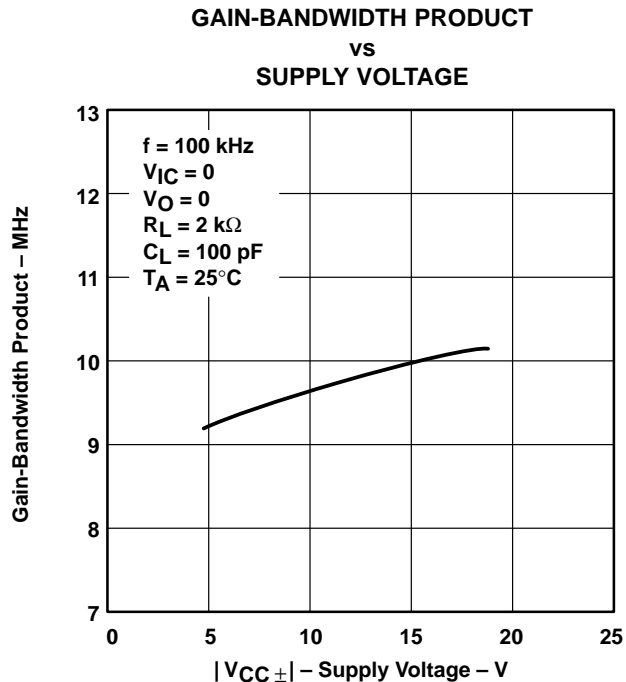


Figure 51

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



## TYPICAL CHARACTERISTICS†

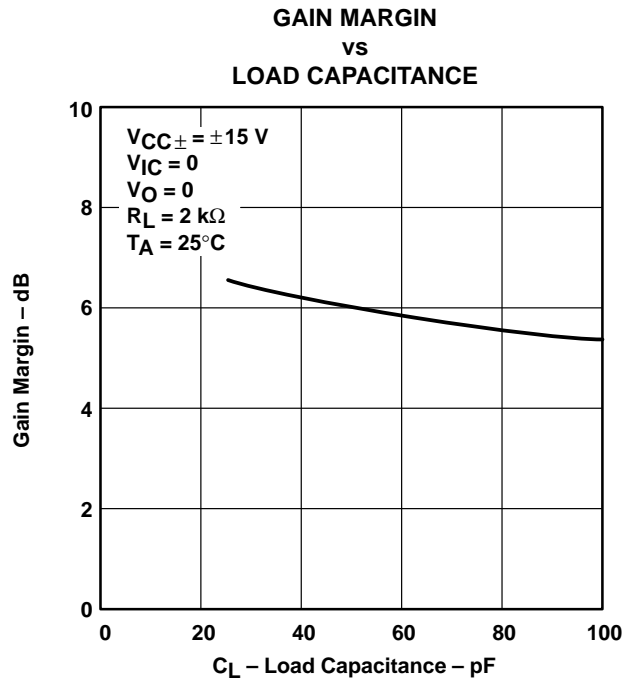


Figure 52

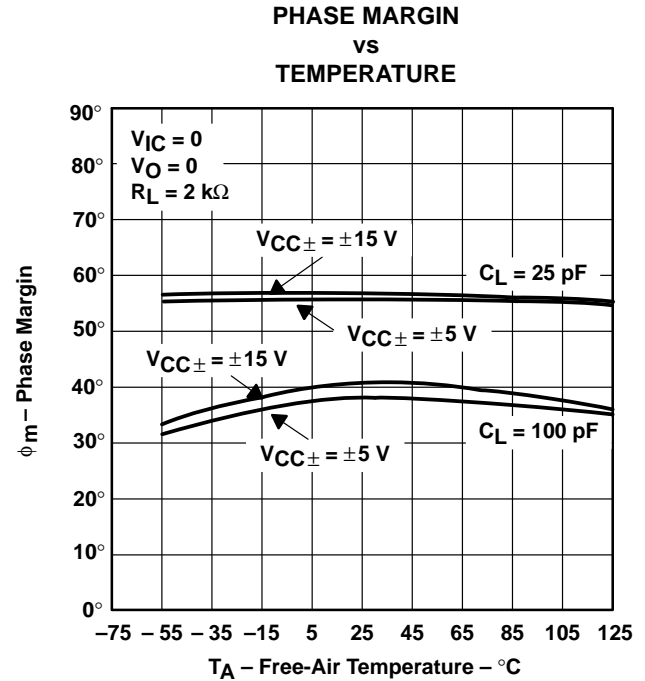


Figure 53

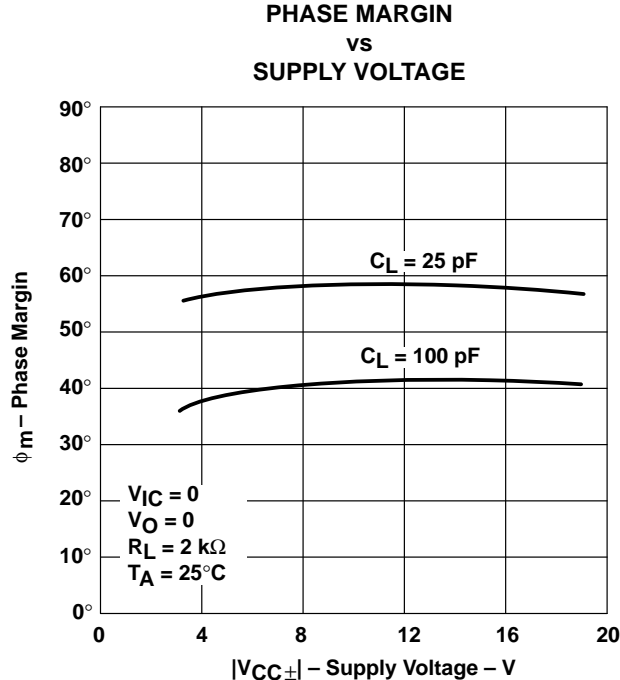


Figure 54

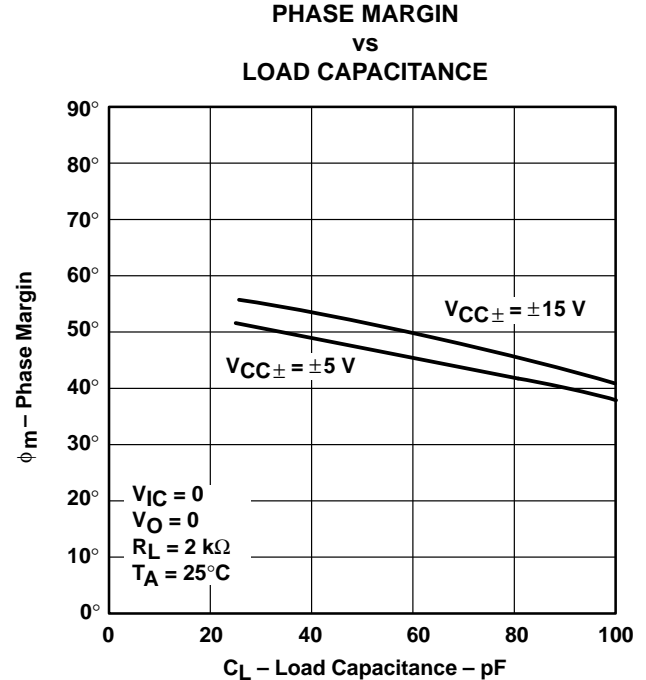


Figure 55

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

# TLE2074, TLE2074A, TLE2074Y EXCALIBUR LOW-NOISE HIGH-SPEED JFET-INPUT QUAD OPERATIONAL AMPLIFIERS

SLOS123A – JUNE 1993 – REVISED AUGUST 1994

## TYPICAL CHARACTERISTICS†

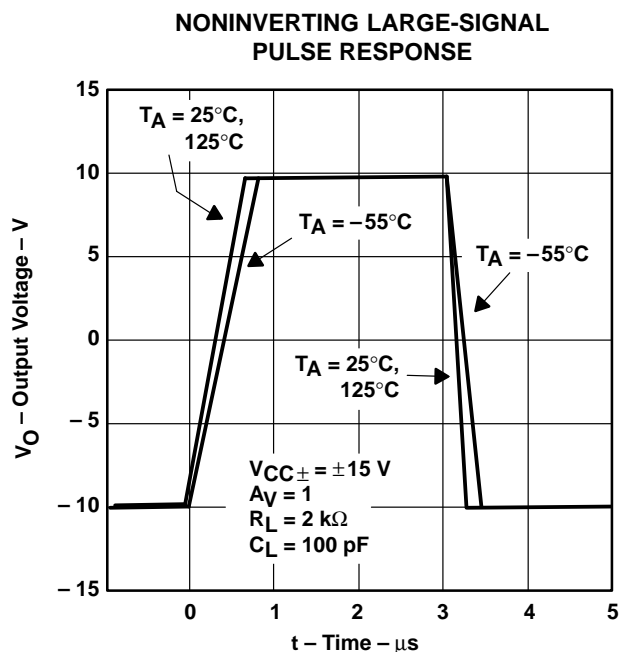


Figure 56

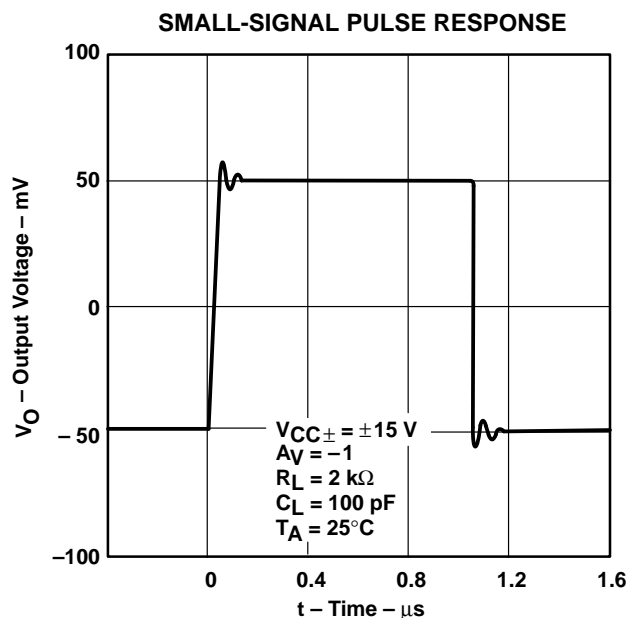


Figure 57

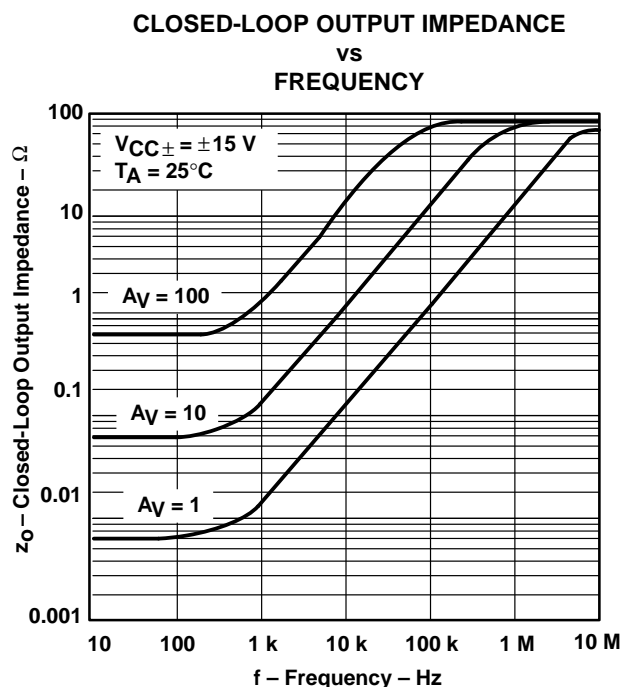


Figure 58

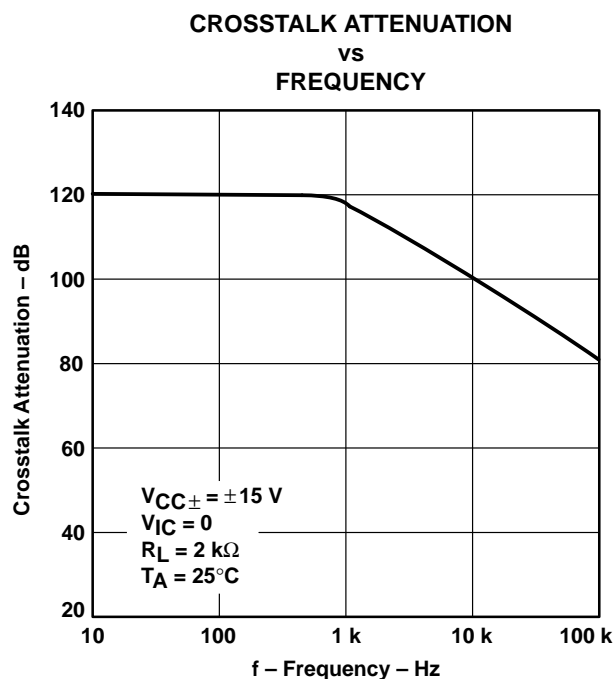


Figure 59

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

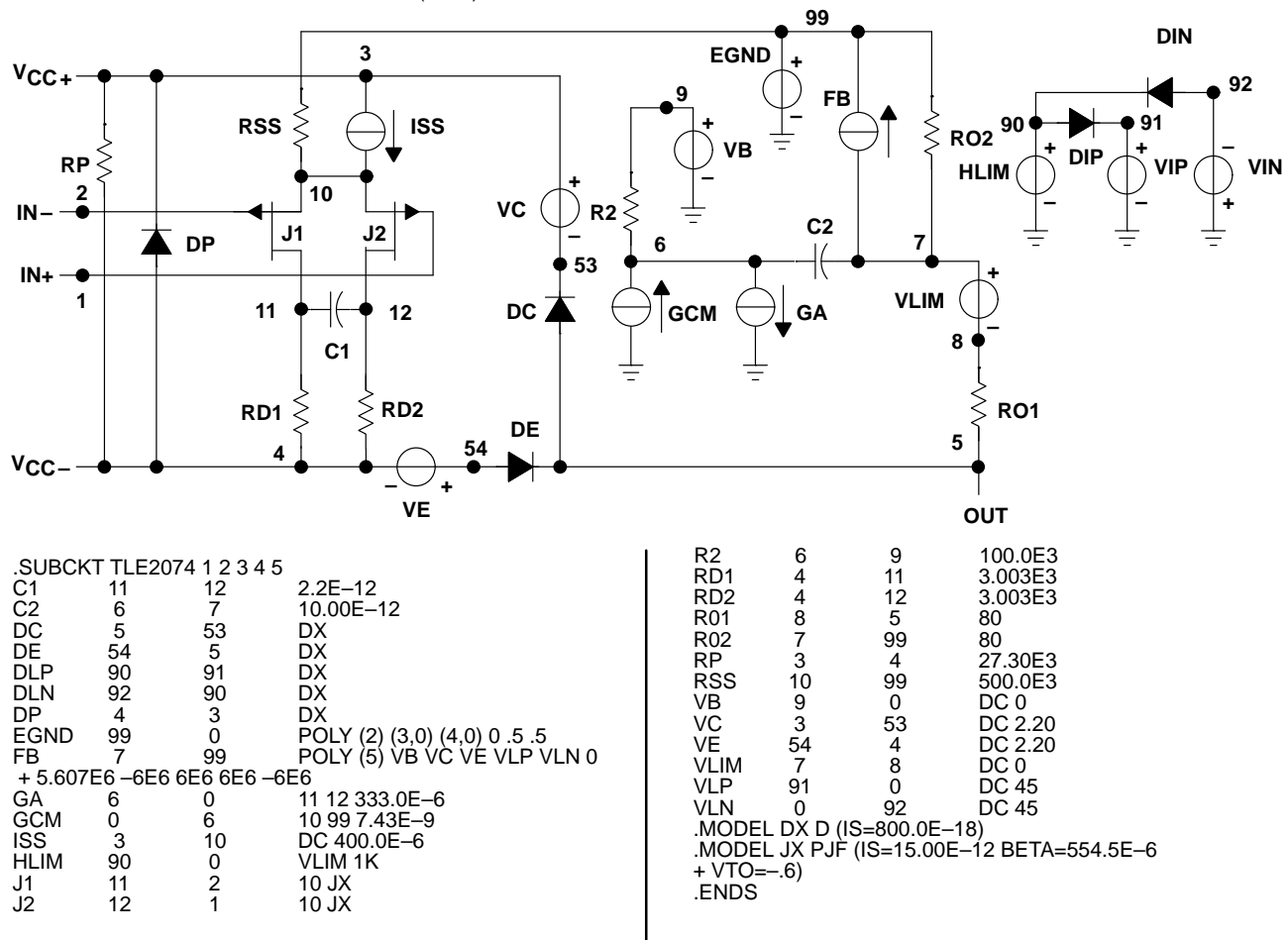
## APPLICATION INFORMATION

### macromodel information

Macromodel information provided was derived using *PSpice™ Parts™* model generation software. The Boyle macromodel (see Note 4) and subcircuit in Figure 60 were generated using the TLE2074 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 60. Boyle Macromodel and Subcircuit**

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