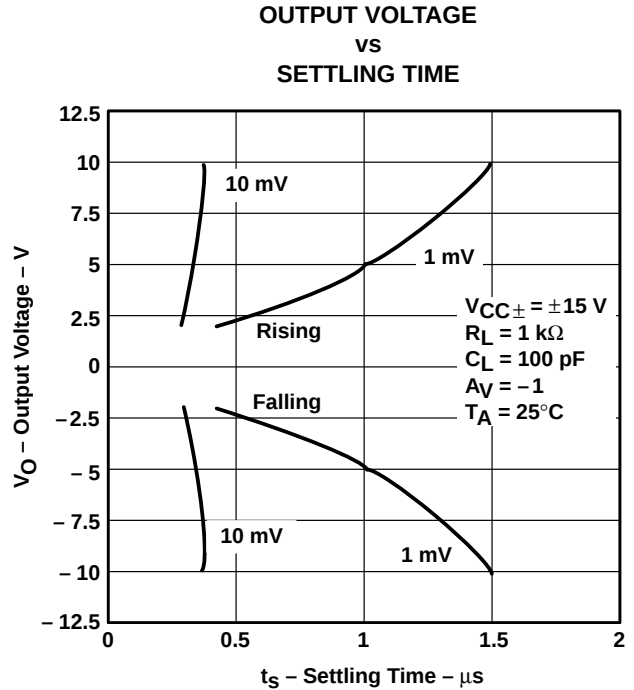
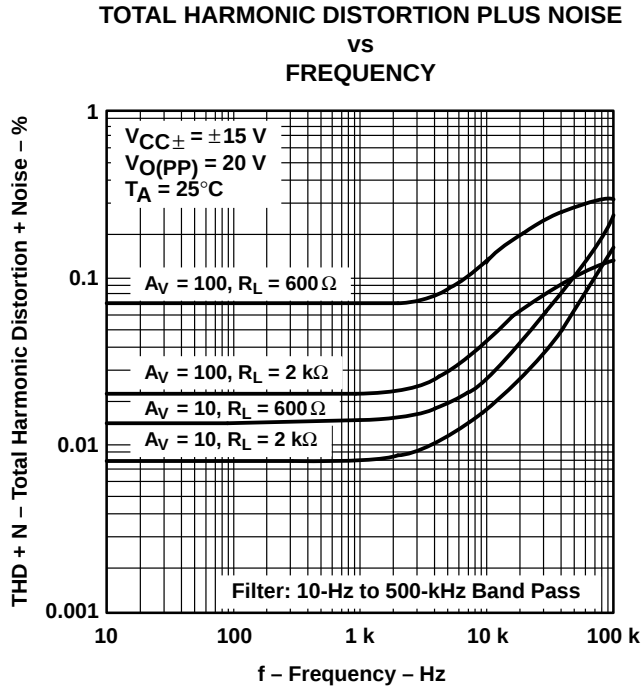


# TLE2082, TLE2082A, TLE2082Y EXCALIBUR HIGH-SPEED JFET-INPUT DUAL OPERATIONAL AMPLIFIERS

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- 40-V/ $\mu$ s Slew Rate Typ
- High-Gain Bandwidth Product . . . 10 MHz
- $\pm 30$ -mA Minimum Short-Circuit Output Current
- Wide Supply Range . . .  $\pm 2.25$  V to  $\pm 19$  V
- Fast Settling Time Using 10-V Step  
400 ns to 10 mV Typ  
1.5  $\mu$ s to 1 mV Typ
- Input Range Includes the Positive Supply
- Macromodel Included



## description

The TLE2082 and TLE2082A are high-performance, high-speed, internally compensated JFET-input dual operational amplifiers built using Texas Instruments complementary bipolar Excalibur process. The TLE2082A has a lower input offset voltage than the TLE2082. Both are pin-compatible upgrades to standard industry products.

### AVAILABLE OPTIONS

| $T_A$                                      | $V_{IOmax}$<br>AT $25^\circ\text{C}$ | PACKAGED DEVICES        |                           |                           |                         | CHIP FORM<br>(Y) |
|--------------------------------------------|--------------------------------------|-------------------------|---------------------------|---------------------------|-------------------------|------------------|
|                                            |                                      | SMALL<br>OUTLINE<br>(D) | CHIP<br>CARRIER<br>(FK)   | CERAMIC<br>DIP<br>(JG)    | PLASTIC<br>DIP<br>(P)   |                  |
| $0^\circ\text{C}$ to $70^\circ\text{C}$    | 4 mV<br>7 mV                         | TLE2082ACD<br>TLE2082CD | —                         | —                         | TLE2082ACP<br>TLE2082CP | —                |
| $-40^\circ\text{C}$ to $85^\circ\text{C}$  | 4 mV<br>7 mV                         | TLE2082AID<br>TLE2082ID | —                         | —                         | TLE2082AIP<br>TLE2082IP | TLE2082Y         |
| $-55^\circ\text{C}$ to $125^\circ\text{C}$ | 4 mV<br>7 mV                         | TLE2082AMD<br>TLE2082MD | TLE2082AMFK<br>TLE2082MFK | TLE2082AMJG<br>TLE2082MJG | TLE2082AMP<br>TLE2082MP | —                |

The D packages are available taped and reeled. Add R suffix to device type (e.g., TLE2082ACDR). 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.



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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.

# TLE2082, TLE2082A, TLE2082Y

## EXCALIBUR HIGH-SPEED

### JFET-INPUT DUAL OPERATIONAL AMPLIFIERS

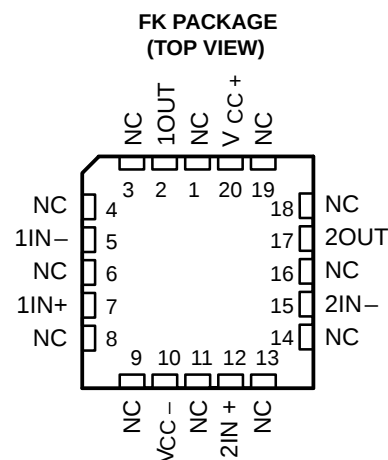
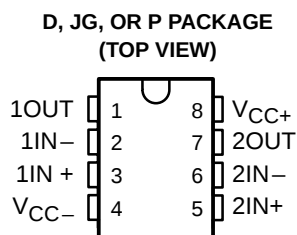
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#### description (continued)

The design features a  $28\text{-V}/\mu\text{s}$  minimum slew rate, which results in a high-power bandwidth. Settling time to 0.1% of a 10-V step (1 k $\Omega$ /100-pF load) is approximately 400 ns. Gain-bandwidth product is typically 10 MHz with an 8-MHz minimum. As such, the TLE2082 and TLE2082A offer significant speed and noise advantages at a low 1.5-mA typical supply current per channel.

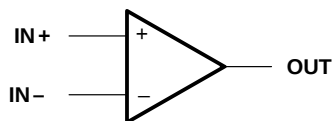
The input current characteristics traditionally associated with JFET-input amplifiers have been maintained. The input offset voltage is graded to a 7-mV and a 4-mV maximum for the TLE2082 and the TLE2082A, respectively. Typically, temperature coefficient of input offset voltage is 2.4  $\mu\text{V}/^\circ\text{C}$  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 currents to at least 30 mA and can sustain shorts to either supply. Care must be taken to ensure that maximum power dissipation is not exceeded.

Both the TLE2082 and TLE2082A are available in a wide variety of packages, including both the industry-standard 8-pin small-outline version 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  $125^\circ\text{C}$ .



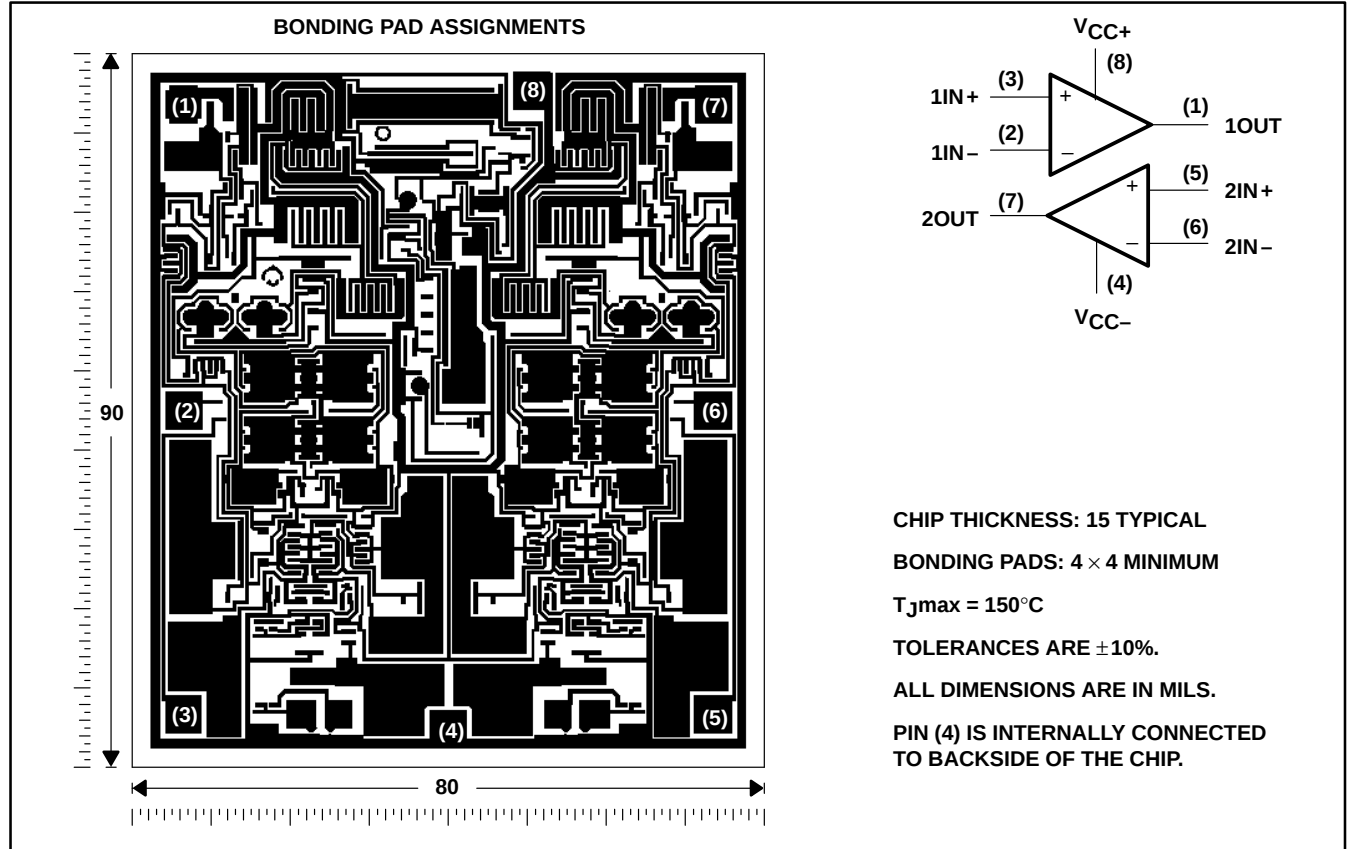
NC – No internal connection

#### symbol



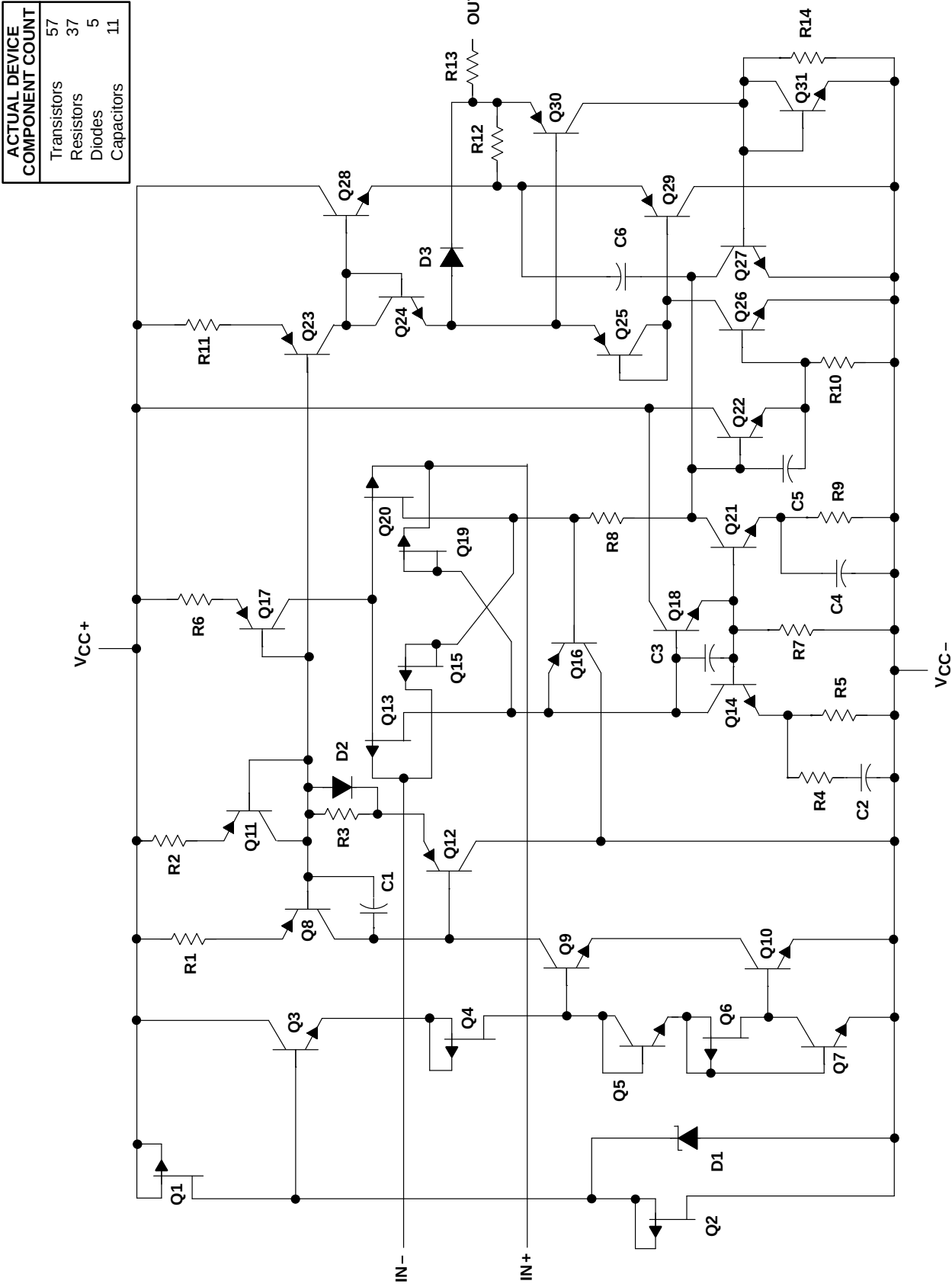
## TLE2082Y chip information

This chip, when properly assembled, displays characteristics similar to the TLE2082. 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.



**TLE2082, TLE2082A, TLE2082Y**  
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equivalent schematic (each channel)



| ACTUAL DEVICE<br>COMPONENT COUNT |    |
|----------------------------------|----|
| Transistors                      | 57 |
| Resistors                        | 37 |
| Diodes                           | 5  |
| Capacitors                       | 11 |

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

|                                                                              |                              |
|------------------------------------------------------------------------------|------------------------------|
| Supply voltage, $V_{CC+}$ (see Note 1)                                       | 19 V                         |
| Supply voltage, $V_{CC-}$ (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: D or P package | 260°C                        |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package     | 300°C                        |

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

- NOTES:
1. All voltage values except differential voltages are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .
  2. Differential voltages are at  $IN+$  with respect to  $IN-$ .
  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 |
|---------|---------------------------------------------|---------------------------------------------------|------------------------------------------|------------------------------------------|-------------------------------------------|
| D       | 725 mW                                      | 5.8 mW/°C                                         | 464 mW                                   | 377 mW                                   | 145 mW                                    |
| FK      | 1375 mW                                     | 11.0 mW/°C                                        | 880 mW                                   | 715 mW                                   | 275 mW                                    |
| JG      | 1050 mW                                     | 8.4 mW/°C                                         | 672 mW                                   | 546 mW                                   | 210 mW                                    |
| P       | 1000 mW                                     | 8.0 mW/°C                                         | 640 mW                                   | 344 mW                                   | 200 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   |

**TLE2082, TLE2082A, TLE2082Y**  
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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**

| PARAMETER        |                                                                      |              | TEST CONDITIONS                                                                   | T <sub>A</sub> <sup>†</sup> | TLE2082C         |           |         | TLE2082AC        |           |     | 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                        | 0.9              |           | 6       | 0.65             |           | 4   | mV    |
|                  |                                                                      |              |                                                                                   | Full range                  |                  |           | 8.1     |                  |           | 5.1 |       |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                      |              |                                                                                   | Full range                  | 2.3              |           | 25      | 2.3              |           | 25  | 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                        | 5                |           | 100     | 5                |           | 100 | pA    |
|                  |                                                                      |              |                                                                                   | Full range                  |                  |           | 1.4     |                  |           | 1.4 | nA    |
| I <sub>IB</sub>  | Input bias current                                                   |              |                                                                                   | 25°C                        | 15               |           | 175     | 15               |           | 175 | pA    |
|                  |                                                                      |              |                                                                                   | Full range                  |                  |           | 5       |                  |           | 5   | nA    |
| V <sub>ICR</sub> | Common-mode input voltage range                                      |              | R <sub>S</sub> = 50 Ω                                                             | 25°C                        | 5 to −1          | 5 to −1.9 | 5 to −1 |                  | 5 to −1.9 | V   |       |
|                  |                                                                      |              |                                                                                   | Full range                  | 5 to −0.9        | 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      |                  |           |     |       |
| I <sub>CC</sub>  | Supply current (both channels)                                       |              | V <sub>O</sub> = 0, No load                                                       | 25°C                        | 2.7              | 2.9       | 3.6     | 2.7              | 2.9       | 3.6 | mA    |
|                  |                                                                      |              |                                                                                   | Full range                  | 3.6              |           |         | 3.6              |           |     |       |

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



**TLE2082, TLE2082A, TLE2082Y**  
**EXCALIBUR HIGH-SPEED**  
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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**  
**(continued)**

| PARAMETER             |                              | TEST CONDITIONS                            |                        | T <sub>A</sub> | TLE2082C |     |     | TLE2082AC |     |     | UNIT |
|-----------------------|------------------------------|--------------------------------------------|------------------------|----------------|----------|-----|-----|-----------|-----|-----|------|
|                       |                              |                                            |                        |                | MIN      | TYP | MAX | MIN       | TYP | MAX |      |
| Crosstalk attenuation |                              | V <sub>IC</sub> = 0, R <sub>L</sub> = 2 kΩ |                        | 25°C           | 120      |     |     | 120       |     |     | dB   |
| I <sub>OS</sub>       | Short-circuit output current | V <sub>O</sub> = 0                         | V <sub>ID</sub> = 1 V  | 25°C           | −35      |     |     | −35       |     |     | mA   |
|                       |                              |                                            | V <sub>ID</sub> = −1 V |                | 45       |     |     | 45        |     |     |      |

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

| PARAMETER          |                                             | TEST CONDITIONS                                                                                                       |                                                            | T <sub>A</sub> <sup>†</sup>                       | TLE2082C |     |     | TLE2082AC |     |     | 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       |     |     | 28        |     |     | nV/√Hz |
|                    |                                             |                                                                                                                       | f = 10 kHz                                                 |                                                   | 11.6     |     |     | 11.6      |     |     |        |
| 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° |           |     |     |        |

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

**TLE2082, TLE2082A, TLE2082Y**  
**EXCALIBUR HIGH-SPEED**  
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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER        |                                                                       |              | TEST CONDITIONS                                                                   | T <sub>A</sub> <sup>†</sup> | TLE2082C         |             |     | TLE2082AC        |             |     | 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                        | 1.1              |             | 7   | 0.7              |             | 4   | mV    |  |
|                  |                                                                       |              |                                                                                   | Full range                  |                  |             | 8.1 |                  |             | 5.1 |       |  |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                       |              |                                                                                   | Full range                  | 2.4              |             | 25  | 2.4              |             | 25  | 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                        | 6                |             | 100 | 6                |             | 100 | pA    |  |
|                  |                                                                       |              |                                                                                   | Full range                  |                  |             | 1.4 |                  |             | 1.4 | nA    |  |
| I <sub>IB</sub>  | Input bias current                                                    |              |                                                                                   | 25°C                        | 20               |             | 175 | 20               |             | 175 | pA    |  |
|                  |                                                                       |              |                                                                                   | Full range                  |                  |             | 5   |                  |             | 5   | nA    |  |
| V <sub>ICR</sub> | Common-mode input voltage range                                       |              | R <sub>S</sub> = 50 Ω                                                             | 25°C                        | 15 to −11        | 15 to −11.9 |     | 15 to −11        | 15 to −11.9 |     | V     |  |
|                  |                                                                       |              |                                                                                   | Full range                  | 15 to −10.9      |             |     | 15 to −10.9      |             |     |       |  |
| V <sub>OM+</sub> | Maximum positive peak output voltage swing                            |              | I <sub>O</sub> = −200 μA                                                          | 25°C                        | 13.8             | 14.1        |     | 13.8             | 14.1        |     | V     |  |
|                  |                                                                       |              |                                                                                   | Full range                  | 13.6             |             |     | 13.6             |             |     |       |  |
|                  |                                                                       |              | I <sub>O</sub> = −2 mA                                                            | 25°C                        | 13.5             | 13.9        |     | 13.5             | 13.9        |     |       |  |
|                  |                                                                       |              |                                                                                   | Full range                  | 13.4             |             |     | 13.4             |             |     |       |  |
|                  |                                                                       |              | I <sub>O</sub> = −20 mA                                                           | 25°C                        | 11.5             | 12.3        |     | 11.5             | 12.3        |     |       |  |
|                  |                                                                       |              |                                                                                   | Full range                  | 11.5             |             |     | 11.5             |             |     |       |  |
| V <sub>OM−</sub> | Maximum negative peak output voltage swing                            |              | I <sub>O</sub> = 200 μA                                                           | 25°C                        | −13.8            | −14.2       |     | −13.8            | −14.2       |     | V     |  |
|                  |                                                                       |              |                                                                                   | Full range                  | −13.7            |             |     | −13.7            |             |     |       |  |
|                  |                                                                       |              | I <sub>O</sub> = 2 mA                                                             | 25°C                        | −13.5            | −14         |     | −13.5            | −14         |     |       |  |
|                  |                                                                       |              |                                                                                   | Full range                  | −13.4            |             |     | −13.4            |             |     |       |  |
|                  |                                                                       |              | I <sub>O</sub> = 20 mA                                                            | 25°C                        | −11.5            | −12.4       |     | −11.5            | −12.4       |     |       |  |
|                  |                                                                       |              |                                                                                   | Full range                  | −11.5            |             |     | −11.5            |             |     |       |  |
| A <sub>VD</sub>  | Large-signal differential voltage amplification                       |              | V <sub>O</sub> = ± 10 V                                                           | R <sub>L</sub> = 600 Ω      | 25°C             | 80          | 96  |                  | 80          | 96  | dB    |  |
|                  |                                                                       |              |                                                                                   |                             | Full range       | 79          |     |                  | 79          |     |       |  |
|                  |                                                                       |              |                                                                                   | R <sub>L</sub> = 2 kΩ       | 25°C             | 90          | 109 |                  | 90          | 109 |       |  |
|                  |                                                                       |              |                                                                                   |                             | Full range       | 89          |     |                  | 89          |     |       |  |
|                  |                                                                       |              |                                                                                   | R <sub>L</sub> = 10 kΩ      | 25°C             | 95          | 118 |                  | 95          | 118 |       |  |
|                  |                                                                       |              |                                                                                   |                             | 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                        | 7.5              |             |     | 7.5              |             |     | pF    |  |
|                  |                                                                       | Differential |                                                                                   | 25°C                        | 2.5              |             |     | 2.5              |             |     |       |  |
| z <sub>O</sub>   | Open-loop output impedance                                            |              | f = 1 MHz                                                                         | 25°C                        | 80               |             |     | 80               |             |     | Ω     |  |
| CMRR             | Common-mode rejection ratio                                           |              | V <sub>IC</sub> = V <sub>ICRmin</sub> , V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω | 25°C                        | 80               | 98          |     | 80               | 98          |     | dB    |  |
|                  |                                                                       |              |                                                                                   | Full range                  | 79               |             |     | 79               |             |     |       |  |
| 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                  | 81               |             |     | 81               |             |     |       |  |
| I <sub>CC</sub>  | Supply current (both channels)                                        |              | V <sub>O</sub> = 0, No load                                                       | 25°C                        | 2.7              | 3.1         | 3.6 | 2.7              | 3.1         | 3.6 | mA    |  |
|                  |                                                                       |              |                                                                                   | Full range                  | 3.6              |             |     | 3.6              |             |     |       |  |

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



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

| PARAMETER             |                              | TEST CONDITIONS                            |                        | T <sub>A</sub> | TLE2082C |     |     | TLE2082AC |     |     | UNIT |
|-----------------------|------------------------------|--------------------------------------------|------------------------|----------------|----------|-----|-----|-----------|-----|-----|------|
|                       |                              |                                            |                        |                | MIN      | TYP | MAX | MIN       | TYP | MAX |      |
| Crosstalk attenuation |                              | V <sub>IC</sub> = 0, R <sub>L</sub> = 2 kΩ |                        | 25°C           | 120      |     |     | 120       |     |     | dB   |
| I <sub>OS</sub>       | Short-circuit output current | V <sub>O</sub> = 0                         | V <sub>ID</sub> = 1 V  | 25°C           | -30      | -45 |     | -30       | -45 |     | mA   |
|                       |                              |                                            | V <sub>ID</sub> = -1 V |                | 30       | 48  |     | 30        | 48  |     |      |

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

| PARAMETER          |                                             | TEST CONDITIONS                                                                                                     |                     | T <sub>A</sub> <sup>†</sup> | TLE2082C |     |        | TLE2082AC |     |        | 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                        | 28       | 40  |        | 28        | 40  |        | V/μs   |
|                    |                                             |                                                                                                                     |                     | Full range                  | 25       |     |        | 25        |     |        |        |
| 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       |     |        | 28        |     |        | nV/√Hz |
|                    |                                             |                                                                                                                     | f = 10 kHz          |                             | 11.6     |     |        | 11.6      |     |        |        |
| 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, R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 25 pF, 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 0°C to 70°C.

**TLE2082, TLE2082A, TLE2082Y**  
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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**

| PARAMETER        |                                                                       |              | TEST CONDITIONS                                                |                        | T <sub>A</sub> <sup>†</sup> | TLE2082I         |            |           | TLE2082AI        |           |     | UNIT |       |  |
|------------------|-----------------------------------------------------------------------|--------------|----------------------------------------------------------------|------------------------|-----------------------------|------------------|------------|-----------|------------------|-----------|-----|------|-------|--|
|                  |                                                                       |              |                                                                |                        |                             | MIN              | TYP        | MAX       | MIN              | TYP       | MAX |      |       |  |
| V <sub>IO</sub>  | Input offset voltage                                                  |              | V <sub>IC</sub> = 0,<br>R <sub>S</sub> = 50 Ω                  | V <sub>O</sub> = 0,    | 25°C                        | 0.9              |            |           | 7                | 0.65      |     | 4    | mV    |  |
|                  |                                                                       | Full range   |                                                                |                        | 8.5                         |                  |            | 5.5       |                  |           |     |      |       |  |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                       |              |                                                                |                        | Full range                  | 2.4              |            |           | 25               | 2.4       |     | 25   | μV/°C |  |
| I <sub>IO</sub>  | Input offset current                                                  |              | V <sub>IC</sub> = 0,<br>See Figure 4                           | V <sub>O</sub> = 0,    | 25°C                        | 5                |            |           | 100              | 5         |     | 100  | pA    |  |
|                  |                                                                       | Full range   |                                                                |                        | 5                           |                  |            | 5         |                  |           | nA  |      |       |  |
| I <sub>IB</sub>  | Input bias current                                                    |              |                                                                |                        | 25°C                        | 15               |            |           | 175              | 15        |     | 175  | pA    |  |
|                  |                                                                       |              |                                                                |                        | Full range                  | 10               |            |           | 10               |           |     | nA   |       |  |
| V <sub>ICR</sub> | Common-mode input voltage range                                       |              | R <sub>S</sub> = 50 Ω                                          |                        | 25°C                        | 5 to -1          | 5 to -1.9  |           | 5 to -1          | 5 to -1.9 |     | V    |       |  |
|                  |                                                                       |              |                                                                |                        | Full range                  | 5 to -0.8        |            | 5 to -0.8 |                  |           |     |      |       |  |
| V <sub>OM+</sub> | Maximum positive peak output voltage swing                            |              | I <sub>O</sub> = -200 μA                                       |                        | 25°C                        | 3.8              | 4.1        |           | 3.8              | 4.1       |     | V    |       |  |
|                  |                                                                       |              |                                                                |                        | Full range                  | 3.7              |            |           | 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> ,<br>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,<br>V <sub>O</sub> = 0,       | R <sub>S</sub> = 50 Ω  | 25°C                        | 82               | 99         |           | 82               | 99        | dB  |      |       |  |
|                  |                                                                       |              |                                                                |                        | Full range                  | 80               |            |           | 80               |           |     |      |       |  |
| I <sub>CC</sub>  | Supply current (both channels)                                        |              | V <sub>O</sub> = 0,                                            | No load                | 25°C                        | 2.7              | 2.9        | 3.6       | 2.7              | 2.9       | 3.6 | mA   |       |  |
|                  |                                                                       |              |                                                                |                        | Full range                  | 3.6              |            |           | 3.6              |           |     |      |       |  |

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

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

| PARAMETER             |                              | TEST CONDITIONS                            |                        | T <sub>A</sub> | TLE2082I |     |     | TLE2082AI |     |     | UNIT |
|-----------------------|------------------------------|--------------------------------------------|------------------------|----------------|----------|-----|-----|-----------|-----|-----|------|
|                       |                              |                                            |                        |                | MIN      | TYP | MAX | MIN       | TYP | MAX |      |
| Crosstalk attenuation |                              | V <sub>IC</sub> = 0, R <sub>L</sub> = 2 kΩ |                        | 25°C           | 120      |     |     | 120       |     |     | dB   |
| I <sub>OS</sub>       | Short-circuit output current | V <sub>O</sub> = 0                         | V <sub>ID</sub> = 1 V  | 25°C           | −35      |     |     | −35       |     |     | mA   |
|                       |                              |                                            | V <sub>ID</sub> = −1 V |                | 45       |     |     | 45        |     |     |      |

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

| PARAMETER          |                                             | TEST CONDITIONS                                                                                                                 |                     | T <sub>A</sub> <sup>†</sup> | TLE2082I |     |        | TLE2082AI |     |        | UNIT   |
|--------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------|----------|-----|--------|-----------|-----|--------|--------|
|                    |                                             |                                                                                                                                 |                     |                             | MIN      | TYP | MAX    | MIN       | TYP | MAX    |        |
| SR +               | Positive slew rate                          | V <sub>O(PP)</sub> = ±2.3 V,<br>A <sub>VD</sub> = −1,      R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF,      See Figure 1 |                     | 25°C                        | 35       |     |        | 35        |     |        | V/μs   |
|                    | Full range                                  |                                                                                                                                 |                     | 20                          |          |     | 20     |           |     |        |        |
| SR −               | Negative slew rate                          |                                                                                                                                 |                     | 25°C                        | 38       |     |        | 38        |     |        | V/μs   |
|                    | Full range                                  |                                                                                                                                 |                     | 20                          |          |     | 20     |           |     |        |        |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1,<br>2-V step,<br>R <sub>L</sub> = 1 kΩ,<br>C <sub>L</sub> = 100 pF                                         | To 10 mV            | 25°C                        | 0.25     |     |        | 0.25      |     |        | μs     |
|                    |                                             |                                                                                                                                 | To 1 mV             |                             | 0.4      |     |        | 0.4       |     |        |        |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω,<br>See Figure 3                                                                                          | f = 10 Hz           | 25°C                        | 28       |     |        | 28        |     |        | nV/√Hz |
|                    |                                             |                                                                                                                                 | f = 10 kHz          |                             | 11.6     |     |        | 11.6      |     |        |        |
| 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,      A <sub>VD</sub> = 10,<br>f = 1 kHz,      R <sub>L</sub> = 2 kΩ,<br>R <sub>S</sub> = 25 Ω         | 25°C                | 0.013%                      |          |     | 0.013% |           |     |        |        |
| B <sub>1</sub>     | Unity-gain bandwidth                        | V <sub>I</sub> = 10 mV,      R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 25 pF,      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,      A <sub>VD</sub> = −1,<br>R <sub>L</sub> = 2 kΩ ,      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,      R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 25 pF,      See Figure 2                                | 25°C                | 56°                         |          |     | 56°    |           |     |        |        |

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

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

| PARAMETER        |                                                                       |              | TEST CONDITIONS                                                                   | T <sub>A</sub> <sup>†</sup> | TLE2082I              |                  |     | TLE2082AI             |                  |     | UNIT  |    |
|------------------|-----------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------|-----------------------------|-----------------------|------------------|-----|-----------------------|------------------|-----|-------|----|
|                  |                                                                       |              |                                                                                   |                             | MIN                   | TYP              | MAX | MIN                   | TYP              | MAX |       |    |
| V <sub>IO</sub>  | Input offset voltage                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω                    | 25°C                        | 1.1 7                 |                  |     | 0.7 4                 |                  |     | mV    |    |
|                  |                                                                       |              |                                                                                   | Full range                  | 8.5                   |                  |     | 5.5                   |                  |     |       |    |
| α <sub>VIO</sub> | Temperature coefficient of input offset voltage                       |              |                                                                                   | Full range                  | 2.4 25                |                  |     | 2.4 25                |                  |     | μV/°C |    |
| I <sub>IO</sub>  | Input offset current                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0, See Figure 4                             | 25°C                        | 6 100                 |                  |     | 6 100                 |                  |     | pA    |    |
|                  |                                                                       |              |                                                                                   | Full range                  | 5                     |                  |     | 5                     |                  |     | nA    |    |
| I <sub>IB</sub>  | Input bias current                                                    |              |                                                                                   | 25°C                        | 20 175                |                  |     | 20 175                |                  |     | pA    |    |
|                  |                                                                       |              |                                                                                   | Full range                  | 10                    |                  |     | 10                    |                  |     | nA    |    |
| V <sub>ICR</sub> | Common-mode input voltage range                                       |              | R <sub>S</sub> = 50 Ω                                                             | 25°C                        | 15 to −11 15 to −11.9 |                  |     | 15 to −11 15 to −11.9 |                  |     | V     |    |
|                  |                                                                       |              |                                                                                   | Full range                  | 15 to −10.8           |                  |     | 15 to −10.8           |                  |     |       |    |
| V <sub>OM+</sub> | Maximum positive peak output voltage swing                            |              | I <sub>O</sub> = −200 μA                                                          | 25°C                        | 13.8 14.1             |                  |     | 13.8 14.1             |                  |     | V     |    |
|                  |                                                                       |              |                                                                                   | Full range                  | 13.7                  |                  |     | 13.7                  |                  |     |       |    |
|                  |                                                                       |              | I <sub>O</sub> = −2 mA                                                            | 25°C                        | 13.5 13.9             |                  |     | 13.5 13.9             |                  |     |       |    |
|                  |                                                                       |              |                                                                                   | Full range                  | 13.4                  |                  |     | 13.4                  |                  |     |       |    |
|                  |                                                                       |              | I <sub>O</sub> = −20 mA                                                           | 25°C                        | 11.5 12.3             |                  |     | 11.5 12.3             |                  |     |       |    |
|                  |                                                                       |              |                                                                                   | Full range                  | 11.5                  |                  |     | 11.5                  |                  |     |       |    |
| V <sub>OM−</sub> | Maximum negative peak output voltage swing                            |              | I <sub>O</sub> = 200 μA                                                           | 25°C                        | −13.8 −14.2           |                  |     | −13.8 −14.2           |                  |     | V     |    |
|                  |                                                                       |              |                                                                                   | Full range                  | −13.7                 |                  |     | −13.7                 |                  |     |       |    |
|                  |                                                                       |              | I <sub>O</sub> = 2 mA                                                             | 25°C                        | −13.5 −14             |                  |     | −13.5 −14             |                  |     |       |    |
|                  |                                                                       |              |                                                                                   | Full range                  | −13.4                 |                  |     | −13.4                 |                  |     |       |    |
|                  |                                                                       |              | I <sub>O</sub> = 20 mA                                                            | 25°C                        | −11.5 −12.4           |                  |     | −11.5 −12.4           |                  |     |       |    |
|                  |                                                                       |              |                                                                                   | Full range                  | −11.5                 |                  |     | −11.5                 |                  |     |       |    |
| A <sub>VD</sub>  | Large-signal differential voltage amplification                       |              | V <sub>O</sub> = ± 10 V                                                           | R <sub>L</sub> = 600 Ω      | 25°C                  | 80 96            |     |                       | 80 96            |     |       | dB |
|                  |                                                                       |              |                                                                                   |                             | Full range            | 79               |     |                       | 79               |     |       |    |
|                  |                                                                       |              |                                                                                   | R <sub>L</sub> = 2 kΩ       | 25°C                  | 90 109           |     |                       | 90 109           |     |       |    |
|                  |                                                                       |              |                                                                                   |                             | Full range            | 89               |     |                       | 89               |     |       |    |
|                  |                                                                       |              |                                                                                   | R <sub>L</sub> = 10 kΩ      | 25°C                  | 95 118           |     |                       | 95 118           |     |       |    |
|                  |                                                                       |              |                                                                                   |                             | 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                  | 7.5              |     |                       | 7.5              |     |       | pF |
|                  |                                                                       | Differential |                                                                                   |                             | 25°C                  | 2.5              |     |                       | 2.5              |     |       |    |
| z <sub>o</sub>   | Open-loop output impedance                                            |              | f = 1 MHz                                                                         |                             | 25°C                  | 80               |     |                       | 80               |     |       | Ω  |
| CMRR             | Common-mode rejection ratio                                           |              | V <sub>IC</sub> = V <sub>ICRmin</sub> , V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω |                             | 25°C                  | 80 98            |     |                       | 80 98            |     |       | dB |
|                  |                                                                       |              |                                                                                   |                             | Full range            | 79               |     |                       | 79               |     |       |    |
| 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               |     |       |    |
| I <sub>CC</sub>  | Supply current (both channels)                                        |              | V <sub>O</sub> = 0, No load                                                       |                             | 25°C                  | 2.7 3.1 3.6      |     |                       | 2.7 3.1 3.6      |     |       | mA |
|                  |                                                                       |              |                                                                                   |                             | Full range            | 3.6              |     |                       | 3.6              |     |       |    |

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



**TLE2082, TLE2082A, TLE2082Y**  
**EXCALIBUR HIGH-SPEED**  
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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**  
**(continued)**

| PARAMETER             |                              | TEST CONDITIONS                            |                        | T <sub>A</sub> | TLE2082I |     |     | TLE2082AI |     |     | UNIT |
|-----------------------|------------------------------|--------------------------------------------|------------------------|----------------|----------|-----|-----|-----------|-----|-----|------|
|                       |                              |                                            |                        |                | MIN      | TYP | MAX | MIN       | TYP | MAX |      |
| Crosstalk attenuation |                              | V <sub>IC</sub> = 0, R <sub>L</sub> = 2 kΩ |                        | 25°C           | 120      |     |     | 120       |     |     | dB   |
| I <sub>OS</sub>       | Short-circuit output current | V <sub>O</sub> = 0                         | V <sub>ID</sub> = 1 V  | 25°C           | -30      | -45 |     | -30       | -45 |     | mA   |
|                       |                              |                                            | V <sub>ID</sub> = -1 V |                | 30       | 48  |     | 30        | 48  |     |      |

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

| PARAMETER          |                                             | TEST CONDITIONS                                                                                                     |                                                                                                                | T <sub>A</sub> <sup>†</sup> | TLE2082I |     |     | TLE2082AI |     |     | 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                        | 28       | 40  |     | 28        | 40  |     | V/μs   |
|                    |                                             |                                                                                                                     |                                                                                                                | Full range                  | 22       |     |     | 22        |     |     |        |
| SR−                | Negative slew rate                          |                                                                                                                     |                                                                                                                | 25°C                        | 30       | 45  |     | 30        | 45  |     | V/μs   |
|                    |                                             |                                                                                                                     |                                                                                                                | Full range                  | 22       |     |     | 22        |     |     |        |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1,<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       |     |     | 28        |     |     | nV/√Hz |
|                    |                                             |                                                                                                                     | f = 10 kHz                                                                                                     |                             | 11.6     |     |     | 11.6      |     |     |        |
| 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,<br>R <sub>L</sub> = 2 kΩ, See Figure 2                              | 25°C                                                                                                           | 8                           | 10       |     | 8   | 10        |     | MHz |        |
| B <sub>OM</sub>    | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 20 V, 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, C <sub>L</sub> = 25 pF,<br>R <sub>L</sub> = 2 kΩ, See Figure 2                              | 25°C                                                                                                           | 57°                         |          |     | 57° |           |     |     |        |

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

**TLE2082, TLE2082A, TLE2082Y**  
**EXCALIBUR HIGH-SPEED**  
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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**

| PARAMETER         |                                                                       |              | TEST CONDITIONS                                                                   | T <sub>A</sub> <sup>†</sup> | TLE2082M         |           |         | TLE2082AM        |           |     | UNIT  |
|-------------------|-----------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------|-----------------------------|------------------|-----------|---------|------------------|-----------|-----|-------|
|                   |                                                                       |              |                                                                                   |                             | MIN              | TYP       | MAX     | MIN              | TYP       | MAX |       |
| V <sub>IO</sub>   | Input offset voltage                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω                    | 25°C                        | 0.9              |           | 7       | 0.65             |           | 4   | mV    |
|                   |                                                                       |              |                                                                                   | Full range                  |                  |           | 9.5     |                  |           | 6.5 |       |
| α <sub>VIO</sub>  | Temperature coefficient of input offset voltage                       |              |                                                                                   | Full range                  | 2.3              |           | 25*     | 2.3              |           | 25* | μV/°C |
| I <sub>IO</sub>   | Input offset current                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0, See Figure 4                             | 25°C                        | 5                |           | 100     | 5                |           | 100 | pA    |
|                   |                                                                       |              |                                                                                   | Full range                  |                  |           | 20      |                  |           | 20  | nA    |
| I <sub>IB</sub>   | Input bias current                                                    |              |                                                                                   | 25°C                        | 15               |           | 175     | 15               |           | 175 | pA    |
|                   |                                                                       |              |                                                                                   | Full range                  |                  |           | 60      |                  |           | 60  | nA    |
| V <sub>ICR</sub>  | Common-mode input voltage range                                       |              | R <sub>S</sub> = 50 Ω                                                             | 25°C                        | 5 to −1          | 5 to −1.9 | 5 to −1 |                  | 5 to −1.9 | V   |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 5 to −0.8        | 5 to −0.8 |         |                  |           |     |       |
| V <sub>OM</sub> + | Maximum positive peak output voltage swing                            |              | I <sub>O</sub> = −200 μA                                                          | 25°C                        | 3.8              | 4.1       | 3.8     |                  | 4.1       | V   |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 3.6              |           | 3.6     |                  |           |     |       |
|                   |                                                                       |              | I <sub>O</sub> = −2 mA                                                            | 25°C                        | 3.5              | 3.9       | 3.5     |                  | 3.9       |     |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 3.3              |           | 3.3     |                  |           |     |       |
|                   |                                                                       |              | I <sub>O</sub> = −20 mA                                                           | 25°C                        | 1.5              | 2.3       | 1.5     |                  | 2.3       |     |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 1.4              |           | 1.4     |                  |           |     |       |
| V <sub>OM</sub> − | Maximum negative peak output voltage swing                            |              | I <sub>O</sub> = 200 μA                                                           | 25°C                        | −3.8             | −4.2      | −3.8    |                  | −4.2      | V   |       |
|                   |                                                                       |              |                                                                                   | Full range                  | −3.6             |           | −3.6    |                  |           |     |       |
|                   |                                                                       |              | I <sub>O</sub> = 2 mA                                                             | 25°C                        | −3.5             | −4.1      | −3.5    |                  | −4.1      |     |       |
|                   |                                                                       |              |                                                                                   | Full range                  | −3.3             |           | −3.3    |                  |           |     |       |
|                   |                                                                       |              | I <sub>O</sub> = 20 mA                                                            | 25°C                        | −1.5             | −2.4      | −1.5    |                  | −2.4      |     |       |
|                   |                                                                       |              |                                                                                   | Full range                  | −1.4             |           | −1.4    |                  |           |     |       |
| A <sub>VD</sub>   | Large-signal differential voltage amplification                       |              | V <sub>O</sub> = ± 2.3 V                                                          | R <sub>L</sub> = 600 Ω      | 25°C             | 80        | 91      | 80               |           | 91  | dB    |
|                   |                                                                       |              |                                                                                   |                             | Full range       | 78        |         | 78               |           |     |       |
|                   |                                                                       |              |                                                                                   | R <sub>L</sub> = 2 kΩ       | 25°C             | 90        | 100     | 90               |           | 100 |       |
|                   |                                                                       |              |                                                                                   |                             | Full range       | 88        |         | 88               |           |     |       |
|                   |                                                                       |              |                                                                                   | R <sub>L</sub> = 10 kΩ      | 25°C             | 95        | 106     | 95               |           | 106 |       |
|                   |                                                                       |              |                                                                                   |                             | Full range       | 93        |         | 93               |           |     |       |
| r <sub>i</sub>    | Input resistance                                                      |              | V <sub>IC</sub> = 0                                                               | 25°C                        | 10 <sup>12</sup> |           |         | 10 <sup>12</sup> |           | Ω   |       |
| c <sub>i</sub>    | Input capacitance                                                     | Common mode  | V <sub>IC</sub> = 0, See Figure 5                                                 | 25°C                        | 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      |                  |           |     |       |

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

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



**TLE2082, TLE2082A, TLE2082Y**  
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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 5$  V (unless otherwise noted)**  
**(continued)**

| PARAMETER                               | TEST CONDITIONS                         | $T_A^\dagger$          | TLE2082M |     |     | TLE2082AM |     |     | UNIT |
|-----------------------------------------|-----------------------------------------|------------------------|----------|-----|-----|-----------|-----|-----|------|
|                                         |                                         |                        | MIN      | TYP | MAX | MIN       | TYP | MAX |      |
| $I_{CC}$ Supply current (both channels) | $V_O = 0$ , No load                     | 25°C                   | 2.7      | 2.9 | 3.6 | 2.7       | 2.9 | 3.6 | mA   |
|                                         |                                         | Full range             |          |     | 3.6 |           |     | 3.6 |      |
| Crosstalk attenuation                   | $V_{IC} = 0$ , $R_L = 2\text{ k}\Omega$ | 25°C                   |          | 120 |     |           | 120 |     | dB   |
| $I_{OS}$ Short-circuit output current   | $V_O = 0$                               | $V_{ID} = 1\text{ V}$  |          | –35 |     |           | –35 |     | mA   |
|                                         |                                         | $V_{ID} = -1\text{ V}$ |          | 45  |     |           | 45  |     |      |

$^\dagger$  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> <sup>†</sup>                  | TLE2082M |        |     | TLE2082AM |        |     | 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                                  |                                                                                                                       |                                                            | 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,<br>C <sub>L</sub> = 100 pF                                  | To 10 mV                                                   | 25°C                                         | 0.25     |        |     | 0.25      |        |     | μs     |
|                    |                                             |                                                                                                                       | To 1 mV                                                    |                                              | 0.4      |        |     | 0.4       |        |     |        |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω,<br>See Figure 3                                                                                | f = 10 Hz                                                  | 25°C                                         | 28       |        |     | 28        |        |     | nV/√Hz |
|                    |                                             |                                                                                                                       | f = 10 kHz                                                 |                                              | 11.6     |        |     | 11.6      |        |     |        |
| 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°       |        |     |        |

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

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

**TLE2082, TLE2082A, TLE2082Y**  
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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER         |                                                                       |              | TEST CONDITIONS                                                                   | T <sub>A</sub> <sup>†</sup> | TLE2082M         |             |                       | TLE2082AM        |     |     | UNIT  |
|-------------------|-----------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------|-----------------------------|------------------|-------------|-----------------------|------------------|-----|-----|-------|
|                   |                                                                       |              |                                                                                   |                             | MIN              | TYP         | MAX                   | MIN              | TYP | MAX |       |
| V <sub>IO</sub>   | Input offset voltage                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω                    | 25°C                        | 1.1 7            |             |                       | 0.7 4            |     |     | mV    |
|                   |                                                                       |              |                                                                                   | Full range                  | 9.5              |             |                       | 6.5              |     |     |       |
| αV <sub>IO</sub>  | Temperature coefficient of input offset voltage                       |              |                                                                                   | Full range                  | 2.4 25*          |             |                       | 2.4 25*          |     |     | μV/°C |
| I <sub>IO</sub>   | Input offset current                                                  |              | V <sub>IC</sub> = 0, V <sub>O</sub> = 0, See Figure 4                             | 25°C                        | 6 100            |             |                       | 6 100            |     |     | pA    |
|                   |                                                                       |              |                                                                                   | Full range                  | 20               |             |                       | 20               |     |     | nA    |
| I <sub>IB</sub>   | Input bias current                                                    |              |                                                                                   | 25°C                        | 20 175           |             |                       | 20 175           |     |     | pA    |
|                   |                                                                       |              |                                                                                   | Full range                  | 65               |             |                       | 65               |     |     | nA    |
| V <sub>ICR</sub>  | Common-mode input voltage range                                       |              | R <sub>S</sub> = 50 Ω                                                             | 25°C                        | 15 to −11        | 15 to −11.9 | 15 to −11 15 to −11.9 |                  |     | V   |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 15 to −10.8      |             | 15 to −10.8           |                  |     |     |       |
| V <sub>OM</sub> + | Maximum positive peak output voltage swing                            |              | I <sub>O</sub> = −200 μA                                                          | 25°C                        | 13.8             | 14.1        | 13.8 14.1             |                  |     | V   |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 13.6 13.6        |             |                       |                  |     |     |       |
|                   |                                                                       |              | I <sub>O</sub> = −2 mA                                                            | 25°C                        | 13.5             | 13.9        | 13.5 13.9             |                  |     |     |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 13.3 13.3        |             |                       |                  |     |     |       |
|                   |                                                                       |              | I <sub>O</sub> = −20 mA                                                           | 25°C                        | 11.5             | 12.3        | 11.5 12.3             |                  |     |     |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 11.4 11.4        |             |                       |                  |     |     |       |
| V <sub>OM</sub> − | Maximum negative peak output voltage swing                            |              | I <sub>O</sub> = 200 μA                                                           | 25°C                        | −13.8            | −14.2       | −13.8 −14.2           |                  |     | V   |       |
|                   |                                                                       |              |                                                                                   | Full range                  | −13.6 −13.6      |             |                       |                  |     |     |       |
|                   |                                                                       |              | I <sub>O</sub> = 2 mA                                                             | 25°C                        | −13.5            | −14         | −13.5 −14             |                  |     |     |       |
|                   |                                                                       |              |                                                                                   | Full range                  | −13.3 −13.3      |             |                       |                  |     |     |       |
|                   |                                                                       |              | I <sub>O</sub> = 20 mA                                                            | 25°C                        | −11.5            | −12.4       | −11.5 −12.4           |                  |     |     |       |
|                   |                                                                       |              |                                                                                   | Full range                  | −11.4 −11.4      |             |                       |                  |     |     |       |
| A <sub>VD</sub>   | Large-signal differential voltage amplification                       |              | V <sub>O</sub> = ± 10 V                                                           | R <sub>L</sub> = 600 Ω      | 25°C             | 80          | 96                    | 80 96            |     |     | dB    |
|                   |                                                                       |              |                                                                                   |                             | Full range       | 78 78       |                       |                  |     |     |       |
|                   |                                                                       |              |                                                                                   | R <sub>L</sub> = 2 kΩ       | 25°C             | 90          | 109                   | 90 109           |     |     |       |
|                   |                                                                       |              |                                                                                   |                             | Full range       | 88 88       |                       |                  |     |     |       |
|                   |                                                                       |              |                                                                                   | R <sub>L</sub> = 10 kΩ      | 25°C             | 95          | 118                   | 95 118           |     |     |       |
|                   |                                                                       |              |                                                                                   |                             | Full range       | 93 93       |                       |                  |     |     |       |
| r <sub>i</sub>    | Input resistance                                                      |              | V <sub>IC</sub> = 0                                                               | 25°C                        | 10 <sup>12</sup> |             |                       | 10 <sup>12</sup> |     |     | Ω     |
| c <sub>i</sub>    | Input capacitance                                                     | Common mode  | V <sub>IC</sub> = 0, See Figure 5                                                 | 25°C                        | 7.5              |             |                       | 7.5              |     |     | pF    |
|                   |                                                                       | Differential |                                                                                   | 2.5                         |                  |             | 2.5                   |                  |     |     |       |
| z <sub>0</sub>    | Open-loop output impedance                                            |              | f = 1 MHz                                                                         | 25°C                        | 80               |             |                       | 80               |     |     | Ω     |
| CMRR              | Common-mode rejection ratio                                           |              | V <sub>IC</sub> = V <sub>ICRmin</sub> , V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω | 25°C                        | 80               | 98          | 80 98                 |                  |     | dB  |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 78 78            |             |                       |                  |     |     |       |
| k <sub>SVR</sub>  | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) |              | V <sub>CC±</sub> = ±5 V to ±15 V, V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω       | 25°C                        | 82               | 99          | 82 99                 |                  |     | dB  |       |
|                   |                                                                       |              |                                                                                   | Full range                  | 80 80            |             |                       |                  |     |     |       |

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

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



**TLE2082, TLE2082A, TLE2082Y**  
**EXCALIBUR HIGH-SPEED**  
**JFET-INPUT DUAL OPERATIONAL AMPLIFIERS**  
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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**  
**(continued)**

| PARAMETER             |                                | TEST CONDITIONS      |                        | T <sub>A</sub> <sup>†</sup> | TLE2082M |     |     | TLE2082AM |     |     | UNIT |
|-----------------------|--------------------------------|----------------------|------------------------|-----------------------------|----------|-----|-----|-----------|-----|-----|------|
|                       |                                |                      |                        |                             | MIN      | TYP | MAX | MIN       | TYP | MAX |      |
| I <sub>CC</sub>       | Supply current (both channels) | V <sub>O</sub> = 0,  | No load                | 25°C                        | 2.7      | 3.1 | 3.6 | 2.7       | 3.1 | 3.6 | mA   |
|                       |                                |                      |                        | Full range                  | 3.6      |     |     | 3.6       |     |     |      |
| Crosstalk attenuation |                                | V <sub>IC</sub> = 0, | R <sub>L</sub> = 2 kΩ  | 25°C                        | 120      |     |     | 120       |     |     | dB   |
| I <sub>OS</sub>       | Short-circuit output current   | V <sub>O</sub> = 0   | V <sub>ID</sub> = 1 V  | 25°C                        | −30      | −45 |     | −30       | −45 |     | mA   |
|                       |                                |                      | V <sub>ID</sub> = −1 V |                             | 30       | 48  |     | 30        | 48  |     |      |

† 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> <sup>†</sup> | TLE2082M |     |        | TLE2082AM |     |        | UNIT   |
|--------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------------|---------------------|-----------------------------|----------|-----|--------|-----------|-----|--------|--------|
|                    |                                             |                                                                                                               |                     |                             | MIN      | TYP | MAX    | MIN       | TYP | MAX    |        |
| SR +               | Positive slew rate                          | V <sub>O(PP)</sub> = 10 V, A <sub>VD</sub> = −1, R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF, See Figure 1 |                     | 25°C                        | 28       | 40  |        | 28        | 40  |        | V/μs   |
|                    | Full range                                  |                                                                                                               |                     | 20                          |          | 20  |        |           |     |        |        |
| SR −               | Negative slew rate                          |                                                                                                               |                     | 25°C                        | 30       | 45  |        | 30        | 45  |        | V/μs   |
|                    | Full range                                  |                                                                                                               |                     | 20                          |          | 20  |        |           |     |        |        |
| t <sub>s</sub>     | Settling time                               | A <sub>VD</sub> = −1, 10-V step, R <sub>L</sub> = 1 kΩ, C <sub>L</sub> = 100 pF                               | To 10 mV            | 25°C                        | 0.4      |     |        | 0.4       |     |        | μs     |
|                    |                                             |                                                                                                               | To 1 mV             |                             | 1.5      |     |        | 1.5       |     |        |        |
| V <sub>n</sub>     | Equivalent input noise voltage              | R <sub>S</sub> = 20 Ω, See Figure 3                                                                           | f = 10 Hz           | 25°C                        | 28       |     |        | 28        |     |        | nV/√Hz |
|                    |                                             |                                                                                                               | f = 10 kHz          |                             | 11.6     |     |        | 11.6      |     |        |        |
| V <sub>N(PP)</sub> | Peak-to-peak equivalent input noise voltage |                                                                                                               | f = 10 Hz to 10 kHz | 25°C                        | 6        |     |        | 6         |     |        | μV     |
|                    |                                             |                                                                                                               | f = 0.1 Hz to 10 Hz |                             | 0.6      |     |        | 0.6       |     |        |        |
| I <sub>n</sub>     | Equivalent input noise current              | V <sub>IC</sub> = 0, f = 10 kHz                                                                               | 25°C                | 2.8                         |          |     | 2.8    |           |     | fA/√Hz |        |
| THD + N            | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 20 V, A <sub>VD</sub> = 10, f = 1 kHz, R <sub>S</sub> = 25 Ω                             | 25°C                | 0.008%                      |          |     | 0.008% |           |     |        |        |
| B <sub>1</sub>     | Unity-gain bandwidth                        | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF, R <sub>L</sub> = 2 kΩ, See Figure 2                           | 25°C                | 8*                          | 10       |     | 8*     | 10        |     | MHz    |        |
| B <sub>OM</sub>    | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ, A <sub>VD</sub> = −1, C <sub>L</sub> = 25 pF                | 25°C                | 478*                        | 637      |     | 478*   | 637       |     | kHz    |        |
| φ <sub>m</sub>     | Phase margin at unity gain                  | V <sub>I</sub> = 10 mV, C <sub>L</sub> = 25 pF, R <sub>L</sub> = 2 kΩ, See Figure 2                           | 25°C                | 57°                         |          |     | 57°    |           |     |        |        |

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

† Full range is -55°C to 125°C.

# TLE2082, TLE2082A, TLE2082Y

## EXCALIBUR HIGH-SPEED

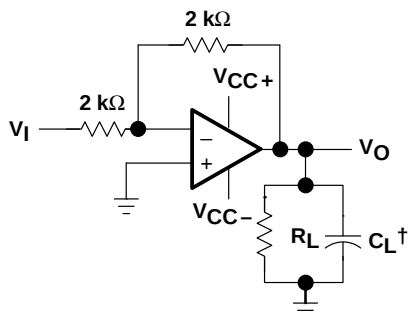
### JFET-INPUT DUAL OPERATIONAL AMPLIFIERS

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

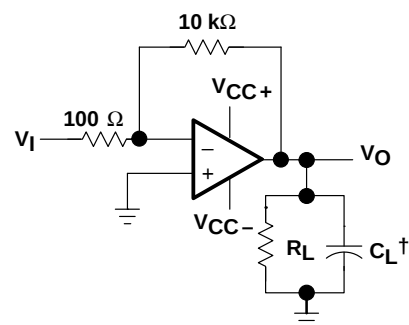
| PARAMETER |                                                                       | TEST CONDITIONS                                                                      | TLE2082Y                   |                  |     | UNIT     |
|-----------|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------|----------------------------|------------------|-----|----------|
|           |                                                                       |                                                                                      | MIN                        | TYP              | MAX |          |
| $V_{IO}$  | Input offset voltage                                                  | $V_{IC} = 0$ , $V_O = 0$ , $R_S = 50\ \Omega$                                        |                            | 1.1              | 6   | mV       |
| $I_{IO}$  | Input offset current                                                  | $V_{IC} = 0$ , $V_O = 0$ , See Figure 4                                              |                            | 6                | 100 | pA       |
| $I_{IB}$  | Input bias current                                                    |                                                                                      |                            | 20               | 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                                                                          |                            | 7.5              |     | pF       |
|           |                                                                       | Differential                                                                         |                            | 2.5              |     |          |
| $z_o$     | Open-loop output impedance                                            | $f = 1\ \text{MHz}$                                                                  |                            | 80               |     | $\Omega$ |
| CMRR      | Common-mode rejection ratio                                           | $V_{IC} = V_{ICRmin}$ , $V_O = 0$ , $R_S = 50\ \Omega$                               | 80                         | 98               |     | dB       |
| $k_{SVR}$ | Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 5\ \text{V}$ to $\pm 15\ \text{V}$ , $R_S = 50\ \Omega$ , $V_O = 0$ | 82                         | 99               |     | dB       |
| $I_{CC}$  | Supply current (both channels)                                        | $V_O = 0$ , No load                                                                  | 2.7                        | 3.1              | 3.6 | 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 1. Slew-Rate Test Circuit



† Includes fixture capacitance

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

## PARAMETER MEASUREMENT INFORMATION

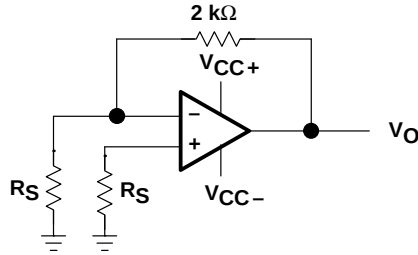


Figure 3. Noise-Voltage Test Circuit

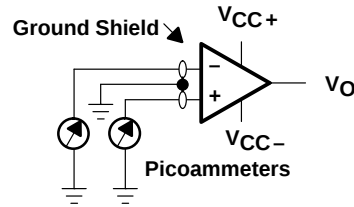


Figure 4. Input-Bias and Offset-Current Test Circuit

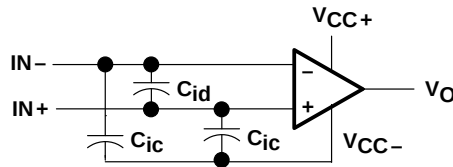


Figure 5. Internal Input Capacitance

### typical values

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

### input bias and offset current

At the picoampere bias-current level typical of the TLE2082 and TLE2082A, accurate measurement of the bias becomes difficult. Not only does this measurement require a picoammeter, but test socket leakages can easily exceed the actual device bias currents. To accurately measure these small currents, Texas Instruments uses a two-step process. The socket leakage is measured using picoammeters with bias voltages applied but with no device in the socket. The device is then inserted in the socket, and a second test is performed that measures both the socket leakage and the device input bias current. The two measurements are then subtracted algebraically to determine the bias current of the device.

## TYPICAL CHARACTERISTICS

Table of Graphs

|                |                                 |                                                    | FIGURE     |
|----------------|---------------------------------|----------------------------------------------------|------------|
| $V_{IO}$       | Input offset voltage            | Distribution                                       | 6          |
| $\alpha_{VIO}$ | Temperature coefficient         | Distribution                                       | 7          |
| $I_{IO}$       | Input offset current            | vs Free-air temperature                            | 8, 9       |
| $I_{IB}$       | Input bias current              | vs Free-air temperature<br>vs Total supply voltage | 8, 9<br>10 |
| $V_{ICR}$      | Common-mode input voltage range | vs Free-air temperature                            | 11         |
| $V_{ID}$       | Differential input voltage      | vs Output voltage                                  | 12, 13     |

## TYPICAL CHARACTERISTICS

**Table of Graphs (Continued)**

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

## TYPICAL CHARACTERISTICS†

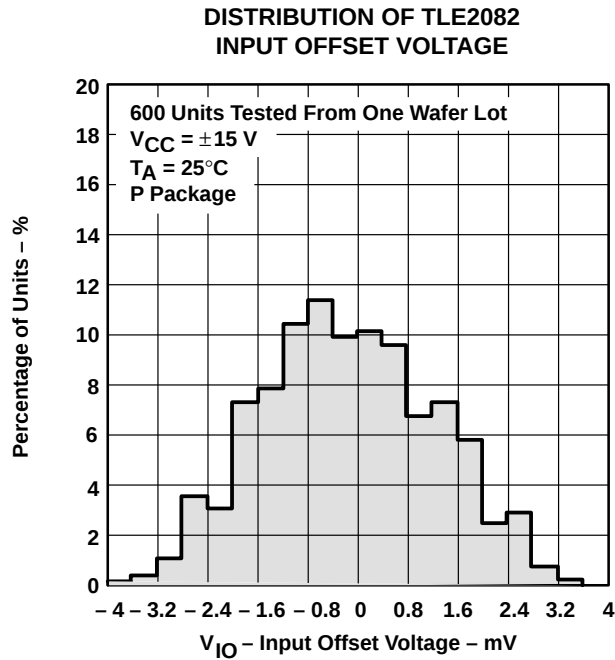


Figure 6

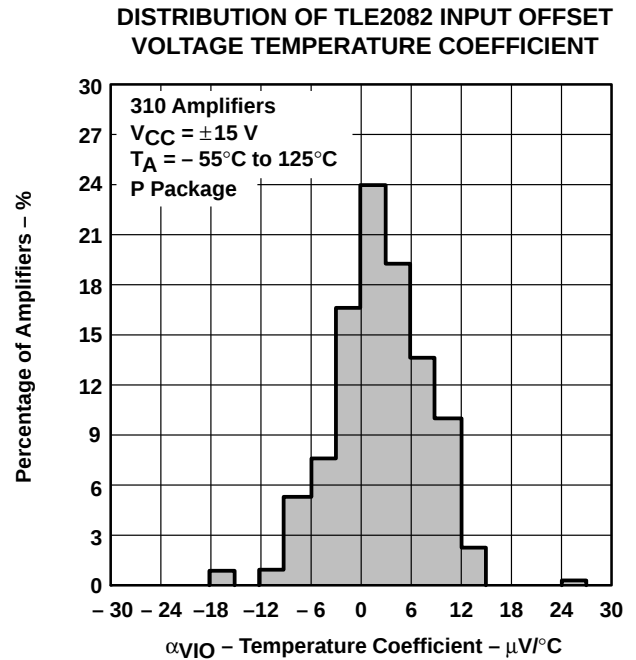


Figure 7

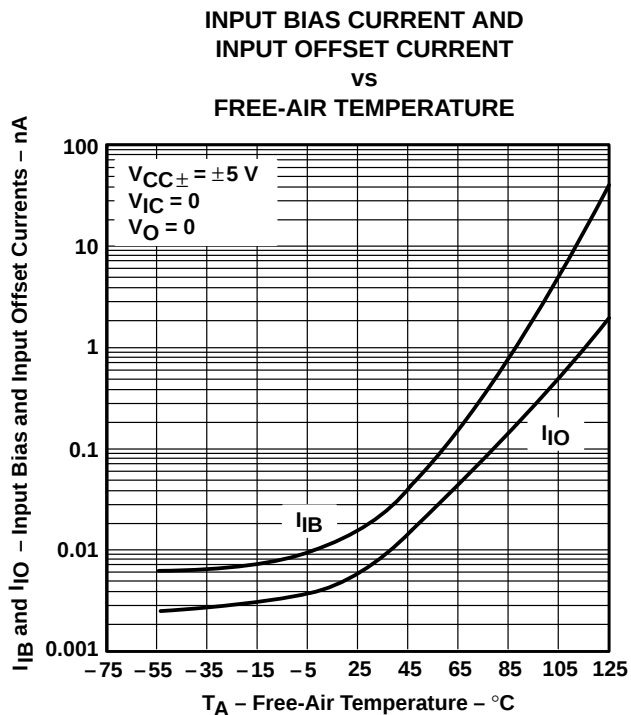


Figure 8

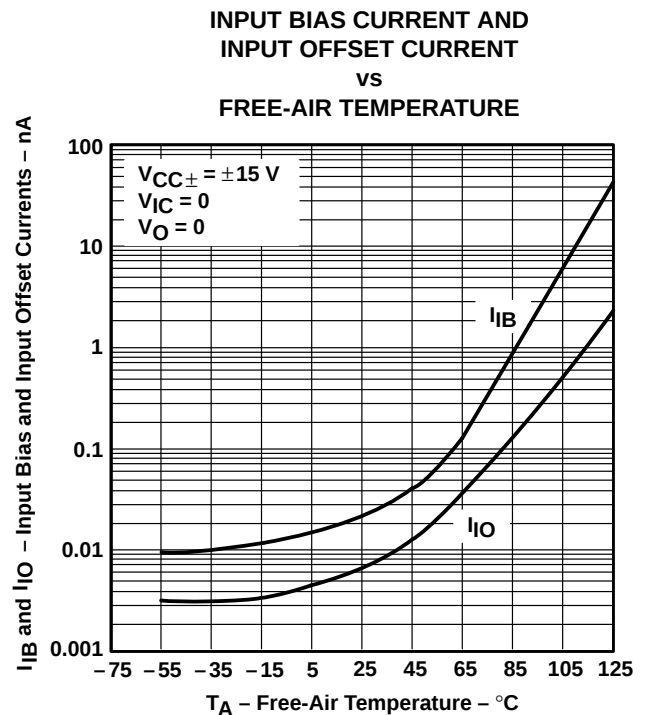
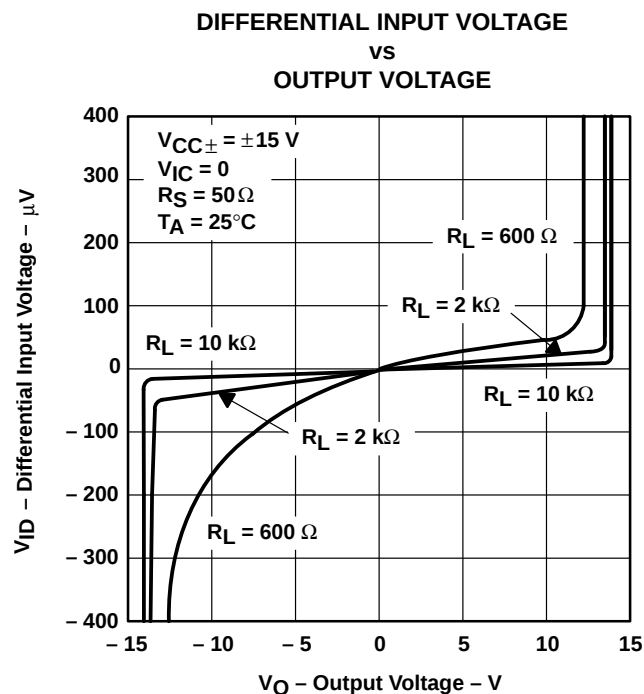
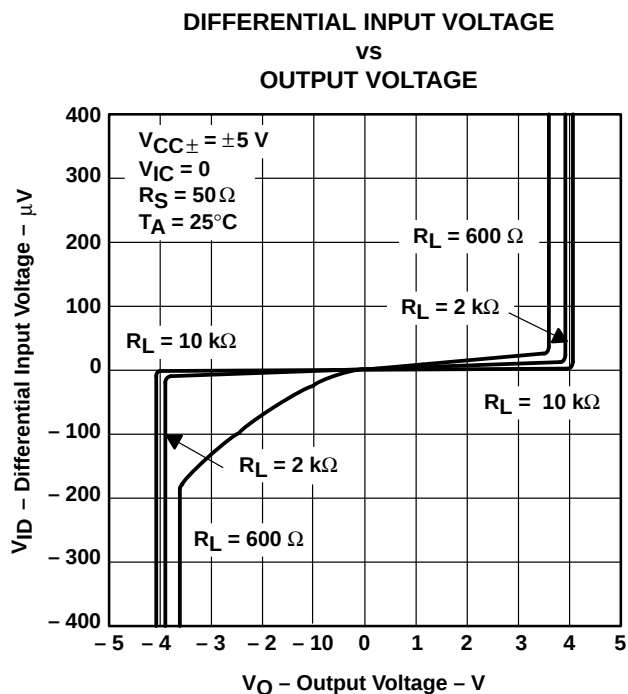
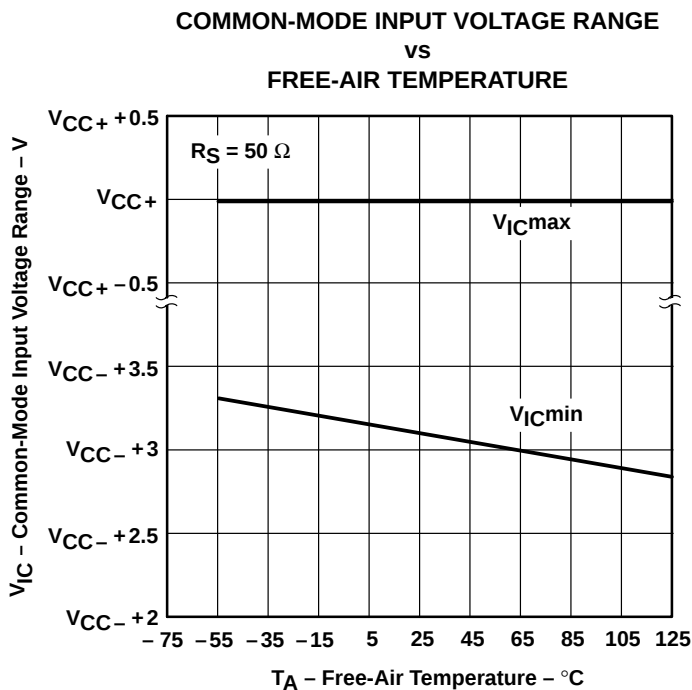
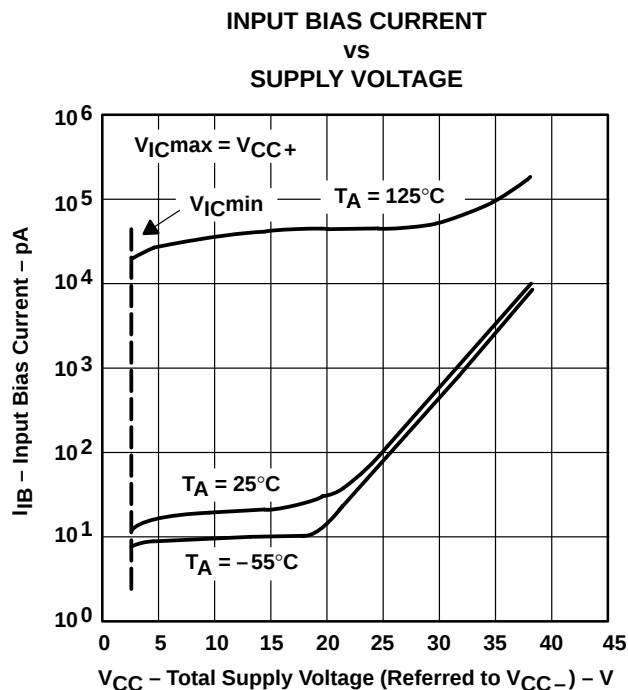


Figure 9

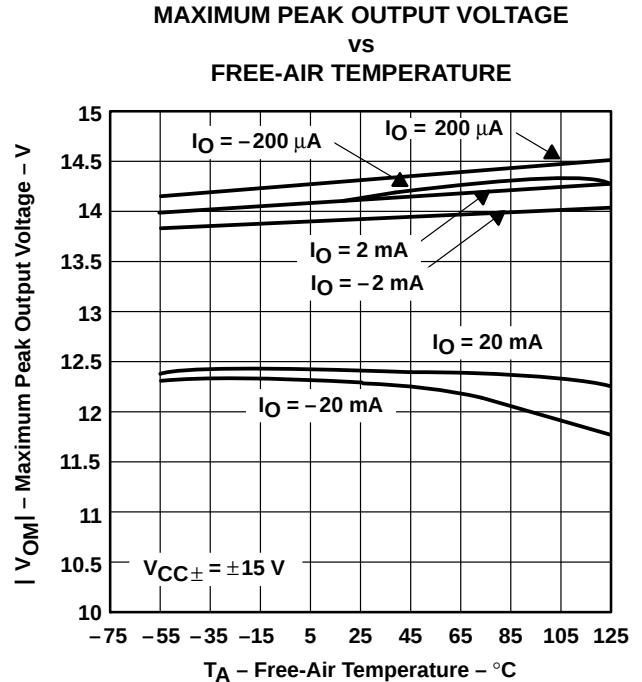
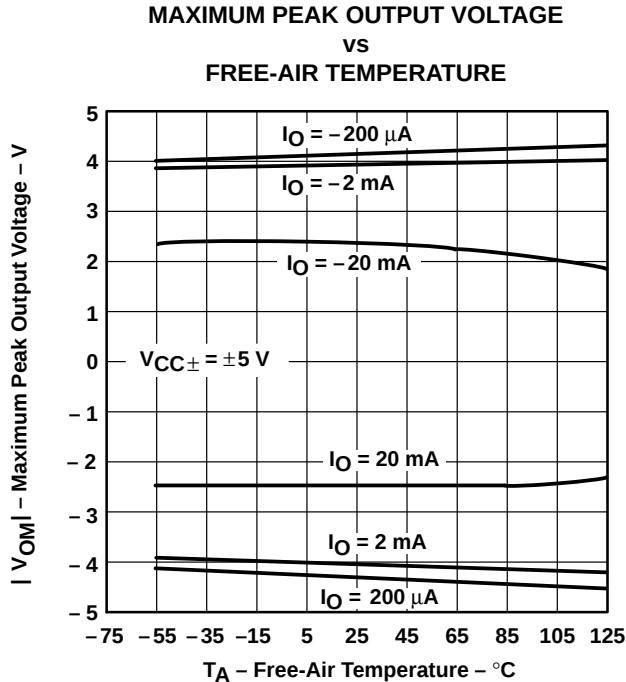
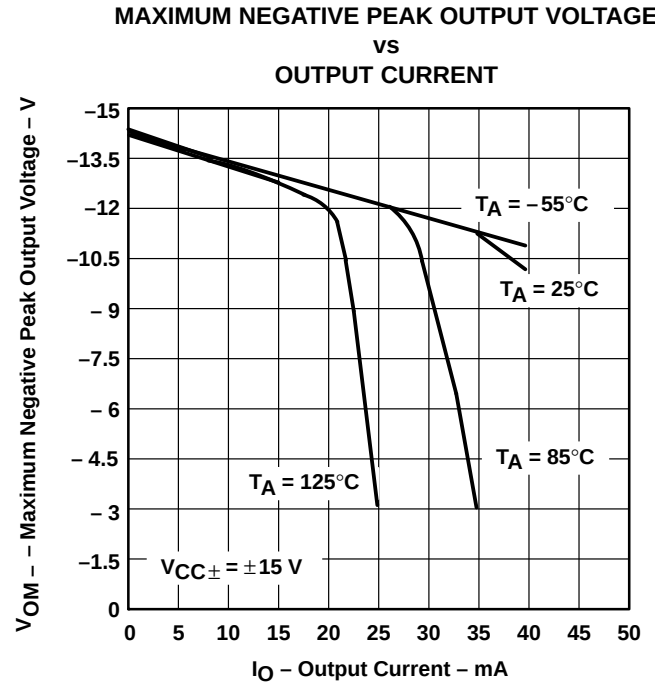
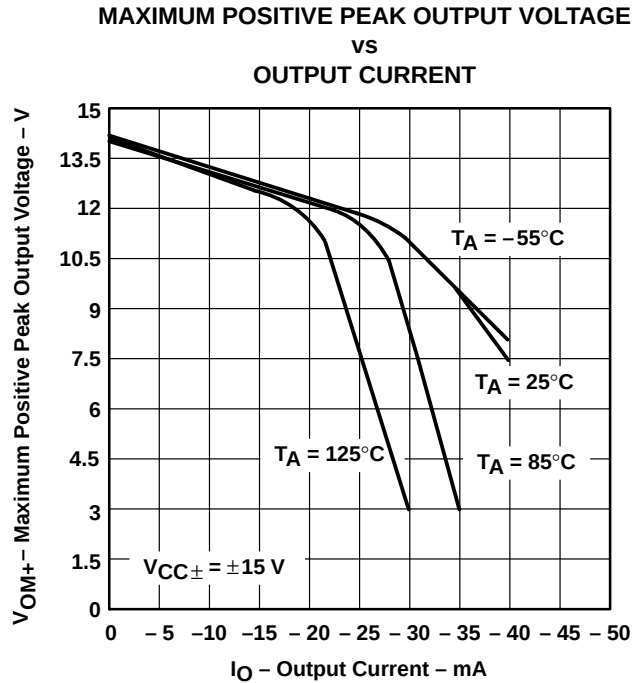
† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

# TYPICAL CHARACTERISTICS†



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

### TYPICAL CHARACTERISTICS†



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

# TYPICAL CHARACTERISTICS†

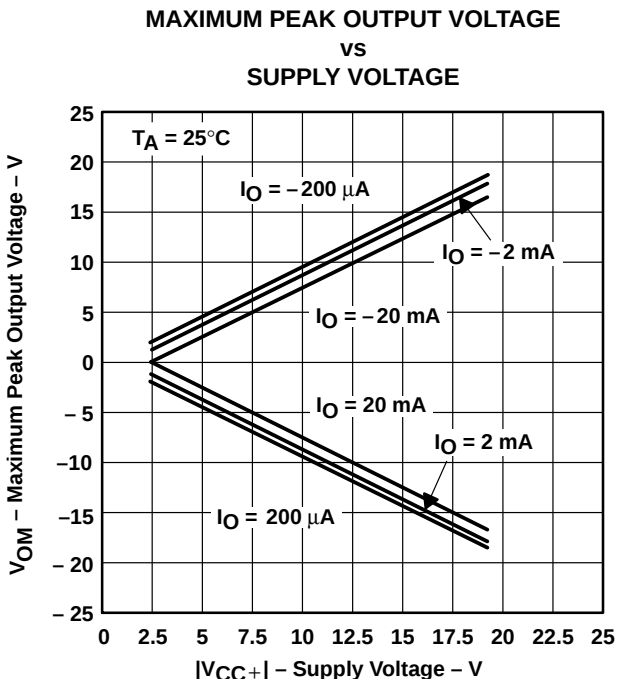


Figure 18

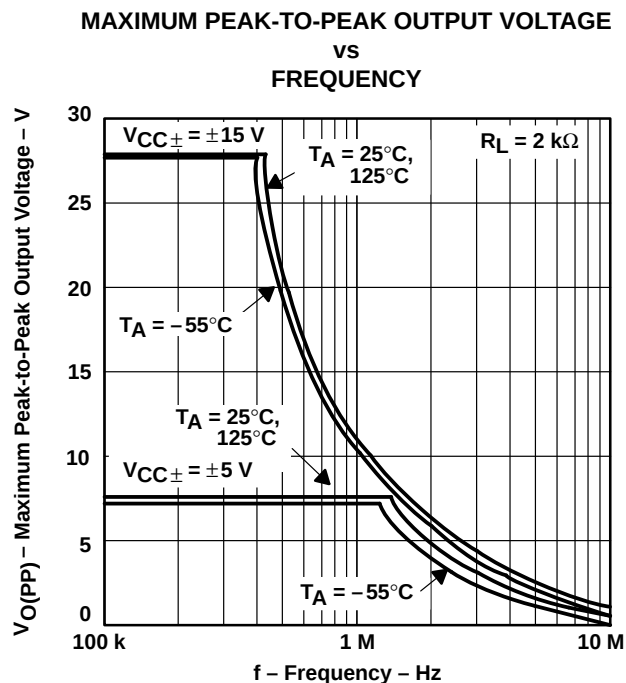


Figure 19

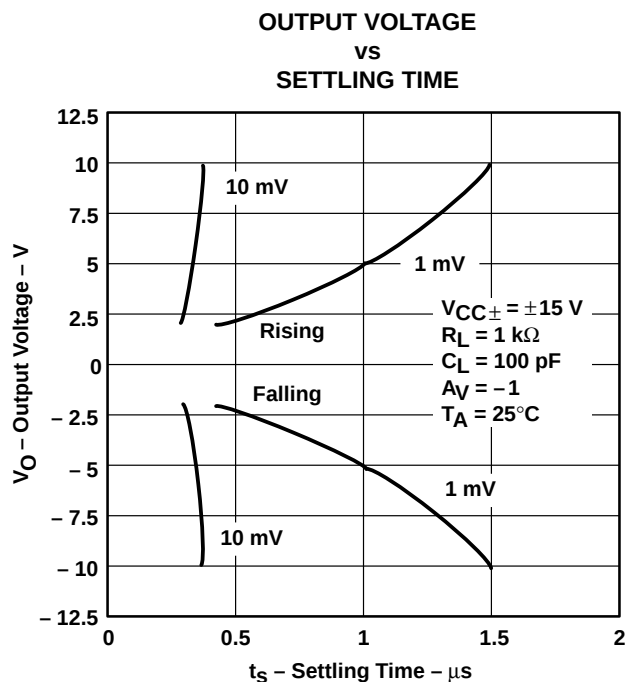


Figure 20

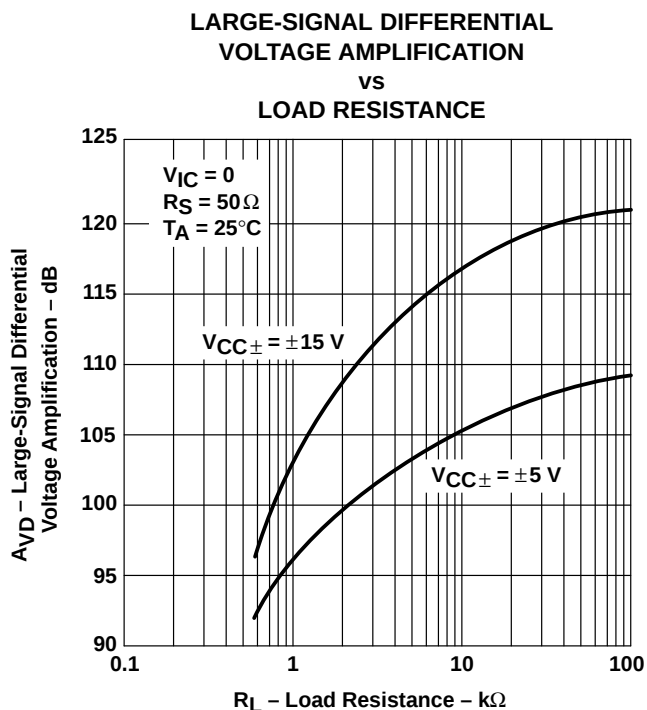


Figure 21

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

### TYPICAL CHARACTERISTICS†

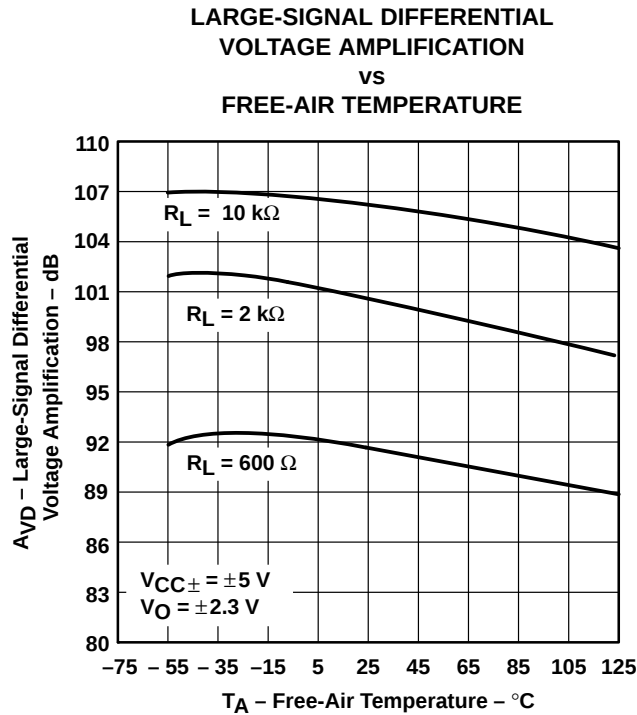


Figure 22

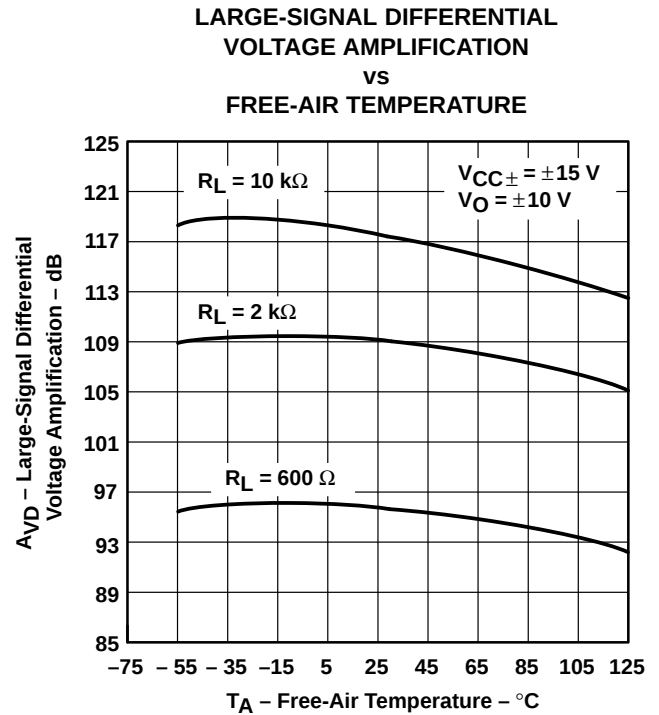


Figure 23

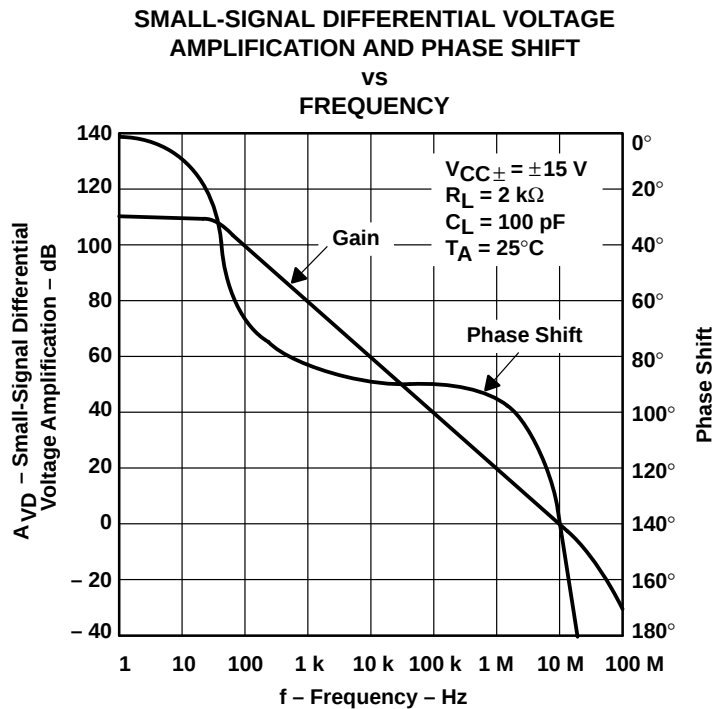


Figure 24

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

# TYPICAL CHARACTERISTICS†

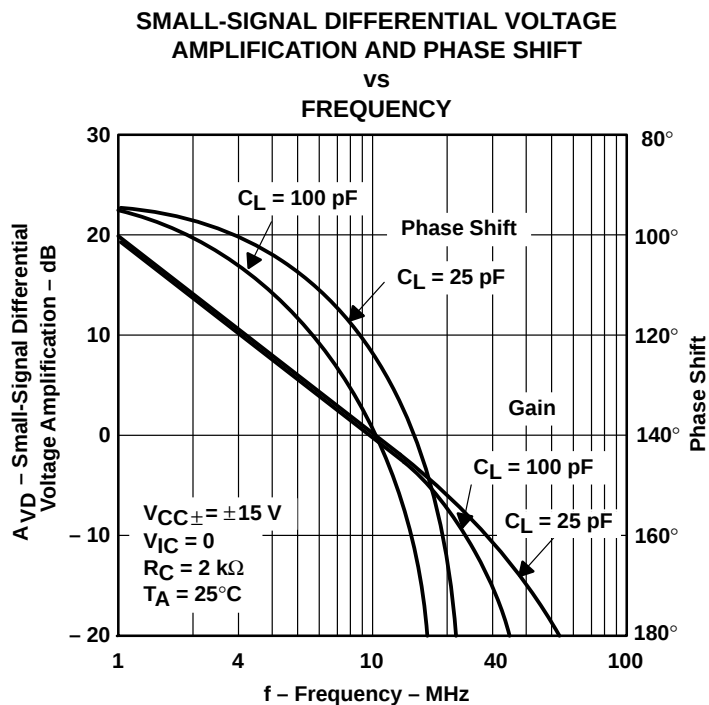


Figure 25

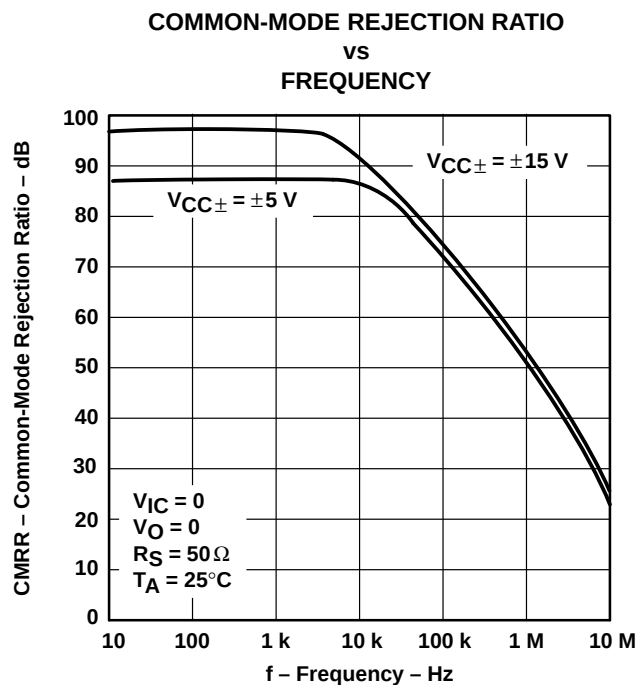


Figure 26

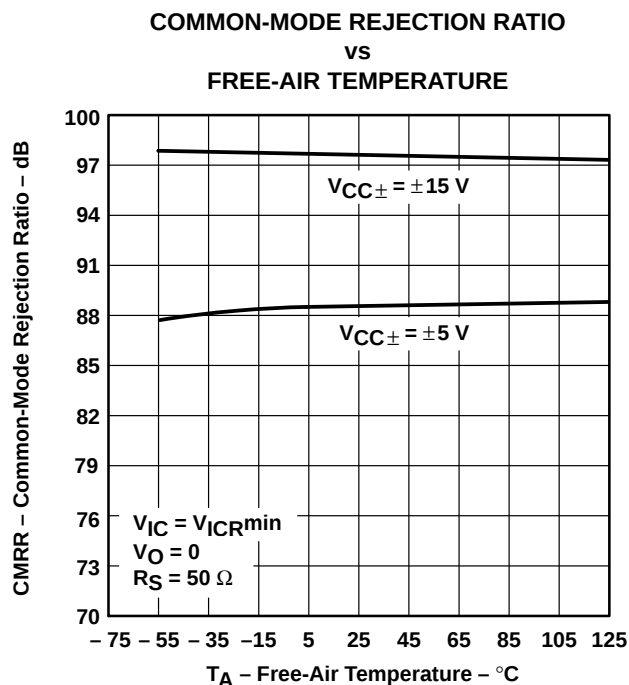


Figure 27

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

## TYPICAL CHARACTERISTICS†

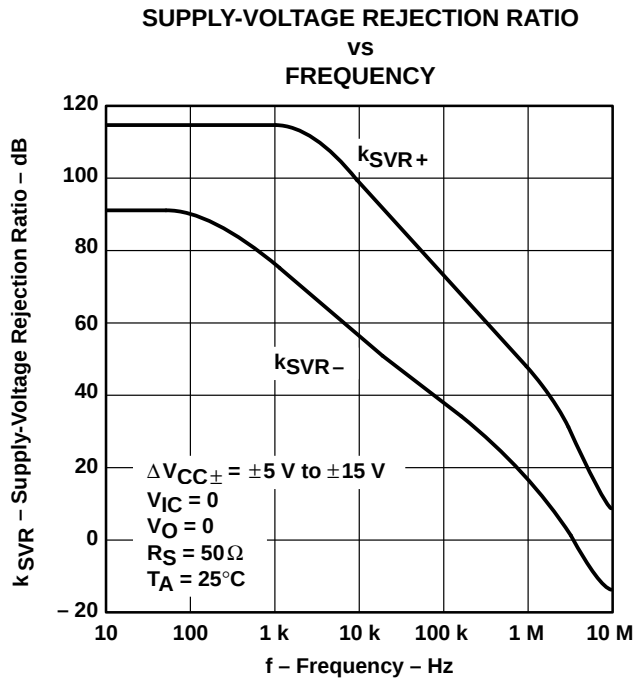


Figure 28

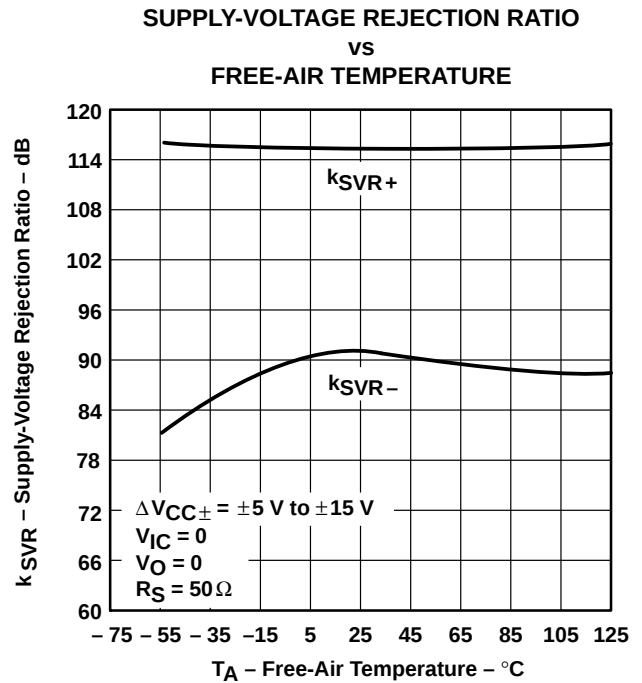


Figure 29

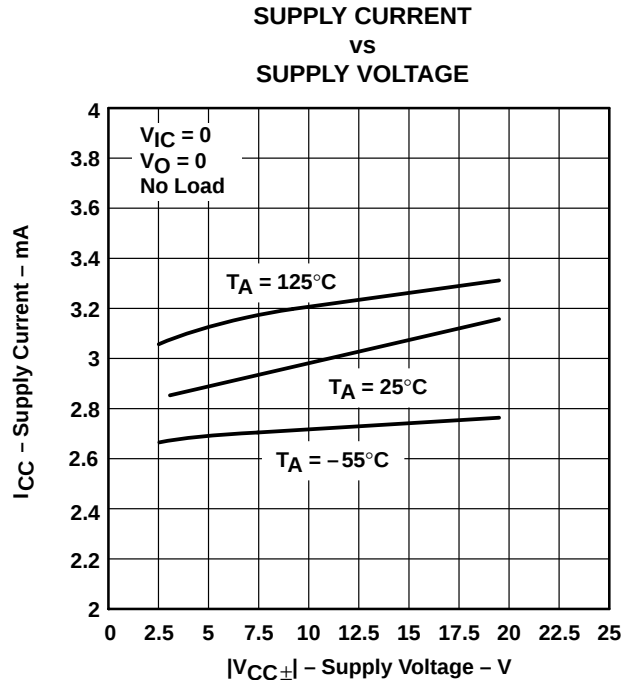


Figure 30

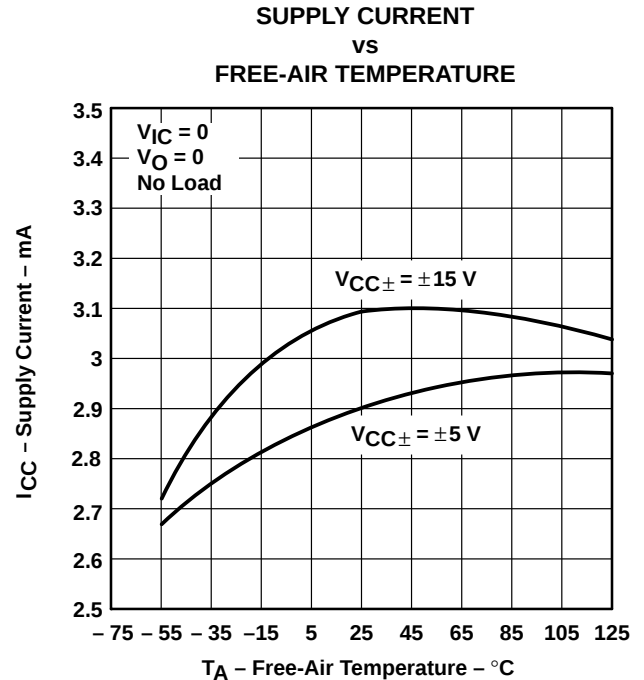


Figure 31

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

## TYPICAL CHARACTERISTICS

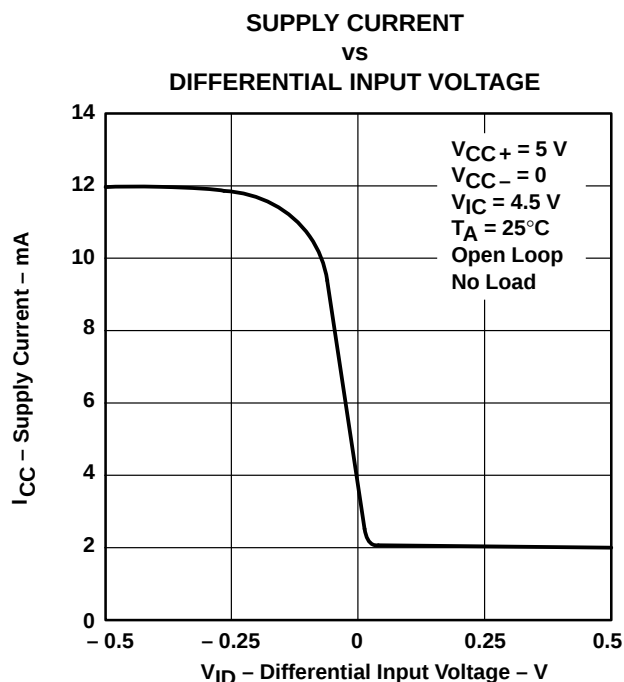


Figure 32

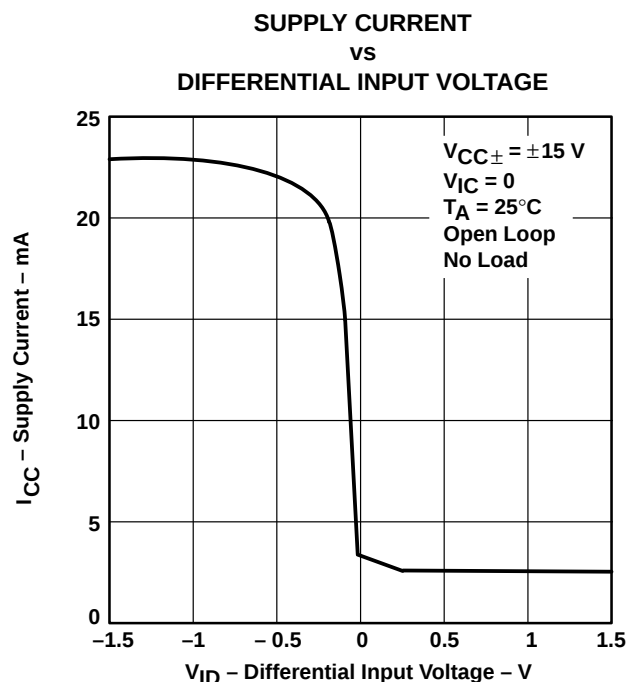


Figure 33

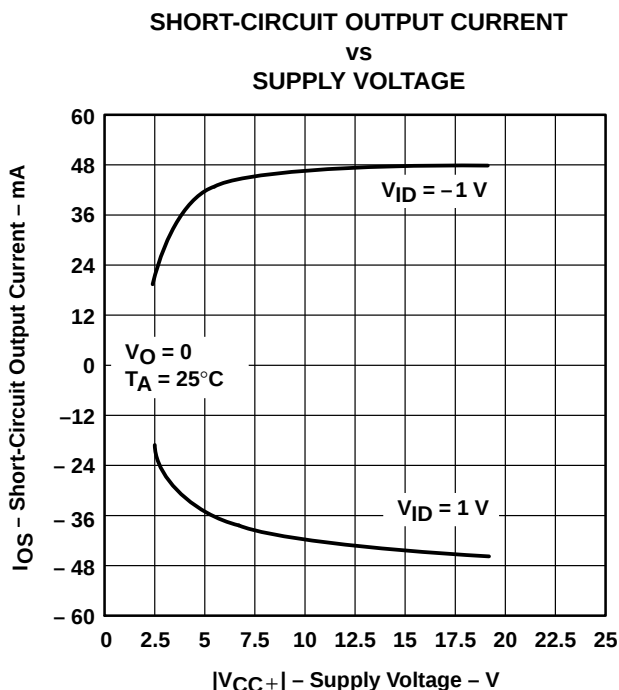


Figure 34

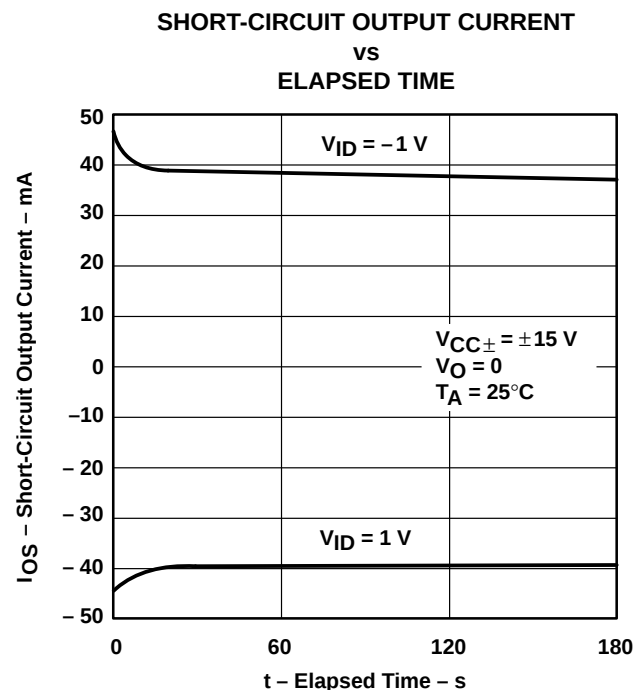
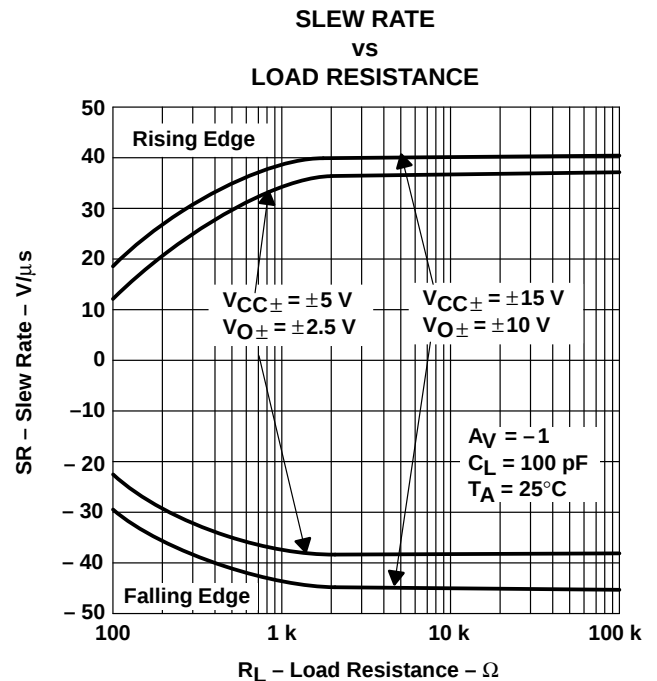
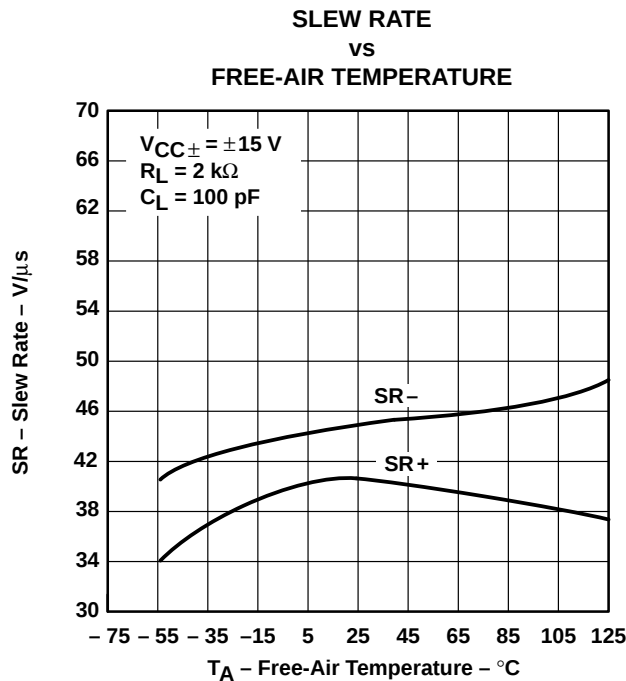
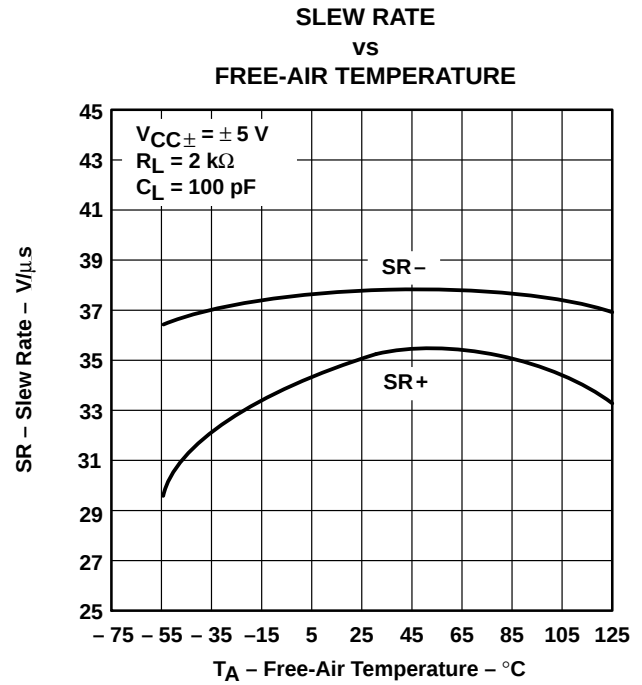
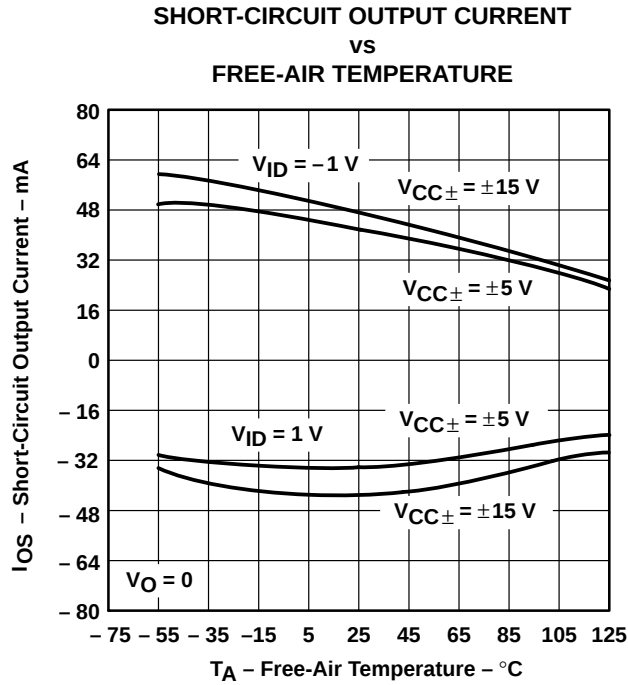


Figure 35

## TYPICAL CHARACTERISTICS†



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

## TYPICAL CHARACTERISTICS

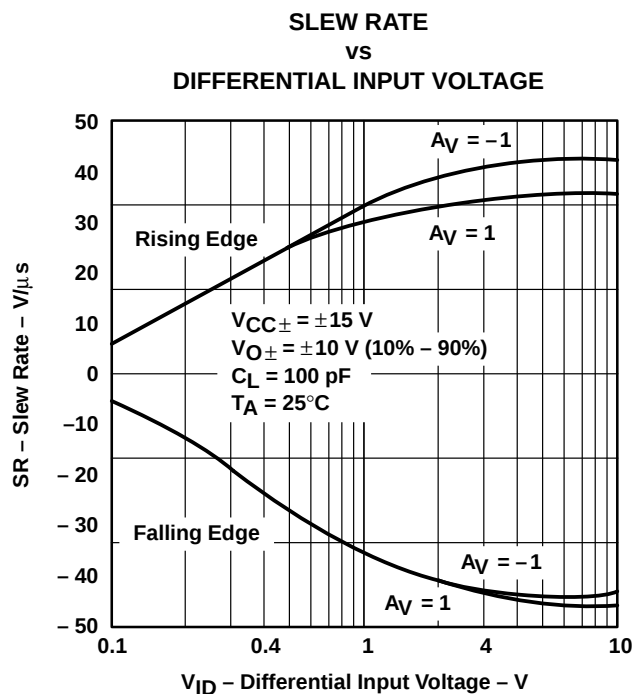


Figure 40

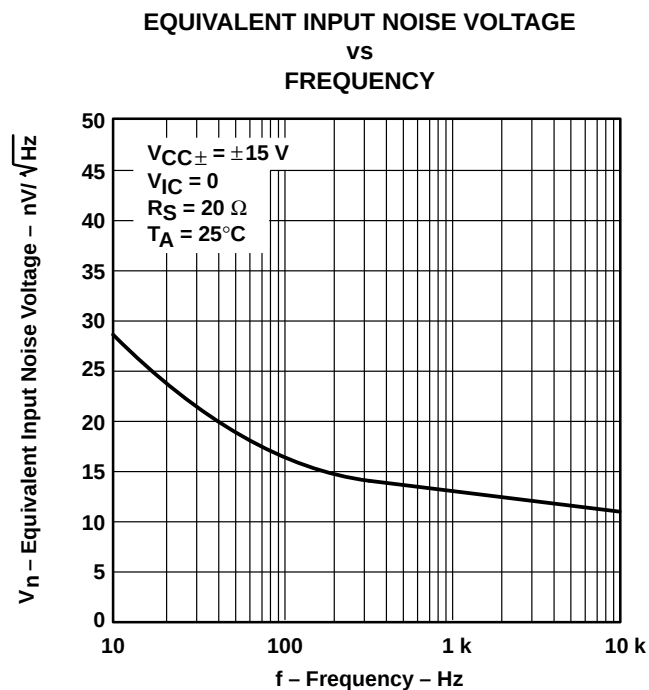


Figure 41

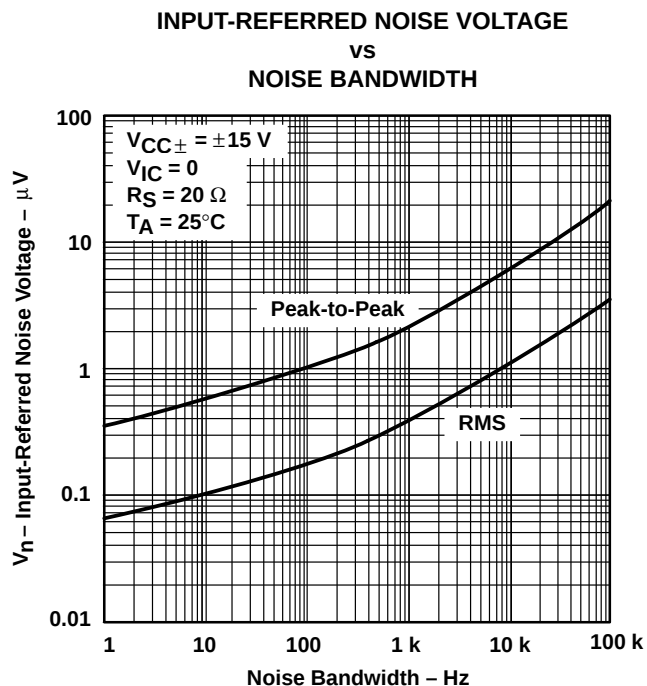


Figure 42

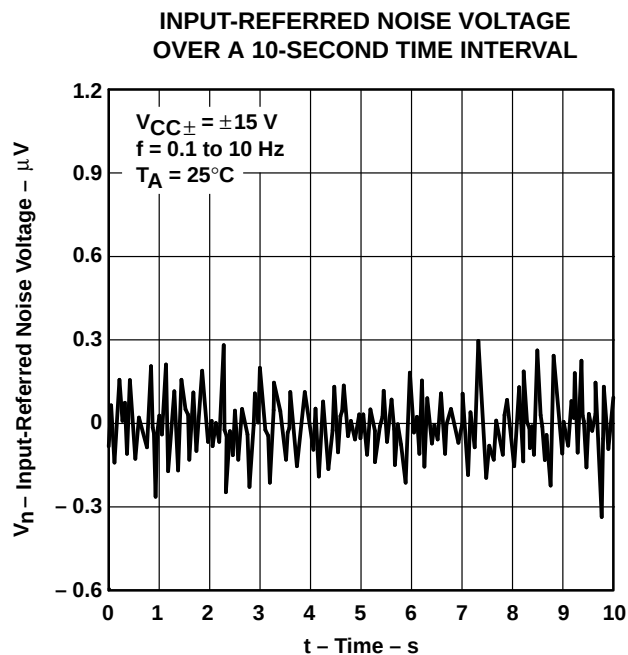


Figure 43

## TYPICAL CHARACTERISTICS

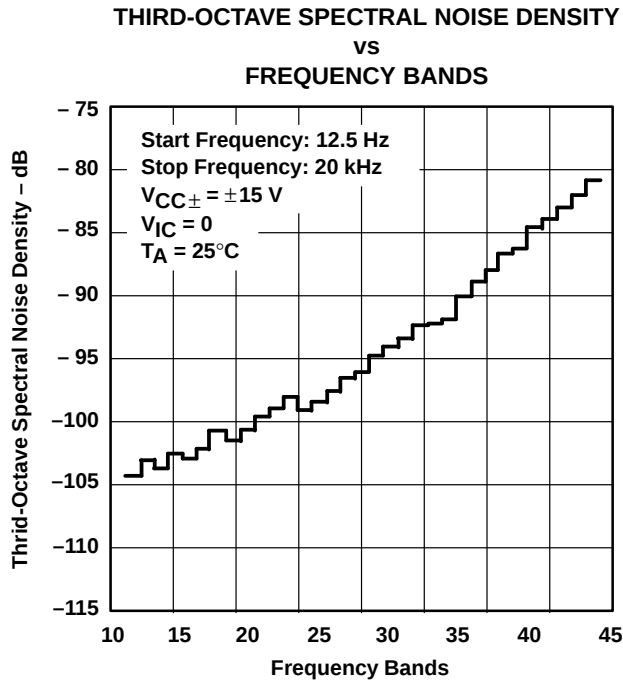


Figure 44

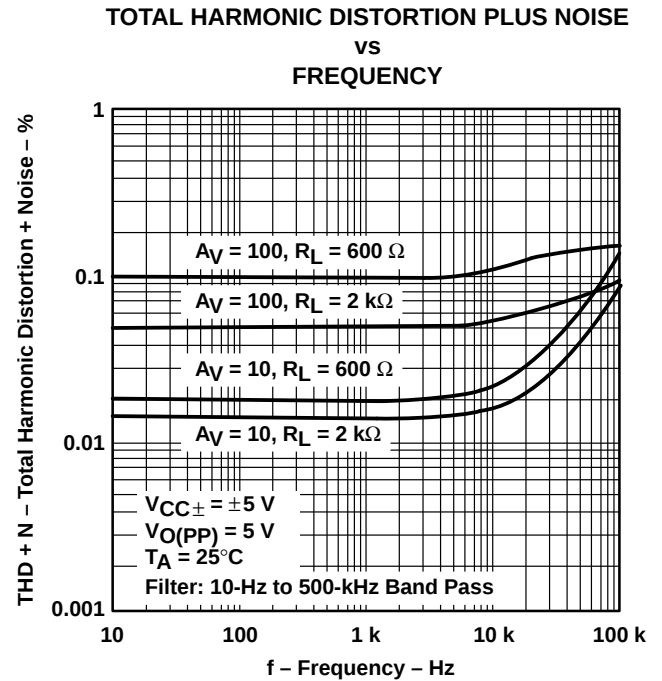


Figure 45

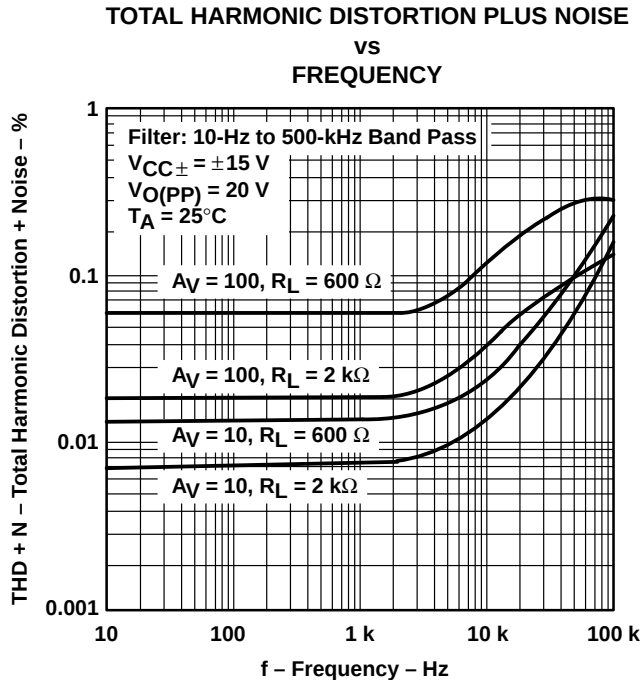


Figure 46

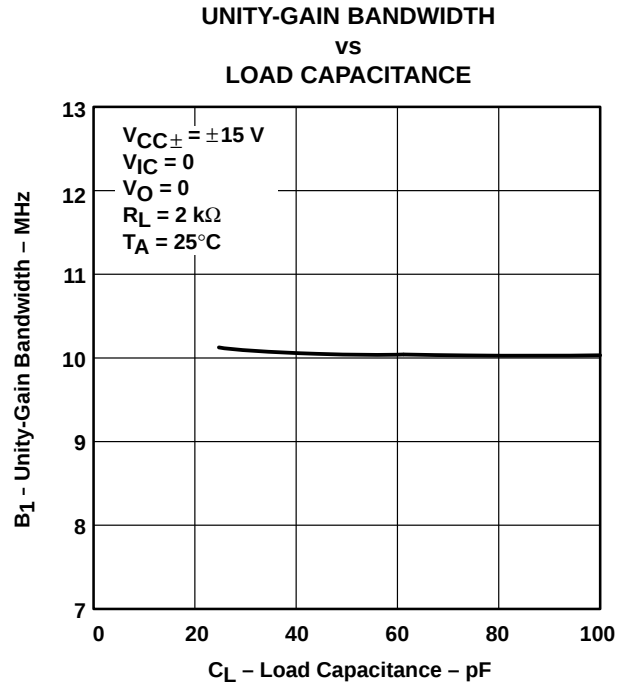


Figure 47

# TYPICAL CHARACTERISTICS†

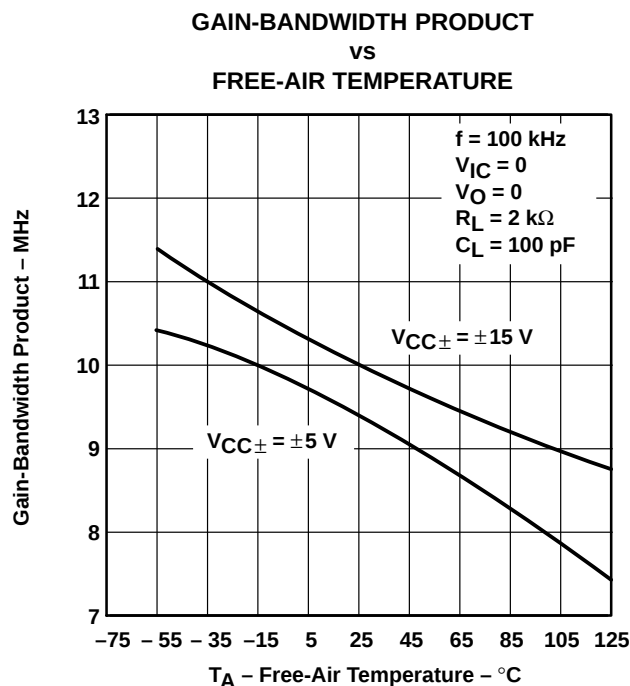


Figure 48

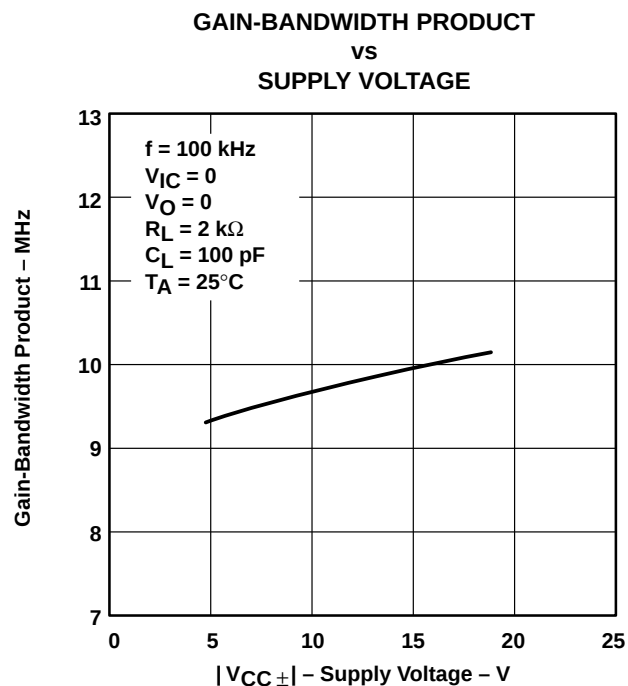


Figure 49

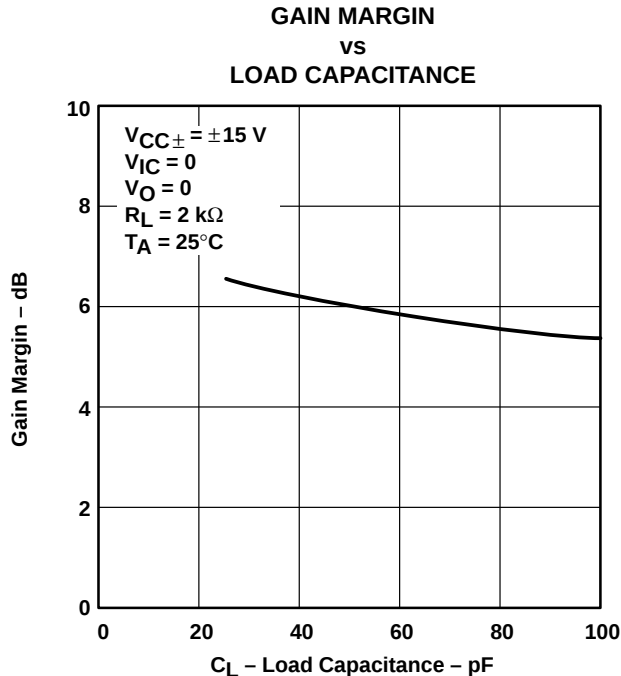


Figure 50

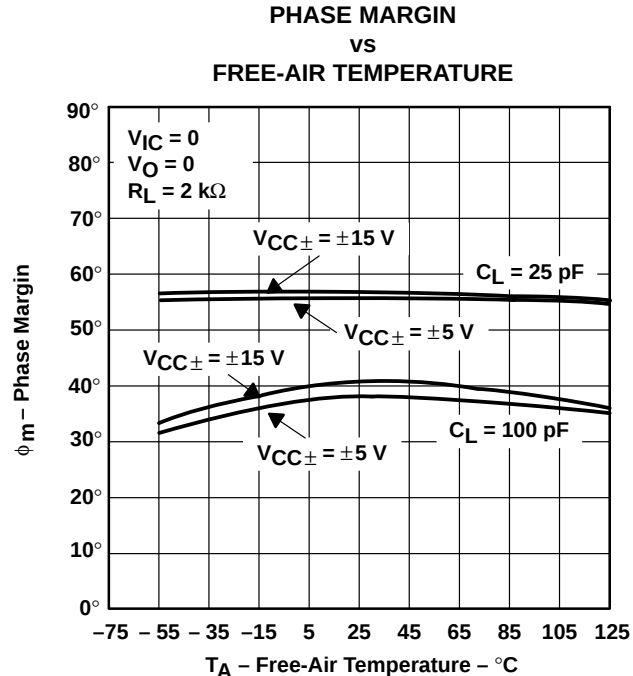


Figure 51

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

TYPICAL CHARACTERISTICS†

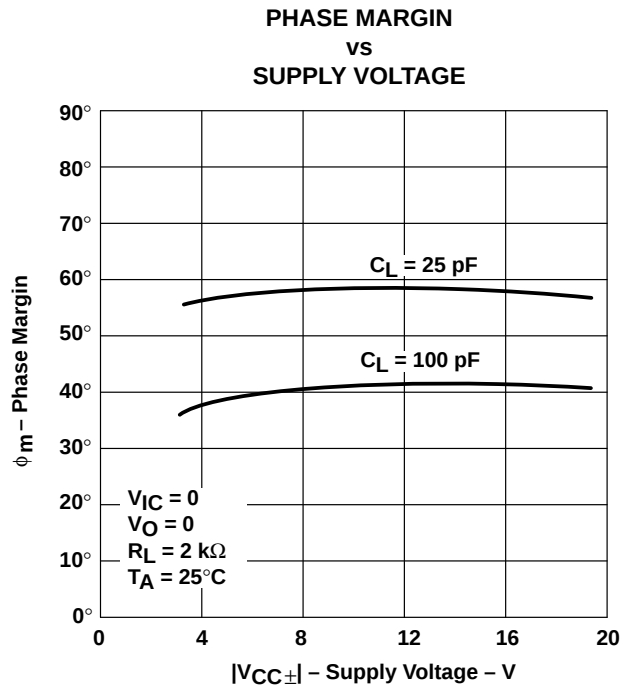


Figure 52

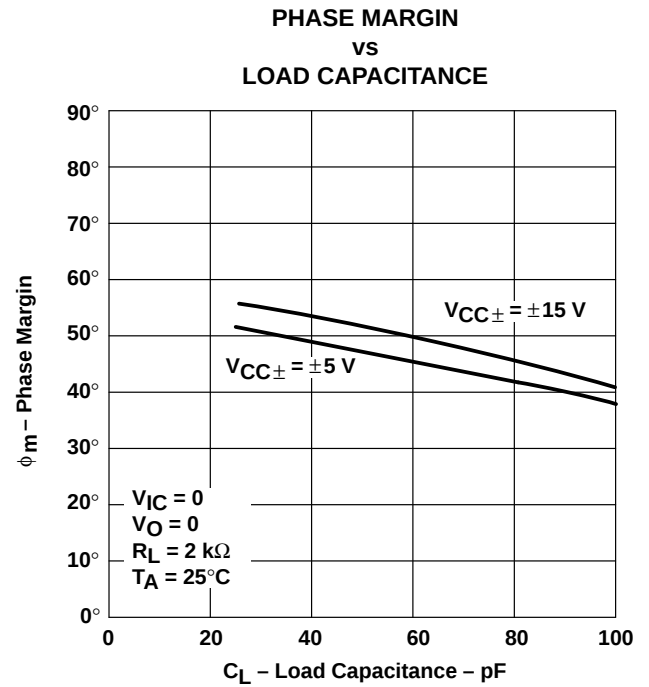


Figure 53

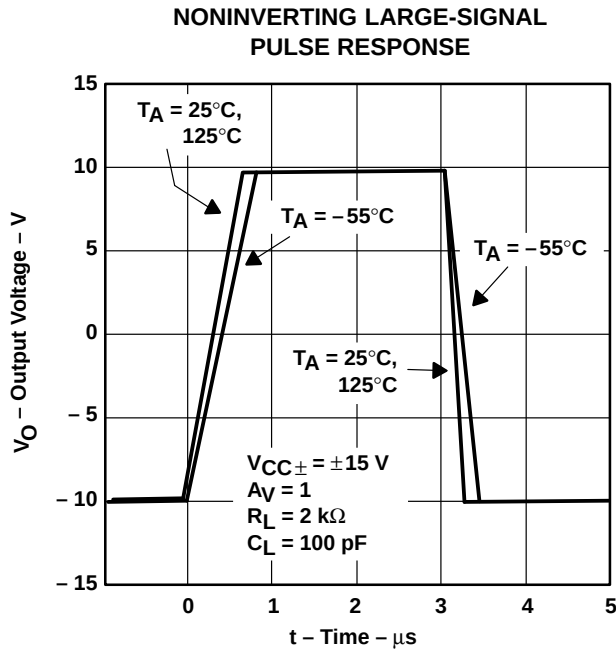


Figure 54

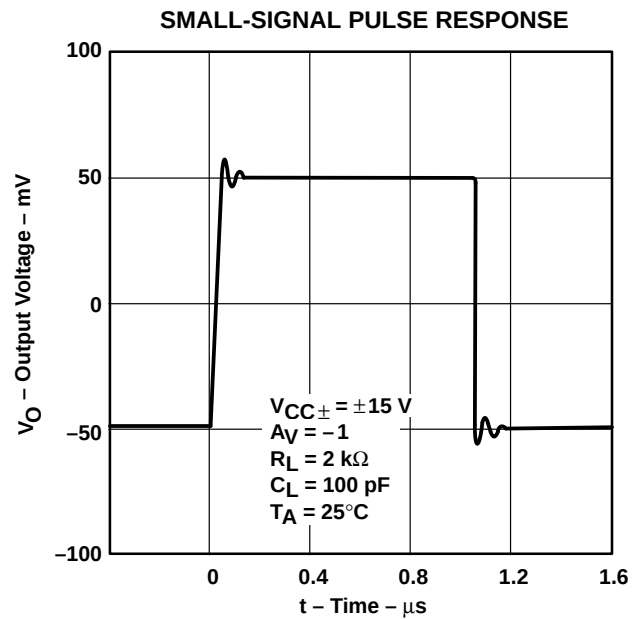


Figure 55

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

## TYPICAL CHARACTERISTICS

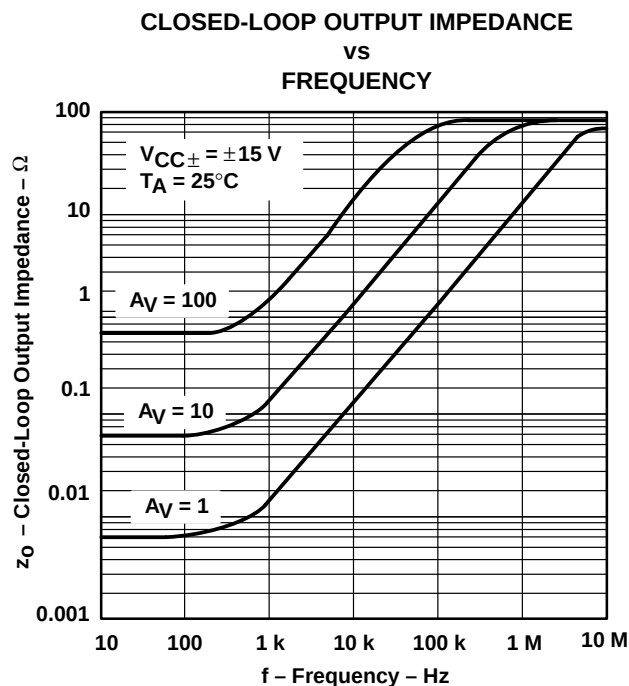


Figure 56

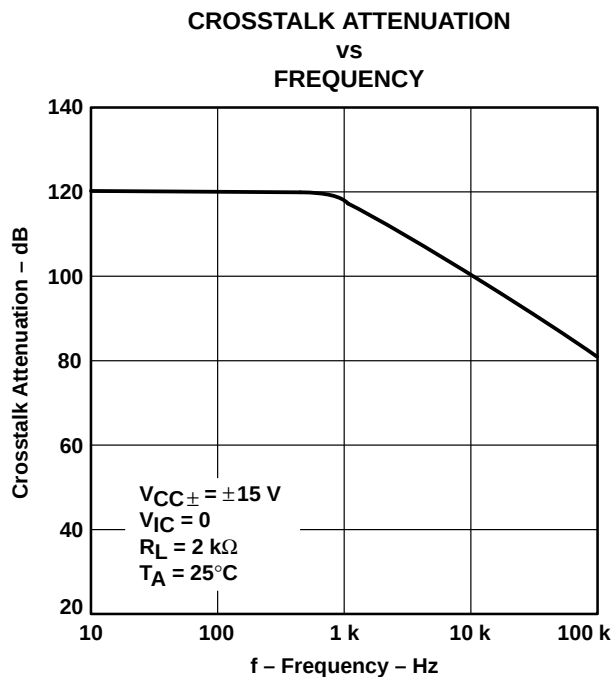


Figure 57

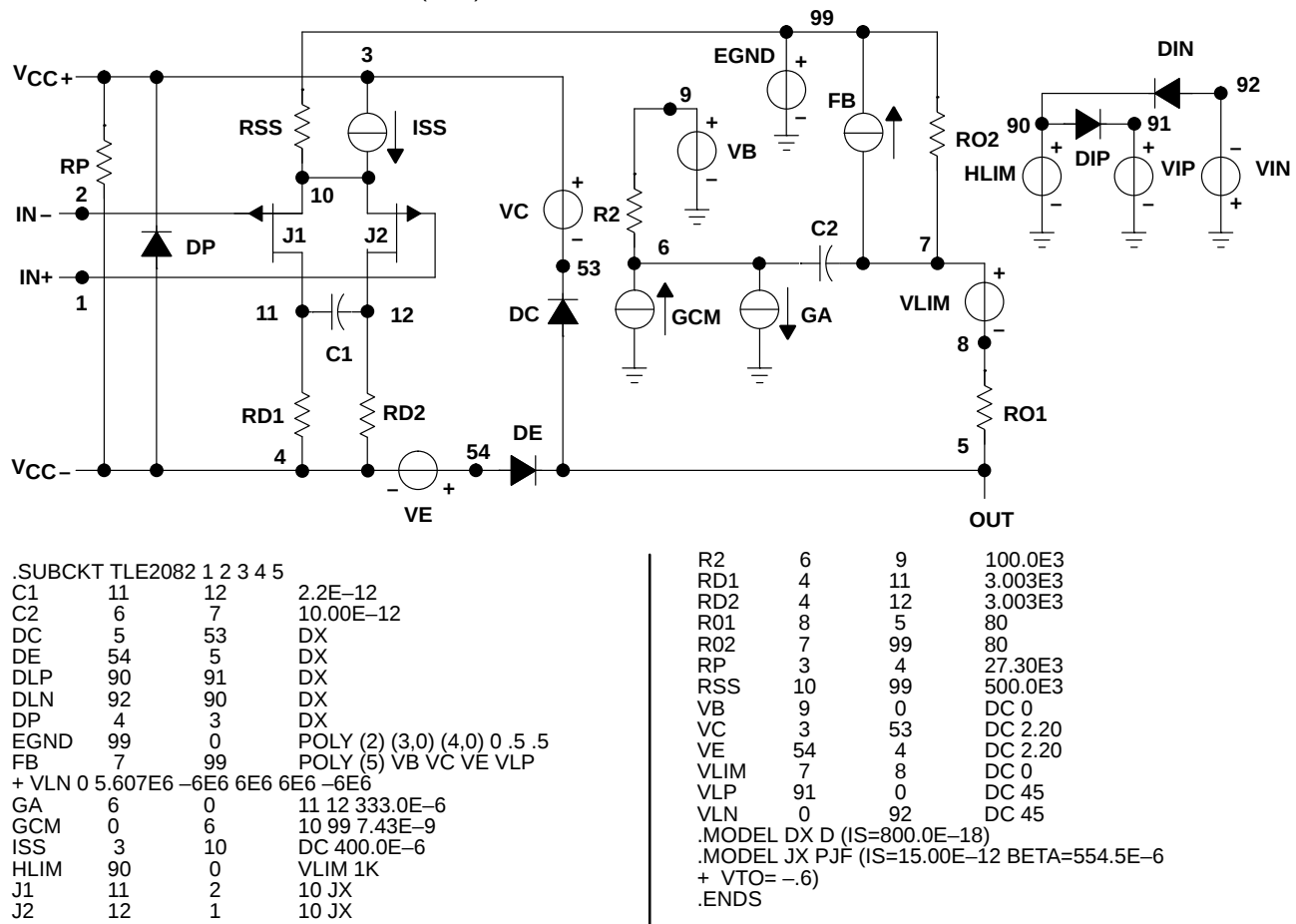
## APPLICATION INFORMATION

### macromodel information

Macromodel information provided was derived using *PSpice™ Parts™* model generation software. The Boyle macromodel (see Note 4) and subcircuit in Figure 58 are generated using the TLE2082 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 58. Boyle Macromodel and Subcircuit**

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