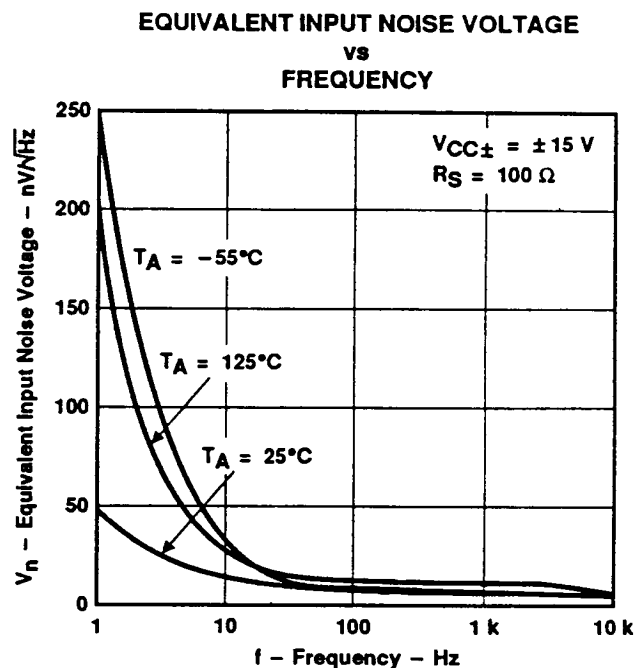
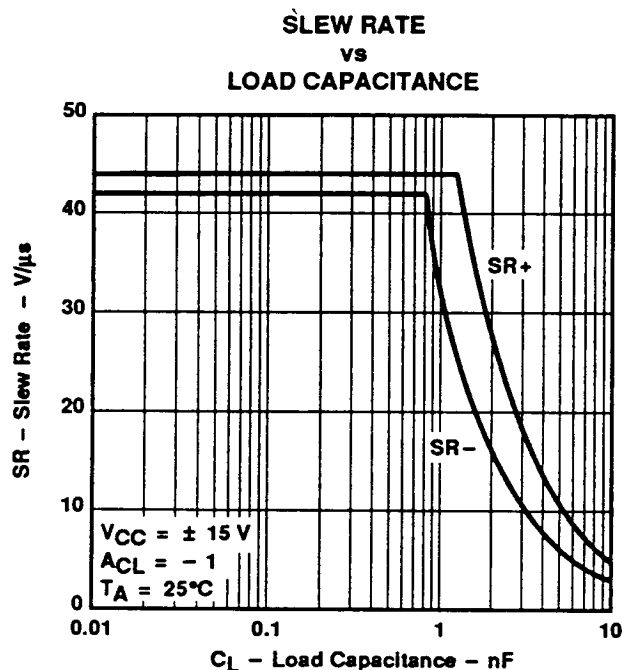


# TLE2141, TLE2141A EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

D3652, NOVEMBER 1990 – REVISED FEBRUARY 1991

## available features

- Low Noise:  
10 Hz ...  $15 \text{ nV}/\sqrt{\text{Hz}}$   
1 kHz ...  $10.5 \text{ nV}/\sqrt{\text{Hz}}$
- 10,000-pF Load Capability
- 20-mA Min Short Circuit Output Current
- 30-V/ $\mu\text{s}$  Min Slew Rate
- High Gain-Bandwidth Product ... 5.9 MHz
- Low  $V_{IO}$  ... 500  $\mu\text{V}$  Max at 25°C
- Single or Split Supply ... 4 V to 44 V
- Fast Settling Time ... 340 ns to 0.1%  
400 ns to 0.01%
- Saturation Recovery ... 150 ns
- Large Output Swing ...  $V_{CC-} + 0.1 \text{ V}$   
to  $V_{CC+} - 1 \text{ V}$



## description

The TLE2141 and TLE2141A are high-performance, internally compensated operational amplifiers built using Texas Instruments complementary bipolar Excalibur process. The TLE2141A is a tighter offset voltage grade of the TLE2141. Both are pin-compatible upgrades to standard industry products.

## AVAILABLE OPTIONS

| $T_A$             | $V_{IO} \text{ max}$<br>AT 25°C        | PACKAGE                  |                         |                        |                     |                       |                     |
|-------------------|----------------------------------------|--------------------------|-------------------------|------------------------|---------------------|-----------------------|---------------------|
|                   |                                        | SMALL-<br>OUTLINE<br>(D) | CHIP<br>CARRIER<br>(FK) | CERAMIC<br>DIP<br>(JG) | METAL<br>CAN<br>(L) | PLASTIC<br>DIP<br>(P) | CHIP<br>FORM<br>(Y) |
| 0°C to<br>70°C    | 500 $\mu\text{V}$<br>900 $\mu\text{V}$ | TLE2141ACD               | —                       | —                      | —                   | TLE2141ACP            | TLE2141Y            |
|                   |                                        | TLE2141CD                | —                       | —                      | —                   | TLE2141CP             |                     |
| -40°C to<br>105°C | 500 $\mu\text{V}$<br>900 $\mu\text{V}$ | TLE2141AID               | —                       | —                      | —                   | TLE2141AIP            |                     |
|                   |                                        | TLE2141ID                | —                       | —                      | —                   | TLE2141IP             |                     |
| -55°C to<br>125°C | 500 $\mu\text{V}$<br>900 $\mu\text{V}$ | TLE2141AMD               | TLE2141AMFK             | TLE2141AMJG            | TLE2141AML          | TLE2141AMP            |                     |
|                   |                                        | TLE2141MD                | TLE2141MFK              | TLE2141MJG             | TLE2141ML           | TLE2141MP             |                     |

D packages are available taped-and-reeled. Add "R" suffix to device type, (e.g., TLE2141ACDR).

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

**TEXAS  
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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.

# TLE2141, TLE2141A EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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## description (continued)

The design incorporates a patent-pending input stage that simultaneously achieves low audio band noise of  $10.5 \text{ nV}/\sqrt{\text{Hz}}$  with a 10-Hz  $1/f$  corner and symmetrical  $40\text{-V}/\mu\text{s}$  slew rate typically with loads up to 800 pF. The resulting low distortion and high power-bandwidth are important in hi-fi audio applications. A fast settling time of 340 ns to 0.1% of a 10-V step with a  $2\text{-k}\Omega$  /100-pF load is useful in fast actuator/positioning drivers. Under similar test conditions, settling time to 0.01% is 400 ns.

The devices are stable with capacitive loads up to 10 nF, although the 6 MHz bandwidth decreases to 1.8 MHz at this high loading level. As such, the TLE2141 and TLE2141A are useful for low droop sample-and-holds and direct buffering of long cables, including 4-20 mA current loops.

The special design also exhibits an improved insensitivity to inherent IC component mismatches as is evidenced by a 500- $\mu\text{V}$  maximum offset voltage and  $1.7\text{-}\mu\text{V}/^\circ\text{C}$  typical drift. Minimum common-mode rejection ratio and supply-voltage rejection ratio are 85 dB and 90 dB, respectively.

Device performance is relatively independent of supply voltage over the  $\pm 2\text{-V}$  to  $\pm 22\text{-V}$  range. Inputs can operate between  $V_{CC-} - 0.3 \text{ V}$  to  $V_{CC+} - 1.8 \text{ V}$  without inducing phase reversal, although excessive input current may flow out of each input exceeding the lower common-mode input range. The all NPN output stage provides a nearly rail-to-rail output swing of  $V_{CC-} + 0.1 \text{ V}$  to  $V_{CC+} - 1 \text{ V}$  under light current loading conditions. The device can sustain shorts to either supply since output current is internally limited, but care must be taken to ensure that maximum package power dissipation is not exceeded.

Both versions can also be used as comparators. Differential inputs of  $V_{CC\pm}$  can be maintained without damage to the device. Open-loop propagation delay with TTL supply levels is typically 200 ns. This gives a good indication as to output stage saturation recovery when the device is over-driven beyond the limits of recommended output swing.

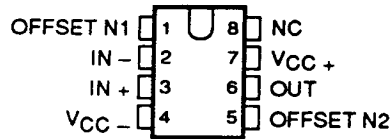
Both the TLE2141 and TLE2141A are available in a wide variety of packages, including both the industry-standard 8-pin small-outline version and chip form for high-density system applications. The C-suffix devices are characterized for operation from  $0^\circ\text{C}$  to  $70^\circ\text{C}$ , the I-suffix from  $-40^\circ\text{C}$  to  $105^\circ\text{C}$ , and the M-suffix over the full military temperature range of  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .



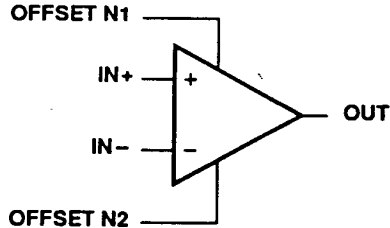
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# TLE2141, TLE2141A EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

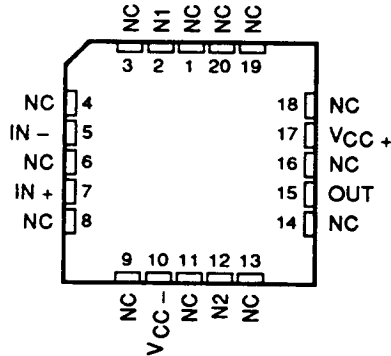
**D, JG, OR P PACKAGE  
(TOP VIEW)**



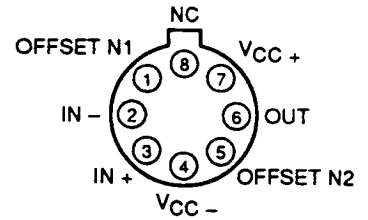
**symbol**



**FK PACKAGE  
(TOP VIEW)**



**L PACKAGE  
(TOP VIEW)**



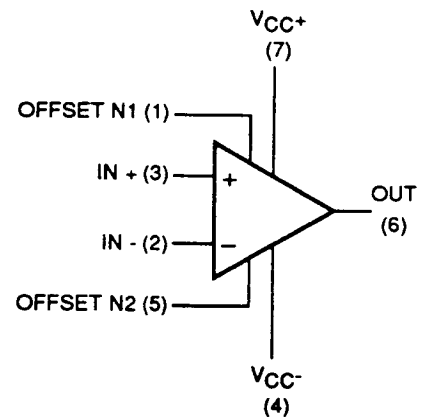
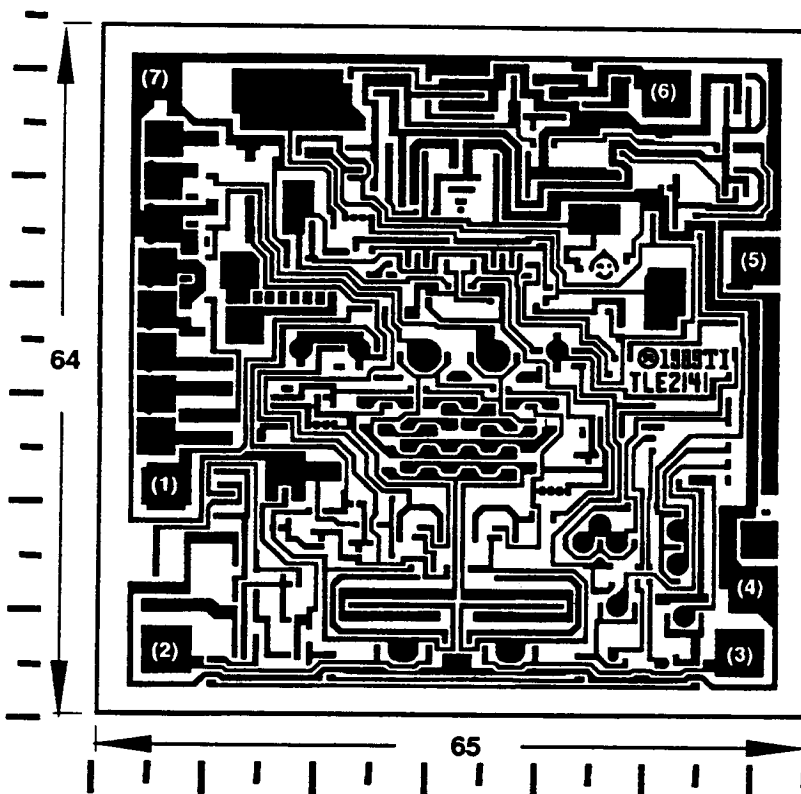
Pin 4 of the L package is in electrical contact with the case.

NC - No internal connection

## chip Information

These chips, properly assembled, display characteristics similar to the TLE2141, (see electrical table on page 18). 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.

**BONDING PAD ASSIGNMENTS**



CHIP THICKNESS:  
15 TYPICAL

BONDING PADS:  
4 X 4 MINIMUM

$T_J \text{ max} = 150^\circ\text{C}$

TOLERANCES  
ARE  $\pm 10\%$

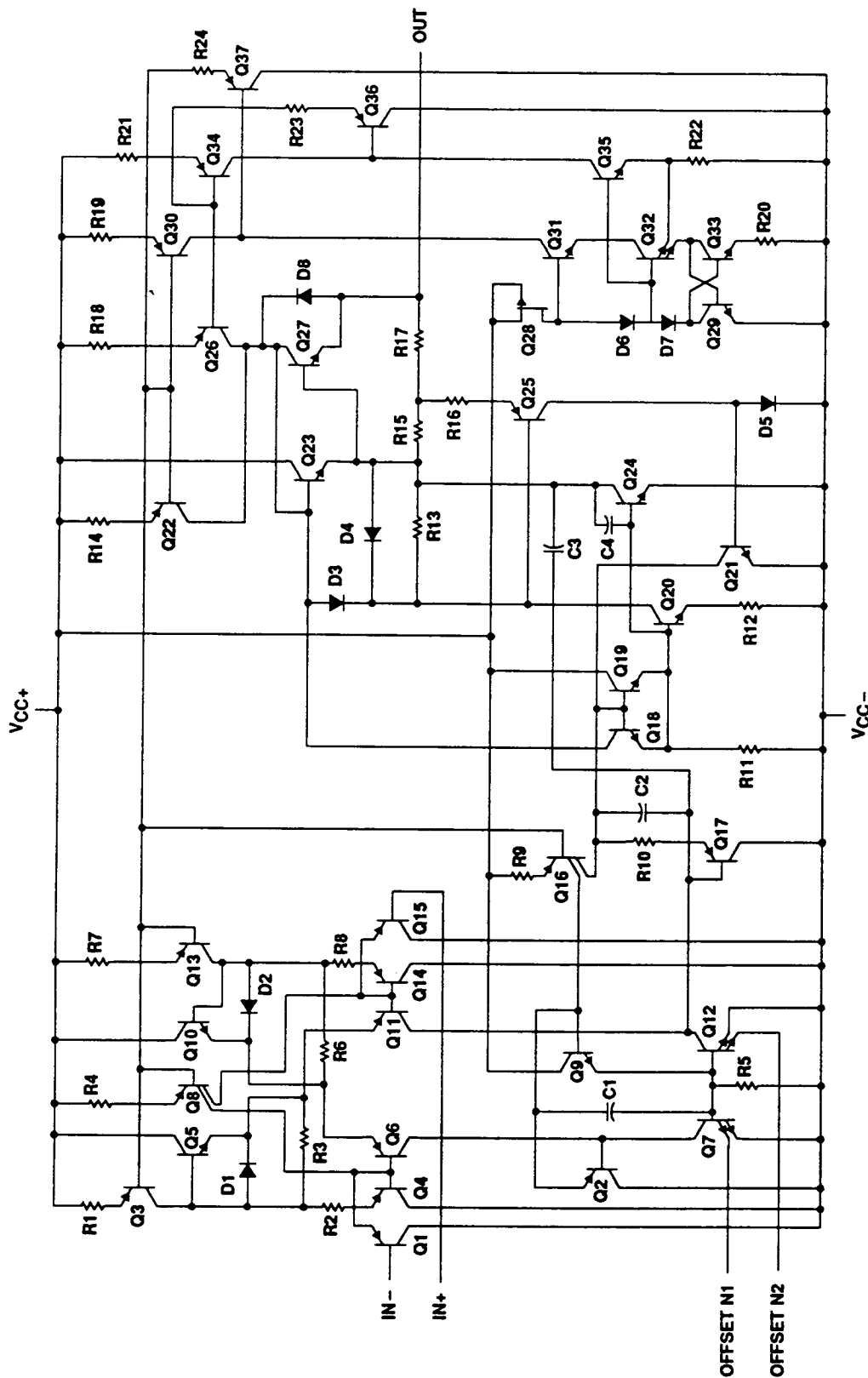
ALL DIMENSIONS  
ARE IN MILS

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**TLE2141, TLE2141A**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

equivalent schematic



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# TLE2141C, TLE2141AC EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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

| PARAMETER                                                                        | TEST CONDITIONS                                                                              | $T_A^\dagger$ | TLE2141C |             |     | TLE2141AC |             |     | UNIT                         |
|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|---------------|----------|-------------|-----|-----------|-------------|-----|------------------------------|
|                                                                                  |                                                                                              |               | MIN      | TYP         | MAX | MIN       | TYP         | MAX |                              |
| $V_{IO}$ Input offset voltage                                                    | $V_O = 2.5\text{ V}, R_S = 50\ \Omega,$<br>$V_{IC} = 2.5\text{ V}$                           | 25°C          | 225      | 1400        |     | 200       | 1000        |     | $\mu\text{V}$                |
|                                                                                  |                                                                                              | Full range    |          | 1700        |     | 1300      |             |     |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                   |                                                                                              | Full range    | 1.7      |             |     | 1.7       |             |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                    |                                                                                              | 25°C          | 8        | 100         |     | 8         | 100         |     | nA                           |
|                                                                                  |                                                                                              | Full range    |          | 150         |     | 150       |             |     |                              |
| $I_{IB}$ Input bias current                                                      |                                                                                              | 25°C          | -0.8     | -2          |     | -0.8      | -2          |     | $\mu\text{A}$                |
|                                                                                  |                                                                                              | Full range    |          | -2.1        |     | -2.1      |             |     |                              |
| $V_{ICR}$ Common-mode input voltage range                                        | $R_S = 50\ \Omega$                                                                           | 25°C          | 0 to 3   | -0.3 to 3.2 |     | 0 to 3    | -0.3 to 3.2 |     | V                            |
|                                                                                  |                                                                                              | Full range    | 0 to 2.9 |             |     | 0 to 2.9  |             |     |                              |
| $V_{OH}$ High-level output voltage                                               | $I_{OH} = -150\ \mu\text{A}$                                                                 | 25°C          | 3.9      | 4.1         |     | 3.9       | 4.1         |     | V                            |
|                                                                                  |                                                                                              | Full range    | 3.8      |             |     | 3.8       |             |     |                              |
|                                                                                  | $I_{OH} = -1.5\text{ mA}$                                                                    | 25°C          | 3.8      | 4           |     | 3.8       | 4           |     |                              |
|                                                                                  |                                                                                              | Full range    | 3.7      |             |     | 3.7       |             |     |                              |
|                                                                                  | $I_{OH} = -15\text{ mA}$                                                                     | 25°C          | 3.2      | 3.7         |     | 3.2       | 3.7         |     |                              |
|                                                                                  |                                                                                              | Full range    | 3.2      |             |     | 3.2       |             |     |                              |
| $V_{OL}$ Low-level output voltage                                                | $I_{OL} = 150\ \mu\text{A}$                                                                  | 25°C          | 75       | 125         |     | 75        | 125         |     | mV                           |
|                                                                                  |                                                                                              | Full range    |          | 150         |     |           | 150         |     |                              |
|                                                                                  | $I_{OL} = 1.5\text{ mA}$                                                                     | 25°C          | 150      | 225         |     | 150       | 225         |     |                              |
|                                                                                  |                                                                                              | Full range    |          | 250         |     |           | 250         |     | V                            |
|                                                                                  | $I_{OL} = 15\text{ mA}$                                                                      | 25°C          | 1.2      | 1.6         |     | 1.2       | 1.6         |     |                              |
|                                                                                  |                                                                                              | Full range    |          | 1.7         |     |           | 1.7         |     |                              |
| $A_{VD}$ Large-signal differential voltage amplification                         | $V_{CC} = \pm 2.5\text{ V}, R_L = 2\text{ k}\Omega,$<br>$V_O = 1\text{ V to } -1.5\text{ V}$ | 25°C          | 50       | 220         |     | 50        | 220         |     | V/mV                         |
|                                                                                  |                                                                                              | Full range    | 25       |             |     | 25        |             |     |                              |
| $r_i$ Input resistance                                                           |                                                                                              | 25°C          |          | 70          |     |           | 70          |     | M $\Omega$                   |
| $c_i$ Input capacitance                                                          |                                                                                              | 25°C          |          | 2.5         |     |           | 2.5         |     | pF                           |
| $z_o$ Open-loop output impedance                                                 | $f = 1\text{ MHz}$                                                                           | 25°C          |          | 30          |     |           | 30          |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                                 | $V_{IC} = V_{ICR}\text{ min},$<br>$R_S = 50\ \Omega$                                         | 25°C          | 85       | 118         |     | 85        | 118         |     | dB                           |
|                                                                                  |                                                                                              | Full range    | 80       |             |     | 80        |             |     |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC} \pm / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V},$<br>$R_S = 50\ \Omega$                    | 25°C          | 90       | 106         |     | 90        | 106         |     | dB                           |
|                                                                                  |                                                                                              | Full range    | 85       |             |     | 85        |             |     |                              |
| $I_{CC}$ Supply current                                                          | $V_O = 2.5\text{ V},$ No Load,<br>$V_{IC} = 2.5\text{ V}$                                    | 25°C          | 3.4      | 4.4         |     | 3.4       | 4.4         |     | mA                           |
|                                                                                  |                                                                                              | Full range    |          | 4.6         |     |           | 4.6         |     |                              |

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



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**TLE2141C, TLE2141AC**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

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

| PARAMETER              |                                             | TEST CONDITIONS                                                                                |          | T <sub>A</sub> | TLE2141C |     |     | TLE2141AC |     |     | UNIT   |
|------------------------|---------------------------------------------|------------------------------------------------------------------------------------------------|----------|----------------|----------|-----|-----|-----------|-----|-----|--------|
|                        |                                             |                                                                                                |          |                | MIN      | TYP | MAX | MIN       | TYP | MAX |        |
| SR +                   | Positive slew rate                          | A <sub>VD</sub> = −1, R <sub>L</sub> = 2 kΩ†, C <sub>L</sub> = 500 pF                          |          | 25°C           | 45       |     |     | 45        |     |     | V/μs   |
| SR −                   | Negative slew rate                          |                                                                                                |          |                | 42       |     |     | 42        |     |     |        |
| Settling time          |                                             | A <sub>VD</sub> = −1, 2.5-V Step                                                               | To 0.1%  | 25°C           | 0.16     |     |     | 0.16      |     |     | μs     |
|                        |                                             |                                                                                                | To 0.01% |                | 0.22     |     |     | 0.22      |     |     |        |
| V <sub>n</sub>         | Equivalent input noise voltage              | R <sub>S</sub> = 100 Ω, f = 10 Hz                                                              |          | 25°C           | 15       |     |     | 15        |     |     | nV/√Hz |
|                        |                                             | R <sub>S</sub> = 100 Ω, f = 1 kHz                                                              |          |                | 10.5     |     |     | 10.5      |     |     |        |
| V <sub>N(PP)</sub>     | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz                                                                             |          | 25°C           | 0.48     |     |     | 0.48      |     |     | μV     |
|                        |                                             | f = 0.1 Hz to 10 Hz                                                                            |          |                | 0.51     |     |     | 0.51      |     |     |        |
| I <sub>n</sub>         | Equivalent input noise current              | f = 10 Hz                                                                                      |          | 25°C           | 1.92     |     |     | 1.92      |     |     | pA/√Hz |
|                        |                                             | f = 1 kHz                                                                                      |          |                | 0.5      |     |     | 0.5       |     |     |        |
| THD + N                | Total harmonic distortion plus noise        | V <sub>O</sub> = 1 V to 3 V, R <sub>L</sub> = 2 kΩ†, A <sub>VD</sub> = 2, f = 10 kHz           |          | 25°C           | 0.0052 % |     |     | 0.0052 %  |     |     |        |
| B <sub>1</sub>         | Unity-gain bandwidth                        | R <sub>L</sub> = 2 kΩ†, C <sub>L</sub> = 100 pF                                                |          | 25°C           | 5.9      |     |     | 5.9       |     |     | MHz    |
| Gain-bandwidth product |                                             | R <sub>L</sub> = 2 kΩ†, C <sub>L</sub> = 100 pF, f = 100 kHz                                   |          | 25°C           | 5.8      |     |     | 5.8       |     |     | MHz    |
| B <sub>OM</sub>        | Maximum output-swing bandwidth              | R <sub>L</sub> = 2 kΩ†, V <sub>O(PP)</sub> = 2 V, A <sub>VD</sub> = 1, C <sub>L</sub> = 100 pF |          | 25°C           | 6.6      |     |     | 6.6       |     |     | MHz    |
| φ <sub>m</sub>         | Phase margin at unity-gain                  | R <sub>L</sub> = 2 kΩ†, C <sub>L</sub> = 100 pF                                                |          | 25°C           | 57°      |     |     | 57°       |     |     |        |

$^\dagger R_L$  terminates at 2.5 V.

# TLE2141C, TLE2141AC

## EXCALIBUR LOW-NOISE HIGH-SPEED

### PRECISION OPERATIONAL AMPLIFIERS

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

| PARAMETER         |                                                                         | TEST CONDITIONS                                                      |                                                  | T <sub>A</sub> † | TLE2141C     |                |     | TLE2141AC    |                |      | 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,<br>V <sub>O</sub> = 0 |                                                  | 25°C             | 200 900      |                |     | 175 500      |                |      | μV    |
|                   | Full range                                                              |                                                                      |                                                  | 1300             |              |                | 800 |              |                |      |       |
| α <sub>VIO</sub>  | Temperature coefficient of input offset voltage                         |                                                                      |                                                  | Full range       | 1.7          |                |     | 1.7          |                |      | μV/°C |
| I <sub>IO</sub>   | Input offset current                                                    |                                                                      |                                                  | 25°C             | 7 100        |                |     | 7 100        |                |      | nA    |
|                   |                                                                         |                                                                      |                                                  | Full range       | 150          |                |     | 150          |                |      |       |
| I <sub>IB</sub>   | Input bias current                                                      |                                                                      |                                                  | 25°C             | – 0.7 – 1.5  |                |     | – 0.7 – 1.5  |                |      | μA    |
|                   |                                                                         | Full range                                                           | – 1.6                                            |                  |              | – 1.6          |     |              |                |      |       |
| V <sub>ICR</sub>  | Common-mode input voltage range                                         | R <sub>S</sub> = 50 Ω                                                |                                                  | 25°C             | – 15 to 13   | – 15.3 to 13.2 |     | – 15 to 13   | – 15.3 to 13.2 | V    |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | – 15 to 12.9 | – 15.3 to 13.1 |     | – 15 to 12.9 | – 15.3 to 13.1 |      |       |
| V <sub>OM</sub> + | Maximum positive peak output voltage swing                              | I <sub>O</sub> = – 150 μA                                            |                                                  | 25°C             | 13.8         | 14.1           |     | 13.8         | 14.1           | V    |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | 13.7         |                |     | 13.7         |                |      |       |
|                   |                                                                         | I <sub>O</sub> = – 1.5 mA                                            |                                                  | 25°C             | 13.7         | 14             |     | 13.7         | 14             |      |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | 13.6         |                |     | 13.6         |                |      |       |
|                   |                                                                         | I <sub>O</sub> = – 15 mA                                             |                                                  | 25°C             | 13.1         | 13.7           |     | 13.1         | 13.7           |      |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | 13           |                |     | 13           |                |      |       |
| V <sub>OM</sub> – | Maximum negative peak output voltage swing                              | I <sub>O</sub> = 150 μA                                              |                                                  | 25°C             | – 14.7       | – 14.9         |     | – 14.7       | – 14.9         | V    |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | – 14.6       |                |     | – 14.6       |                |      |       |
|                   |                                                                         | I <sub>O</sub> = 1.5 mA                                              |                                                  | 25°C             | – 14.5       | – 14.8         |     | – 14.5       | – 14.8         |      |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | – 14.4       |                |     | – 14.4       |                |      |       |
|                   |                                                                         | I <sub>O</sub> = 15 mA                                               |                                                  | 25°C             | – 13.4       | – 13.8         |     | – 13.4       | – 13.8         |      |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | – 13.3       |                |     | – 13.3       |                |      |       |
| A <sub>VD</sub>   | Large-signal differential voltage amplification                         | V <sub>O</sub> = ± 10 V                                              |                                                  | 25°C             | 100          | 450            |     | 100          | 450            | V/mV |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | 75           |                |     | 75           |                |      |       |
| r <sub>i</sub>    | Input resistance                                                        | R <sub>L</sub> = 2 kΩ                                                |                                                  | 25°C             | 65           |                |     | 65           |                |      | MΩ    |
| c <sub>i</sub>    | Input capacitance                                                       |                                                                      |                                                  | 25°C             | 2.5          |                |     | 2.5          |                |      | pF    |
| Z <sub>O</sub>    | Open-loop output impedance                                              | f = 1 MHz                                                            |                                                  | 25°C             | 30           |                |     | 30           |                |      | Ω     |
| CMRR              | Common-mode rejection ratio                                             | V <sub>IC</sub> = V <sub>ICR</sub> min,<br>R <sub>S</sub> = 50 Ω     |                                                  | 25°C             | 85           | 108            |     | 85           | 108            | dB   |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | 80           |                |     | 80           |                |      |       |
| k <sub>SVR</sub>  | Supply-voltage rejection ratio (ΔV <sub>CC</sub> ± / ΔV <sub>IO</sub> ) | V <sub>CC</sub> ± = ± 2.5 V to ± 15 V,<br>R <sub>S</sub> = 50 Ω      |                                                  | 25°C             | 90           | 106            |     | 90           | 106            | dB   |       |
|                   |                                                                         |                                                                      |                                                  | Full range       | 85           |                |     | 85           |                |      |       |
| I <sub>OS</sub>   | Short-circuit output current                                            | V <sub>O</sub> = 0                                                   | V <sub>ID</sub> = 1 V<br>V <sub>ID</sub> = – 1 V | 25°C             | – 25         | – 50           |     | – 25         | – 50           | mA   |       |
|                   |                                                                         |                                                                      |                                                  |                  | 20           | 31             |     | 20           | 31             |      |       |
| I <sub>CC</sub>   | Supply current                                                          | V <sub>O</sub> = 0, No Load                                          |                                                  | 25°C             | 3.5 4.5      |                |     | 3.5 4.5      |                |      | mA    |
|                   |                                                                         |                                                                      |                                                  | Full range       | 4.7          |                |     | 4.7          |                |      |       |

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



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**TLE2141C, TLE2141AC**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

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

| PARAMETER              |                                             | TEST CONDITIONS                                                                                   |          | T <sub>A</sub> | TLE2141C |     |     | TLE2141AC |     |      | UNIT   |
|------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------|----------|----------------|----------|-----|-----|-----------|-----|------|--------|
|                        |                                             |                                                                                                   |          |                | MIN      | TYP | MAX | MIN       | TYP | MAX  |        |
| SR +                   | Positive slew rate                          | A <sub>VD</sub> = − 1, R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 500 pF                          |          | 25°C           | 30       | 45  |     | 30        | 45  | V/μs |        |
| SR −                   | Negative slew rate                          |                                                                                                   |          | 25°C           | 30       | 42  |     | 30        | 42  |      |        |
| Settling time          |                                             | A <sub>VD</sub> = − 1,<br>10 V Step                                                               | To 0.1%  | 25°C           | 0.34     |     |     | 0.34      |     |      | μs     |
|                        |                                             |                                                                                                   | To 0.01% |                | 0.4      |     |     | 0.4       |     |      |        |
| V <sub>n</sub>         | Equivalent input noise voltage              | R <sub>S</sub> = 100 Ω, f = 10 Hz                                                                 |          | 25°C           | 15       |     |     | 15        |     |      | nV/√Hz |
|                        |                                             | R <sub>S</sub> = 100 Ω, f = 1 kHz                                                                 |          |                | 10.5     |     |     | 10.5      |     |      |        |
| V <sub>N(PP)</sub>     | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz                                                                                |          | 25°C           | 0.48     |     |     | 0.48      |     |      | μV     |
|                        |                                             | f = 0.1 Hz to 10 Hz                                                                               |          |                | 0.51     |     |     | 0.51      |     |      |        |
| I <sub>n</sub>         | Equivalent input noise current              | f = 10 Hz                                                                                         |          | 25°C           | 1.89     |     |     | 1.89      |     |      | pA/√Hz |
|                        |                                             | f = 1 kHz                                                                                         |          |                | 0.47     |     |     | 0.47      |     |      |        |
| THD + N                | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ,<br>A <sub>VD</sub> = 10, f = 10 kHz             |          | 25°C           | 0.01%    |     |     | 0.01%     |     |      |        |
| B <sub>1</sub>         | Unity-gain bandwidth                        | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                                                    |          | 25°C           | 6        |     |     | 6         |     |      | MHz    |
| Gain-bandwidth product |                                             | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF,<br>f = 100 kHz                                    |          | 25°C           | 5.9      |     |     | 5.9       |     |      | MHz    |
| B <sub>OM</sub>        | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ,<br>A <sub>VD</sub> = 1, C <sub>L</sub> = 100 pF |          | 25°C           | 668      |     |     | 668       |     |      | kHz    |
| ϕ <sub>m</sub>         | Phase margin at unity gain                  | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                                                    |          | 25°C           | 58°      |     |     | 58°       |     |      |        |



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# TLE2142I, TLE2141AI EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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

| PARAMETER                                                                        | TEST CONDITIONS                                                                                  | $T_A^\dagger$ | TLE2141I |      |      | TLE2141AI |      |      | UNIT                         |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------|----------|------|------|-----------|------|------|------------------------------|
|                                                                                  |                                                                                                  |               | MIN      | TYP  | MAX  | MIN       | TYP  | MAX  |                              |
| $V_{IO}$ Input offset voltage                                                    | $V_O = 2.5\text{ V}$ ,<br>$R_S = 50\ \Omega$ ,<br>$V_{IC} = 2.5\text{ V}$                        | 25°C          |          | 225  | 1400 |           | 200  | 1000 | $\mu\text{V}$                |
|                                                                                  |                                                                                                  | Full range    |          |      | 1900 |           |      | 1500 |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                   |                                                                                                  | Full range    |          | 1.7  |      |           | 1.7  |      | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                    |                                                                                                  | 25°C          |          | 8    | 100  |           | 8    | 100  | nA                           |
|                                                                                  |                                                                                                  | Full range    |          |      | 200  |           |      | 200  |                              |
| $I_{IB}$ Input bias current                                                      |                                                                                                  | 25°C          |          | -0.8 | -2   |           | -0.8 | -2   | $\mu\text{A}$                |
|                                                                                  |                                                                                                  | Full range    |          |      | -2.2 |           |      | -2.2 |                              |
| $V_{ICR}$ Common-mode input voltage range                                        | $R_S = 50\ \Omega$                                                                               | 25°C          | 0        | -0.3 |      | 0         | -0.3 |      | V                            |
|                                                                                  |                                                                                                  |               | to       | to   |      | to        | to   |      |                              |
|                                                                                  |                                                                                                  |               | 3        | 3.2  |      | 3         | 3.2  |      |                              |
|                                                                                  |                                                                                                  | Full range    | 0        | -0.3 |      | 0         | -0.3 |      |                              |
| $V_{OH}$ High-level output voltage                                               | $I_{OH} = -150\ \mu\text{A}$                                                                     | 25°C          | 3.9      | 4.1  |      | 3.9       | 4.1  |      | V                            |
|                                                                                  | $I_{OH} = -1.5\text{ mA}$                                                                        |               | 3.8      | 4    |      | 3.8       | 4    |      |                              |
|                                                                                  | $I_{OH} = -15\text{ mA}$                                                                         |               | 3.2      | 3.7  |      | 3.2       | 3.7  |      |                              |
|                                                                                  | $I_{OH} = -100\ \mu\text{A}$                                                                     | Full range    | 3.8      |      |      | 3.8       |      |      |                              |
|                                                                                  | $I_{OH} = -1\text{ mA}$                                                                          |               | 3.7      |      |      | 3.7       |      |      |                              |
|                                                                                  | $I_{OH} = -10\text{ mA}$                                                                         |               | 3.3      |      |      | 3.3       |      |      |                              |
|                                                                                  |                                                                                                  |               |          |      |      |           |      |      |                              |
| $V_{OL}$ Low-level output voltage                                                | $I_{OL} = 150\ \mu\text{A}$                                                                      | 25°C          |          | 75   | 125  |           | 75   | 125  | mV                           |
|                                                                                  | $I_{OL} = 1.5\text{ mA}$                                                                         |               |          | 150  | 225  |           | 150  | 225  | V                            |
|                                                                                  | $I_{OL} = 15\text{ mA}$                                                                          |               |          | 1.2  | 1.6  |           | 1.2  | 1.6  | V                            |
|                                                                                  | $I_{OL} = 100\ \mu\text{A}$                                                                      | Full range    |          | 175  |      |           | 175  |      | mV                           |
|                                                                                  | $I_{OL} = 1\text{ mA}$                                                                           |               |          | 225  |      |           | 225  |      | V                            |
|                                                                                  | $I_{OL} = 10\text{ mA}$                                                                          |               |          | 1.4  |      |           | 1.4  |      | V                            |
|                                                                                  |                                                                                                  |               |          |      |      |           |      |      |                              |
| $A_{VD}$ Large-signal differential voltage amplification                         | $V_{CC} = \pm 2.5\text{ V}$ , $R_L = 2\text{ k}\Omega$ ,<br>$V_O = 1\text{ V to } -1.5\text{ V}$ | 25°C          | 50       | 220  |      | 50        | 220  |      | V/mV                         |
|                                                                                  |                                                                                                  | Full range    | 10       |      |      | 10        |      |      |                              |
| $r_i$ Input resistance                                                           |                                                                                                  | 25°C          |          | 70   |      |           | 70   |      | $\text{M}\Omega$             |
| $C_i$ Input capacitance                                                          |                                                                                                  | 25°C          |          | 2.5  |      |           | 2.5  |      | pF                           |
| $Z_o$ Open-loop output impedance                                                 | $f = 1\text{ MHz}$                                                                               | 25°C          |          | 30   |      |           | 30   |      | $\Omega$                     |
| CMRR Common-mode rejection ratio                                                 | $V_{IC} = V_{ICR}\text{ min.}$ ,<br>$R_S = 50\ \Omega$                                           | 25°C          | 85       | 118  |      | 85        | 118  |      | dB                           |
|                                                                                  |                                                                                                  | Full range    | 80       |      |      | 80        |      |      |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC} \pm / \Delta V_{IO}$ ) | $V_{CC} \pm = \pm 2.5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$                      | 25°C          | 90       | 106  |      | 90        | 106  |      | dB                           |
|                                                                                  |                                                                                                  | Full range    | 85       |      |      | 85        |      |      |                              |
| $I_{CC}$ Supply current                                                          | $V_O = 2.5\text{ V}$ , No Load,<br>$V_{IC} = 2.5\text{ V}$                                       | 25°C          |          | 3.4  | 4.4  |           | 3.4  | 4.4  | mA                           |
|                                                                                  |                                                                                                  | Full range    |          |      | 4.6  |           |      | 4.6  |                              |

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $105^\circ\text{C}$ .



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**TLE2142I, TLE2141AI**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

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

| PARAMETER                                               | TEST CONDITIONS                                                                                               | $T_A$ | TLE2142I |          |     | TLE2141AI |          |     | UNIT                   |
|---------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-------|----------|----------|-----|-----------|----------|-----|------------------------|
|                                                         |                                                                                                               |       | MIN      | TYP      | MAX | MIN       | TYP      | MAX |                        |
| SR + Positive slew rate                                 | $A_{VD} = -1$ , $R_L = 2\text{ k}\Omega^{\dagger}$ ,<br>$C_L = 500\text{ pF}$                                 | 25°C  |          | 45       |     |           | 45       |     | V/ $\mu\text{s}$       |
| SR – Negative slew rate                                 |                                                                                                               |       |          | 42       |     |           | 42       |     |                        |
| Settling time                                           | $A_{VD} = -1$ ,<br>2.5-V Step                                                                                 | 25°C  |          | 0.16     |     |           | 0.16     |     | $\mu\text{s}$          |
|                                                         |                                                                                                               |       |          | 0.22     |     |           | 0.22     |     |                        |
| $V_n$ Equivalent input noise voltage                    | $R_S = 100\ \Omega$ , $f = 10\text{ Hz}$                                                                      | 25°C  |          | 15       |     |           | 15       |     | nV/ $\sqrt{\text{Hz}}$ |
|                                                         | $R_S = 100\ \Omega$ , $f = 1\text{ kHz}$                                                                      |       |          | 10.5     |     |           | 10.5     |     |                        |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                                                            | 25°C  |          | 0.48     |     |           | 0.48     |     | $\mu\text{V}$          |
|                                                         | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                                           |       |          | 0.51     |     |           | 0.51     |     |                        |
| $I_n$ Equivalent input noise current                    | $f = 10\text{ Hz}$                                                                                            | 25°C  |          | 1.92     |     |           | 1.92     |     | pA/ $\sqrt{\text{Hz}}$ |
|                                                         | $f = 1\text{ kHz}$                                                                                            |       |          | 0.5      |     |           | 0.5      |     |                        |
| THD + N Total harmonic distortion plus noise            | $V_O = 1\text{ V to }3\text{ V}$ , $R_L = 2\text{ k}\Omega^{\dagger}$ ,<br>$A_{VD} = 2$ , $f = 10\text{ kHz}$ | 25°C  |          | 0.0052 % |     |           | 0.0052 % |     |                        |
| $B_1$ Unity-gain bandwidth                              | $R_L = 2\text{ k}\Omega^{\dagger}$ , $C_L = 100\text{ pF}$                                                    | 25°C  |          | 5.9      |     |           | 5.9      |     | MHz                    |
| Gain-bandwidth product                                  | $R_L = 2\text{ k}\Omega^{\dagger}$ , $C_L = 100\text{ pF}$ ,<br>$f = 100\text{ kHz}$                          | 25°C  |          | 5.8      |     |           | 5.8      |     | MHz                    |
| $B_{OM}$ Maximum output-swing bandwidth                 | $R_L = 2\text{ k}\Omega^{\dagger}$ , $V_{O(PP)} = 2\text{ V}$ ,<br>$A_{VD} = 1$ , $C_L = 100\text{ pF}$       | 25°C  |          | 6.6      |     |           | 6.6      |     | MHz                    |
| $\phi_m$ Phase margin at unity-gain                     | $R_L = 2\text{ k}\Omega^{\dagger}$ , $C_L = 100\text{ pF}$                                                    | 25°C  |          | 57°      |     |           | 57°      |     |                        |

$^{\dagger}R_L$  terminates at 2.5 V.

# TLE2141I, TLE2141AI

## EXCALIBUR LOW-NOISE HIGH-SPEED

### PRECISION OPERATIONAL AMPLIFIERS

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

| PARAMETER                                                                       | TEST CONDITIONS                                                                | $T_A^\dagger$ | TLE2141I          |                     |      | TLE2141AI         |                     |      | UNIT                         |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------|---------------|-------------------|---------------------|------|-------------------|---------------------|------|------------------------------|
|                                                                                 |                                                                                |               | MIN               | TYP                 | MAX  | MIN               | TYP                 | MAX  |                              |
| $V_{IO}$ Input offset voltage                                                   | $V_{IC} = 0$ ,<br>$R_S = 50\ \Omega$ ,<br>$V_O = 0$                            | 25°C          |                   | 200                 | 900  |                   | 175                 | 500  | $\mu\text{V}$                |
|                                                                                 |                                                                                | Full range    |                   |                     | 1500 |                   |                     | 1000 |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                  |                                                                                | Full range    |                   | 1.7                 |      |                   | 1.7                 |      | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                   |                                                                                | 25°C          |                   | 7                   | 100  |                   | 7                   | 100  |                              |
|                                                                                 |                                                                                | Full range    |                   |                     | 200  |                   |                     | 200  | nA                           |
| $I_{IB}$ Input bias current                                                     |                                                                                | 25°C          |                   | -0.7                | -1.5 |                   | -0.7                | -1.5 |                              |
|                                                                                 |                                                                                | Full range    |                   |                     | -1.7 |                   |                     | -1.7 | $\mu\text{A}$                |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50\ \Omega$                                                             | 25°C          | -15<br>to<br>13   | -15.3<br>to<br>13.2 |      | -15<br>to<br>13   | -15.3<br>to<br>13.2 |      | V                            |
|                                                                                 |                                                                                | Full range    | -15<br>to<br>12.7 | -15.3<br>to<br>12.9 |      | -15<br>to<br>12.7 | -15.3<br>to<br>12.9 |      |                              |
| $V_{OM+}$ Maximum positive peak output voltage swing                            | $I_O = -150\ \mu\text{A}$<br>$I_O = -1.5\ \text{mA}$<br>$I_O = -15\ \text{mA}$ | 25°C          | 13.8              | 14.1                |      | 13.8              | 14.1                |      | V                            |
|                                                                                 |                                                                                |               | 13.7              | 14                  |      | 13.7              | 14                  |      |                              |
|                                                                                 |                                                                                |               | 13.1              | 13.7                |      | 13.1              | 13.7                |      |                              |
|                                                                                 | $I_O = -100\ \mu\text{A}$<br>$I_O = -1\ \text{mA}$<br>$I_O = -10\ \text{mA}$   | Full range    | 13.7              |                     |      | 13.7              |                     |      |                              |
|                                                                                 |                                                                                |               | 13.6              |                     |      | 13.6              |                     |      |                              |
|                                                                                 |                                                                                |               | 13.1              |                     |      | 13.1              |                     |      |                              |
| $V_{OM-}$ Maximum negative peak output voltage swing                            | $I_O = 150\ \mu\text{A}$<br>$I_O = 1.5\ \text{mA}$<br>$I_O = 15\ \text{mA}$    | 25°C          | -14.7             | -14.9               |      | -14.7             | -14.9               |      | V                            |
|                                                                                 |                                                                                |               | -14.5             | -14.8               |      | -14.5             | -14.8               |      |                              |
|                                                                                 |                                                                                |               | -13.4             | -13.8               |      | -13.4             | -13.8               |      |                              |
|                                                                                 | $I_O = 100\ \mu\text{A}$<br>$I_O = 1\ \text{mA}$<br>$I_O = 10\ \text{mA}$      | Full range    | -14.6             |                     |      | -14.6             |                     |      |                              |
|                                                                                 |                                                                                |               | -14.5             |                     |      | -14.5             |                     |      |                              |
|                                                                                 |                                                                                |               | -13.4             |                     |      | -13.4             |                     |      |                              |
| $A_{VD}$ Large-signal differential voltage amplification                        | $V_O = \pm 10\ \text{V}$ , $R_L = 2\ \text{k}\Omega$                           | 25°C          | 100               | 450                 |      | 100               | 450                 |      | V/mV                         |
|                                                                                 |                                                                                | Full range    | 40                |                     |      | 40                |                     |      |                              |
| $r_i$ Input resistance                                                          |                                                                                | 25°C          |                   | 65                  |      |                   | 65                  |      | M $\Omega$                   |
| $c_i$ Input capacitance                                                         |                                                                                | 25°C          |                   | 2.5                 |      |                   | 2.5                 |      | pF                           |
| $z_o$ Open-loop output impedance                                                | $f = 1\ \text{MHz}$                                                            | 25°C          |                   | 30                  |      |                   | 30                  |      | $\Omega$                     |
| CMRR Common-mode rejection ratio                                                | $V_{IC} = V_{ICR}\ \text{min.}$                                                | 25°C          | 85                | 108                 |      | 85                | 108                 |      | dB                           |
|                                                                                 | $R_S = 50\ \Omega$                                                             | Full range    | 80                |                     |      | 80                |                     |      |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\ \text{V to } \pm 15\ \text{V}$ ,<br>$R_S = 50\ \Omega$   | 25°C          | 90                | 106                 |      | 90                | 106                 |      | dB                           |
|                                                                                 |                                                                                | Full range    | 85                |                     |      | 85                |                     |      |                              |
| $I_{OS}$ Short-circuit output current                                           | $V_O = 0$                                                                      | 25°C          | -25               | -50                 |      | -25               | -50                 |      | mA                           |
|                                                                                 |                                                                                |               | 20                | 31                  |      | 20                | 31                  |      |                              |
| $I_{CC}$ Supply current                                                         | $V_O = 0$ , No Load                                                            | 25°C          |                   | 3.5                 | 4.5  |                   | 3.5                 | 4.5  | mA                           |
|                                                                                 |                                                                                | Full range    |                   |                     | 4.7  |                   |                     | 4.7  |                              |

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $105^\circ\text{C}$ .



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**TLE2141I, TLE2141AI**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

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

| PARAMETER              |                                             | TEST CONDITIONS                                                                                   |          | T <sub>A</sub> | TLE2141I |     |      | TLE2141AI |     |        | UNIT |
|------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------|----------|----------------|----------|-----|------|-----------|-----|--------|------|
|                        |                                             |                                                                                                   |          |                | MIN      | TYP | MAX  | MIN       | TYP | MAX    |      |
| SR +                   | Positive slew rate                          | A <sub>VD</sub> = − 1, R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 500 pF                          |          | 25°C           | 30       | 45  |      | 30        | 45  | V/μs   |      |
| SR −                   | Negative slew rate                          |                                                                                                   |          | 25°C           | 30       | 42  |      | 30        | 42  |        |      |
| Settling time          |                                             | A <sub>VD</sub> = − 1,<br>10 V Step                                                               | To 0.1%  | 25°C           | 0.34     |     |      | 0.34      |     |        | μs   |
|                        |                                             |                                                                                                   | To 0.01% |                | 0.4      |     |      | 0.4       |     |        |      |
| V <sub>n</sub>         | Equivalent input noise voltage              | R <sub>S</sub> = 100 Ω, f = 10 Hz                                                                 | 25°C     | 15             |          |     | 15   |           |     | nV/√Hz |      |
|                        |                                             | R <sub>S</sub> = 100 Ω, f = 1 kHz                                                                 |          | 10.5           |          |     | 10.5 |           |     |        |      |
| V <sub>N(PP)</sub>     | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz                                                                                | 25°C     | 0.48           |          |     | 0.48 |           |     | μV     |      |
|                        |                                             | f = 0.1 Hz to 10 Hz                                                                               |          | 0.51           |          |     | 0.51 |           |     |        |      |
| I <sub>n</sub>         | Equivalent input noise current              | f = 10 Hz                                                                                         | 25°C     | 1.89           |          |     | 1.89 |           |     | pA/√Hz |      |
|                        |                                             | f = 1 kHz                                                                                         |          | 0.47           |          |     | 0.47 |           |     |        |      |
| THD + N                | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ,<br>A <sub>VD</sub> = 10, f = 10 kHz             |          | 25°C           | 0.01%    |     |      | 0.01%     |     |        |      |
| B <sub>1</sub>         | Unity-gain bandwidth                        | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                                                    |          | 25°C           | 6        |     |      | 6         |     |        | MHz  |
| Gain-bandwidth product |                                             | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF,<br>f = 100 kHz                                    |          | 25°C           | 5.9      |     |      | 5.9       |     |        | MHz  |
| B <sub>OM</sub>        | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ,<br>A <sub>VD</sub> = 1, C <sub>L</sub> = 100 pF |          | 25°C           | 668      |     |      | 668       |     |        | kHz  |
| ϕ <sub>m</sub>         | Phase margin at unity gain                  | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                                                    |          | 25°C           | 58°      |     |      | 58°       |     |        |      |

# TLE2141M, TLE2141AM EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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

| PARAMETER                                                                       | TEST CONDITIONS                                                                                     | $T_A$ <sup>†</sup> | TLE2141M             |                   |      | TLE2141AM            |                   |      | UNIT                         |
|---------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|--------------------|----------------------|-------------------|------|----------------------|-------------------|------|------------------------------|
|                                                                                 |                                                                                                     |                    | MIN                  | TYP               | MAX  | MIN                  | TYP               | MAX  |                              |
| $V_{IO}$ Input offset voltage                                                   | $V_O = 2.5\text{ V}$ ,<br>$R_S = 50\ \Omega$ ,<br>$V_{IC} = 2.5\text{ V}$                           | 25°C               |                      | 225               | 1400 |                      | 200               | 1000 | $\mu\text{V}$                |
|                                                                                 |                                                                                                     | Full range         |                      |                   | 2100 |                      |                   | 1700 |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                  |                                                                                                     | Full range         |                      | 1.7               |      |                      | 1.7               |      | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                   |                                                                                                     | 25°C               |                      | 8                 | 100  |                      | 8                 | 100  | nA                           |
|                                                                                 |                                                                                                     | Full range         |                      |                   | 250  |                      |                   | 250  |                              |
| $I_{IB}$ Input bias current                                                     |                                                                                                     | 25°C               |                      | -0.8              | -2   |                      | -0.8              | -2   | $\mu\text{A}$                |
|                                                                                 |                                                                                                     | Full range         |                      |                   | -2.3 |                      |                   | -2.3 |                              |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50\ \Omega$                                                                                  | 25°C               | 0<br>to<br>3         | -0.3<br>to<br>3.2 |      | 0<br>to<br>3         | -0.3<br>to<br>3.2 |      | V                            |
|                                                                                 |                                                                                                     | Full range         | 0<br>to<br>2.7       | -0.3<br>to<br>2.9 |      | 0<br>to<br>2.7       | -0.3<br>to<br>2.9 |      |                              |
|                                                                                 |                                                                                                     | 25°C               | 3.9<br>3.8<br>3.2    | -0.3<br>4<br>3.7  |      | 3.9<br>3.8<br>3.2    | -0.3<br>4<br>3.7  |      |                              |
|                                                                                 |                                                                                                     | Full range         | 3.75<br>3.65<br>3.25 | -0.3<br>4<br>3.7  |      | 3.75<br>3.65<br>3.25 | -0.3<br>4<br>3.7  |      |                              |
| $V_{OH}$ High-level output voltage                                              | $I_{OH} = -150\ \mu\text{A}$                                                                        | 25°C               |                      |                   |      |                      |                   |      | V                            |
|                                                                                 | $I_{OH} = -1.5\text{ mA}$                                                                           |                    |                      |                   |      |                      |                   |      |                              |
|                                                                                 | $I_{OH} = -15\text{ mA}$                                                                            |                    |                      |                   |      |                      |                   |      |                              |
|                                                                                 | $I_{OH} = -100\ \mu\text{A}$                                                                        | Full range         |                      |                   |      |                      |                   |      |                              |
|                                                                                 | $I_{OH} = -1\text{ mA}$                                                                             |                    |                      |                   |      |                      |                   |      |                              |
|                                                                                 | $I_{OH} = -10\text{ mA}$                                                                            |                    |                      |                   |      |                      |                   |      |                              |
| $V_{OL}$ Low-level output voltage                                               | $I_{OL} = 150\ \mu\text{A}$                                                                         | 25°C               |                      | 75                | 125  |                      | 75                | 125  | mV                           |
|                                                                                 | $I_{OL} = 1.5\text{ mA}$                                                                            |                    |                      | 150               | 225  |                      | 150               | 225  |                              |
|                                                                                 | $I_{OL} = 15\text{ mA}$                                                                             |                    |                      | 1.2               | 1.4  |                      | 1.2               | 1.4  |                              |
|                                                                                 | $I_{OL} = 100\ \mu\text{A}$                                                                         | Full range         |                      |                   | 200  |                      |                   | 200  | mV                           |
|                                                                                 | $I_{OL} = 1\text{ mA}$                                                                              |                    |                      |                   | 250  |                      |                   | 250  |                              |
|                                                                                 | $I_{OL} = 10\text{ mA}$                                                                             |                    |                      |                   | 1.25 |                      |                   | 1.25 |                              |
| $AVD$ Large-signal differential voltage amplification                           | $V_{CC\pm} = \pm 2.5\text{ V}$ , $R_L = 2\text{ k}\Omega$ ,<br>$V_O = 1\text{ V to } -1.5\text{ V}$ | 25°                | 50                   | 220               |      | 50                   | 220               |      | V/mV                         |
|                                                                                 |                                                                                                     | Full range         | 5                    |                   |      | 5                    |                   |      |                              |
| $r_i$ Input resistance                                                          |                                                                                                     | 25°C               |                      | 70                |      |                      | 70                |      | M $\Omega$                   |
| $C_i$ Input capacitance                                                         |                                                                                                     | 25°C               |                      | 2.5               |      |                      | 2.5               |      | pF                           |
| $Z_o$ Open-loop output impedance                                                | $f = 1\text{ MHz}$                                                                                  | 25°C               |                      | 30                |      |                      | 30                |      | $\Omega$                     |
| $CMRR$ Common-mode rejection ratio                                              | $V_{IC} = V_{ICR}\text{ min.}$ ,<br>$R_S = 50\ \Omega$                                              | 25°C               | 85                   | 118               |      | 85                   | 118               |      | dB                           |
|                                                                                 |                                                                                                     | Full range         | 80                   |                   |      | 80                   |                   |      |                              |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5\text{ V to } \pm 15\text{ V}$ ,<br>$R_S = 50\ \Omega$                          | 25°C               | 90                   | 106               |      | 90                   | 106               |      | dB                           |
|                                                                                 |                                                                                                     | Full range         | 85                   |                   |      | 85                   |                   |      |                              |
| $I_{CC}$ Supply current                                                         | $V_O = 2.5\text{ V}$ , No Load,<br>$V_{IC} = 2.5\text{ V}$                                          | 25°C               |                      | 3.4               | 4.4  |                      | 3.4               | 4.4  | mA                           |
|                                                                                 |                                                                                                     | Full range         |                      |                   | 4.6  |                      |                   | 4.6  |                              |

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



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**TLE2141M, TLE2141AM**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

operating characteristics,  $V_{CC} = 5\text{ V}$

| PARAMETER       | TEST CONDITIONS                             | $T_A$                                                                                                       | TLE2141M |     |     | TLE2141AM |     |     | UNIT                         |
|-----------------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------|----------|-----|-----|-----------|-----|-----|------------------------------|
|                 |                                             |                                                                                                             | MIN      | TYP | MAX | MIN       | TYP | MAX |                              |
| SR+             | Positive slew rate                          | $A_{VD} = -1$ , $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$C_L = 500\text{ pF}$                                 | 25°C     |     |     |           |     |     | $\text{V}/\mu\text{s}$       |
| SR-             | Negative slew rate                          |                                                                                                             |          |     |     |           |     |     |                              |
| Settling time   | $A_{VD} = -1$ ,<br>2.5-V Step               | To 0.1%                                                                                                     | 25°C     |     |     |           |     |     | $\mu\text{s}$                |
|                 |                                             | To 0.01%                                                                                                    |          |     |     |           |     |     |                              |
| $V_n$           | Equivalent input noise voltage              | $R_S = 100\ \Omega$ , $f = 10\text{ Hz}$                                                                    | 25°C     |     |     |           |     |     | $\text{nV}/\sqrt{\text{Hz}}$ |
|                 |                                             | $R_S = 100\ \Omega$ , $f = 1\text{ kHz}$                                                                    |          |     |     |           |     |     |                              |
| $V_{N(PP)}$     | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                                                          | 25°C     |     |     |           |     |     | $\mu\text{V}$                |
|                 |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                                         |          |     |     |           |     |     |                              |
| $I_n$           | Equivalent input noise current              | $f = 10\text{ Hz}$                                                                                          | 25°C     |     |     |           |     |     | $\text{pA}/\sqrt{\text{Hz}}$ |
|                 |                                             | $f = 1\text{ kHz}$                                                                                          |          |     |     |           |     |     |                              |
| THD+N           | Total harmonic distortion plus noise        | $V_O = 1\text{ V to }3\text{ V}$ , $R_L = 2\text{ k}\Omega^\dagger$ ,<br>$A_{VD} = 2$ , $f = 10\text{ kHz}$ | 25°C     |     |     |           |     |     |                              |
| B1              | Unity-gain bandwidth                        | $R_L = 2\text{ k}\Omega^\dagger$ , $C_L = 100\text{ pF}$                                                    | 25°C     |     |     |           |     |     | MHz                          |
|                 | Gain-bandwidth product                      | $R_L = 2\text{ k}\Omega^\dagger$ , $C_L = 100\text{ pF}$ ,<br>$f = 100\text{ kHz}$                          | 25°C     |     |     |           |     |     | MHz                          |
| B <sub>OM</sub> | Maximum output-swing bandwidth              | $R_L = 2\text{ k}\Omega^\dagger$ , $V_{O(PP)} = 2\text{ V}$ ,<br>$A_{VD} = 1$                               | 25°C     |     |     |           |     |     | MHz                          |
| $\phi_m$        | Phase margin at unity gain                  | $R_L = 2\text{ k}\Omega^\dagger$ , $C_L = 100\text{ pF}$                                                    | 25°C     |     |     |           |     |     |                              |

$^\dagger R_L$  terminates at 2.5 V.

# TLE2141M, TLE2141AM EXCALIBUR LOW-NOISE HIGH-SPEED PRECISION OPERATIONAL AMPLIFIERS

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

| PARAMETER                                                                       | TEST CONDITIONS                                          | $T_A^\dagger$ | TLE2141M    |               |       | TLE2141AM   |               |       | UNIT             |
|---------------------------------------------------------------------------------|----------------------------------------------------------|---------------|-------------|---------------|-------|-------------|---------------|-------|------------------|
|                                                                                 |                                                          |               | MIN         | TYP           | MAX   | MIN         | TYP           | MAX   |                  |
| $V_{IO}$ Input offset voltage                                                   | $V_{IC} = 0, R_S = 50 \Omega$                            | 25°C          |             | 200           | 900   |             | 175           | 500   | $\mu V$          |
|                                                                                 |                                                          | Full range    |             |               | 1700  |             |               | 1200  |                  |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                  |                                                          | Full range    |             | 1.7           |       |             | 1.7           |       | $\mu V/^\circ C$ |
| $I_{IO}$ Input offset current                                                   |                                                          | 25°C          |             | 7             | 100   |             | 7             | 100   | nA               |
|                                                                                 |                                                          | Full range    |             |               | 250   |             |               | 250   |                  |
| $I_{IB}$ Input bias current                                                     |                                                          | 25°C          |             | -0.7          | -1.5  |             | -0.7          | -1.5  | $\mu A$          |
|                                                                                 |                                                          | Full range    |             |               | -1.8  |             |               | -1.8  |                  |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50 \Omega$                                        | 25°C          | -15 to 13   | -15.3 to 13.2 |       | -15 to 13   | -15.3 to 13.2 |       | V                |
|                                                                                 |                                                          | Full range    | -15 to 12.7 | -15.3 to 12.9 |       | -15 to 12.7 | -15.3 to 12.9 |       |                  |
| $V_{OM+}$ Maximum positive peak output voltage swing                            | $I_O = -150 \mu A$                                       | 25°C          |             | 13.8          | 14.1  |             | 13.8          | 14.1  | V                |
|                                                                                 | $I_O = -1.5$ mA                                          |               |             | 13.7          | 14    |             | 13.7          | 14    |                  |
|                                                                                 | $I_O = -15$ mA                                           |               |             | 13.1          | 13.7  |             | 13.1          | 13.7  |                  |
|                                                                                 | $I_O = -100 \mu A$                                       |               |             | 13.7          |       |             | 13.7          |       |                  |
|                                                                                 | $I_O = -1$ mA                                            | Full range    |             | 13.6          |       |             | 13.6          |       |                  |
|                                                                                 | $I_O = -10$ mA                                           |               |             | 13.1          |       |             | 13.1          |       |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                            | $I_O = 150 \mu A$                                        | 25°C          |             | -14.7         | -14.9 |             | -14.7         | -14.9 | V                |
|                                                                                 | $I_O = 1.5$ mA                                           |               |             | -14.5         | -14.8 |             | -14.5         | -14.8 |                  |
|                                                                                 | $I_O = 15$ mA                                            |               |             | -13.4         | -13.8 |             | -13.4         | -13.8 |                  |
|                                                                                 | $I_O = 100 \mu A$                                        |               |             | -14.6         |       |             | -14.6         |       |                  |
|                                                                                 | $I_O = 1$ mA                                             | Full range    |             | -14.5         |       |             | -14.5         |       |                  |
|                                                                                 | $I_O = 10$ mA                                            |               |             | -13.4         |       |             | -13.4         |       |                  |
| $A_{VD}$ Large-signal differential voltage amplification                        | $V_O = \pm 10$ V, $R_L = 2$ k $\Omega$                   | 25°C          |             | 100           | 450   |             | 100           | 450   | V/mV             |
|                                                                                 |                                                          | Full range    |             | 20            |       |             | 20            |       |                  |
| $r_i$ Input resistance                                                          |                                                          | 25°C          |             | 65            |       |             | 65            |       | M $\Omega$       |
| $c_i$ Input capacitance                                                         |                                                          | 25°C          |             | 2.5           |       |             | 2.5           |       | pF               |
| $z_o$ Open-loop output impedance                                                | $f = 1$ MHz                                              | 25°C          |             | 30            |       |             | 30            |       | $\Omega$         |
| CMRR Common-mode rejection ratio                                                | $V_{IC} = V_{ICR}$ min, $R_S = 50 \Omega$                | 25°C          |             | 85            | 108   |             | 85            | 108   | dB               |
|                                                                                 |                                                          | Full range    |             | 80            |       |             | 80            |       |                  |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5$ V to $\pm 15$ V, $R_S = 50 \Omega$ | 25°C          |             | 90            | 106   |             | 90            | 106   | dB               |
|                                                                                 |                                                          | Full range    |             | 85            |       |             | 85            |       |                  |
| $I_{OS}$ Short-circuit output current                                           | $V_O = 0$                                                | 25°C          |             | -25           | -50   |             | -25           | -50   | mA               |
|                                                                                 |                                                          |               |             | 20            | 31    |             | 20            | 31    |                  |
| $I_{CC}$ Supply current                                                         | $V_O = 0$ , No Load, $V_{IC} = 2.5$ V                    | 25°C          |             | 3.5           | 4.5   |             | 3.5           | 4.5   | mA               |
|                                                                                 |                                                          | Full range    |             |               | 4.7   |             |               | 4.7   |                  |

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



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**TLE2141M, TLE2141AM**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

operating characteristics,  $V_{CC\pm} = \pm 15 \text{ V}$

| PARAMETER              |                                             | TEST CONDITIONS                                                                                   |          | T <sub>A</sub> | TLE2141M |     |      | TLE2141AM |     |        | UNIT |
|------------------------|---------------------------------------------|---------------------------------------------------------------------------------------------------|----------|----------------|----------|-----|------|-----------|-----|--------|------|
|                        |                                             |                                                                                                   |          |                | MIN      | TYP | MAX  | MIN       | TYP | MAX    |      |
| SR +                   | Positive slew rate                          | A <sub>VD</sub> = - 1, R <sub>L</sub> = 2 kΩ,<br>C <sub>L</sub> = 100 pF                          |          | 25°C           | 30       | 45  |      | 30        | 45  | V/μs   |      |
| SR -                   | Negative slew rate                          |                                                                                                   |          | 25°C           | 30       | 42  |      | 30        | 42  |        |      |
| Settling time          |                                             | A <sub>VD</sub> = - 1,<br>10 V Step                                                               | To 0.1%  | 25°C           | 0.34     |     |      | 0.34      |     |        | μs   |
|                        |                                             |                                                                                                   | To 0.01% |                | .4       |     |      | .4        |     |        |      |
| V <sub>n</sub>         | Equivalent input noise voltage              | R <sub>S</sub> = 100 Ω, f = 10 Hz                                                                 | 25°C     | 15             |          |     | 15   |           |     | nV/√Hz |      |
|                        |                                             | R <sub>S</sub> = 100 Ω, f = 1 kHz                                                                 |          | 10.5           |          |     | 10.5 |           |     |        |      |
| V <sub>N(PP)</sub>     | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz                                                                                | 25°C     | 0.48           |          |     | 0.48 |           |     | μV     |      |
|                        |                                             | f = 0.1 Hz to 10 Hz                                                                               |          | 0.51           |          |     | 0.51 |           |     |        |      |
| I <sub>n</sub>         | Equivalent input noise current              | f = 10 Hz                                                                                         | 25°C     | 1.89           |          |     | 1.89 |           |     | pA/√Hz |      |
|                        |                                             | f = 1 kHz                                                                                         |          | 0.47           |          |     | 0.47 |           |     |        |      |
| THD + N                | Total harmonic distortion plus noise        | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ,<br>A <sub>VD</sub> = 10, f = 10 kHz             |          | 25°C           | 0.01 %   |     |      | 0.01 %    |     |        |      |
| B <sub>1</sub>         | Unity-gain bandwidth                        | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                                                    |          | 25°C           | 6        |     |      | 6         |     |        | MHz  |
| Gain-bandwidth product |                                             | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF,<br>f = 100 kHz                                    |          | 25°C           | 5.9      |     |      | 5.9       |     |        | MHz  |
| B <sub>OM</sub>        | Maximum output-swing bandwidth              | V <sub>O(PP)</sub> = 20 V, R <sub>L</sub> = 2 kΩ,<br>A <sub>VD</sub> = 1, C <sub>L</sub> = 100 pF |          | 25°C           | 668      |     |      | 668       |     |        | kHz  |
| φ <sub>m</sub>         | Phase margin at unity gain                  | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 100 pF                                                    |          | 25°C           | 58°      |     |      | 58°       |     |        |      |

**TEXAS**  
**INSTRUMENTS**

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# TLE2141Y

## EXCALIBUR LOW-NOISE HIGH-SPEED

### PRECISION OPERATIONAL AMPLIFIERS

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

| PARAMETER                                                                       | TEST CONDITIONS                                                          | TLE2141Y                |                     |      | UNIT             |
|---------------------------------------------------------------------------------|--------------------------------------------------------------------------|-------------------------|---------------------|------|------------------|
|                                                                                 |                                                                          | MIN                     | TYP                 | MAX  |                  |
| $V_{IO}$ Input offset voltage                                                   | $V_{IC} = 0$ , $R_S = 50 \Omega$ , $V_O = 0$                             |                         | 200                 | 1000 | $\mu\text{V}$    |
| $I_{IO}$ Input offset current                                                   |                                                                          |                         | 7                   | 100  | nA               |
| $I_{IB}$ Input bias current                                                     |                                                                          |                         | -0.7                | -1.5 | $\mu\text{A}$    |
| $V_{ICR}$ Common-mode input voltage range                                       | $R_S = 50 \Omega$                                                        | -15<br>to<br>13         | -15.3<br>to<br>13.2 |      | V                |
| $V_{OM+}$ Maximum positive peak output voltage swing                            | $I_O = -150 \mu\text{A}$                                                 | 13.8                    | 14.1                |      | V                |
|                                                                                 | $I_O = -1.5 \text{ mA}$                                                  | 13.7                    | 14                  |      |                  |
|                                                                                 | $I_O = -15 \text{ mA}$                                                   | 13.3                    | 13.7                |      |                  |
| $V_{OM-}$ Maximum negative peak output voltage swing                            | $I_O = 150 \mu\text{A}$                                                  | -14.7                   | -14.9               |      | V                |
|                                                                                 | $I_O = 1.5 \text{ mA}$                                                   | -14.5                   | -14.8               |      |                  |
|                                                                                 | $I_O = 15 \text{ mA}$                                                    | -13.4                   | -13.8               |      |                  |
| $A_{VD}$ Large-signal differential voltage amplification                        | $V_O = \pm 10 \text{ V}$ , $R_L = 2 \text{ k}\Omega$                     | 100                     | 450                 |      | V/mV             |
| $r_i$ Input resistance                                                          |                                                                          |                         | 65                  |      | $\text{M}\Omega$ |
| $c_i$ Input capacitance                                                         |                                                                          |                         | 2.5                 |      | pF               |
| $z_o$ Open-loop output impedance                                                | $f = 1 \text{ MHz}$                                                      |                         | 30                  |      | $\Omega$         |
| $\text{CMRR}$ Common-mode rejection ratio                                       | $V_{IC} = V_{ICR} \text{ min.}$ , $R_S = 50 \Omega$                      | 80                      | 108                 |      | dB               |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm} / \Delta V_{IO}$ ) | $V_{CC\pm} = \pm 2.5 \text{ V to } \pm 15 \text{ V}$ , $R_S = 50 \Omega$ | 85                      | 106                 |      | dB               |
| $I_{OS}$ Short-circuit output current                                           | $V_O = 0$                                                                | $V_{ID} = 1 \text{ V}$  | -25                 | -50  | mA               |
|                                                                                 |                                                                          | $V_{ID} = -1 \text{ V}$ | 20                  | 31   |                  |
| $I_{CC}$ Supply current                                                         | $V_O = 0$ , No Load                                                      |                         | 3.5                 | 4.5  | mA               |



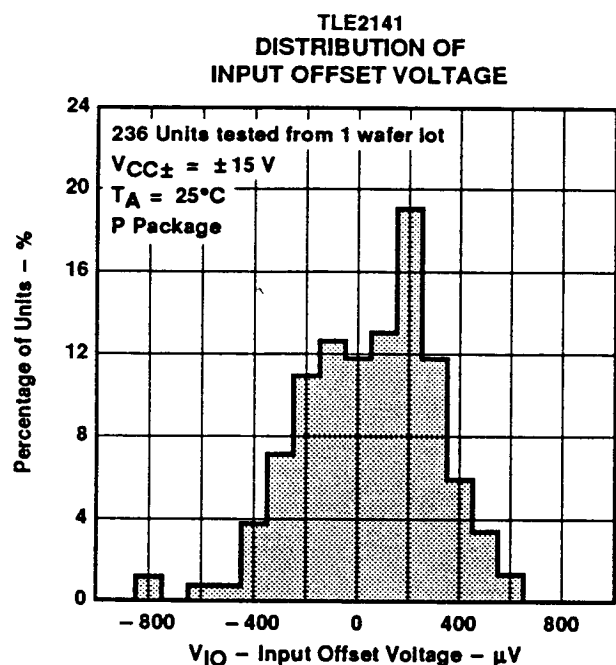
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## TYPICAL CHARACTERISTICS

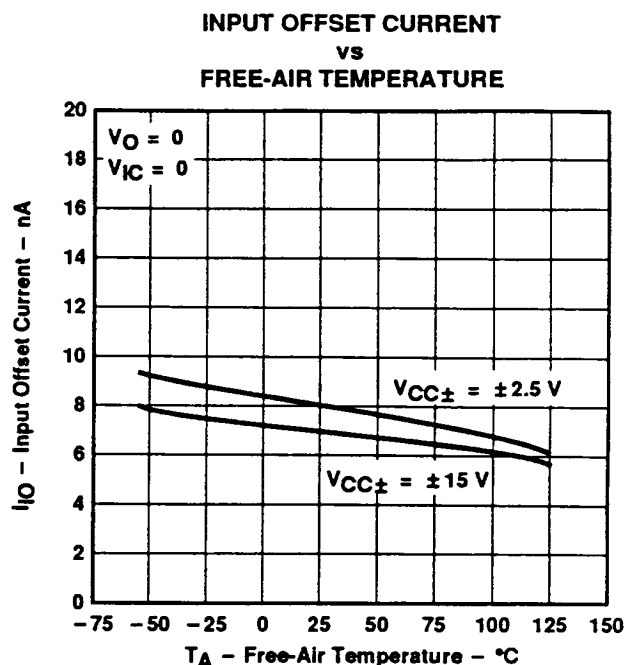
| TABLE OF GRAPHS |                                           |                         | FIGURE |
|-----------------|-------------------------------------------|-------------------------|--------|
| $V_{IO}$        | Input offset voltage                      | Distribution            | 1      |
| $I_{IO}$        | Input offset current                      | vs Temperature          | 2      |
| $I_{IB}$        | Input bias current                        | vs Temperature          | 3      |
|                 |                                           | vs Common-mode voltage  | 4      |
| $V_{OM+}$       | Maximum positive peak output voltage      | vs Supply voltage       | 5      |
|                 |                                           | vs Temperature          | 6      |
|                 |                                           | vs Output current       | 7      |
|                 |                                           | vs Settling time        | 9      |
| $V_{OM-}$       | Maximum negative peak output voltage      | vs Supply voltage       | 5      |
|                 |                                           | vs Temperature          | 6      |
|                 |                                           | vs Output current       | 8      |
|                 |                                           | vs Settling time        | 9      |
| $V_{O(PP)}$     | Maximum peak-to-peak output voltage swing | vs Frequency            | 10     |
| $V_{OH}$        | High-level output voltage                 | vs Output current       | 11     |
| $V_{OL}$        | Low-level output voltage                  | vs Output current       | 12     |
| $A_{VD}$        | Differential voltage amplification        | vs Temperature          | 13     |
|                 |                                           | vs Frequency            | 14     |
| $z_O$           | Closed loop output impedance              | vs Frequency            | 15     |
| $I_{OS}$        | Short-circuit output current              | vs Temperature          | 16     |
| CMRR            | Common-mode rejection ratio               | vs Frequency            | 17     |
|                 |                                           | vs Temperature          | 18     |
| $k_{SVR}$       | Supply-voltage rejection ratio            | vs Frequency            | 19     |
|                 |                                           | vs Temperature          | 20     |
| $I_{CC}$        | Supply current                            | vs Temperature          | 21     |
|                 |                                           | vs Supply-voltage       | 22     |
| $V_N$           | Noise voltage                             | vs Frequency            | 23     |
| $V_{NPP}$       | Noise voltage                             | Over a 10-second period | 24     |
| $I_n$           | Equivalent input noise current            | vs Frequency            | 25     |
| THD + N         | Total harmonic distortion plus noise      | vs Frequency            | 26     |
| SR              | Slew rate                                 | vs Temperature          | 27     |
|                 |                                           | vs Load capacitance     | 28     |
| Pulse response  | Noninverting large-signal                 | vs Time                 | 29     |
|                 | Inverting large-signal                    | vs Time                 | 30     |
|                 | Small-signal                              | vs Time                 | 31     |
| $B_1$           | Unity-gain bandwidth                      | vs Load capacitance     | 32     |
|                 | Gain margin                               | vs Load capacitance     | 33     |
| $\phi_m$        | Phase margin                              | vs Load capacitance     | 34     |
|                 | Phase shift                               | vs Frequency            | 14     |

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

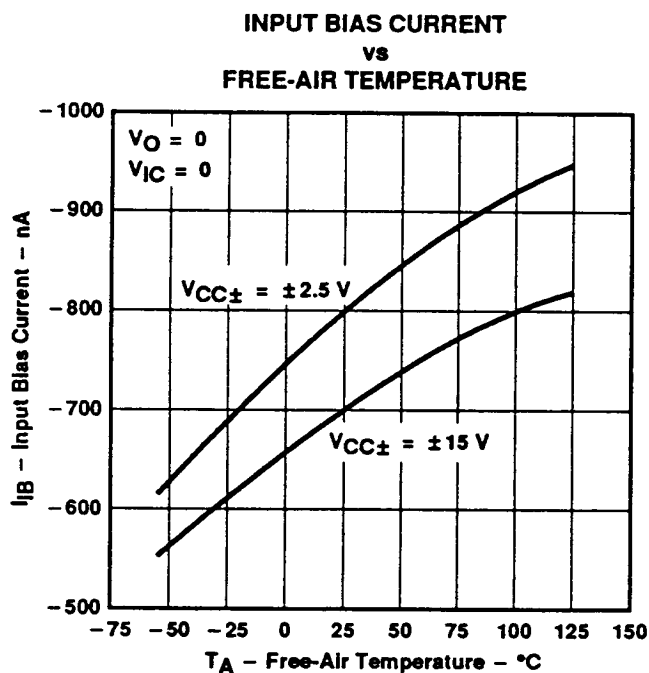
**TYPICAL CHARACTERISTICS†**



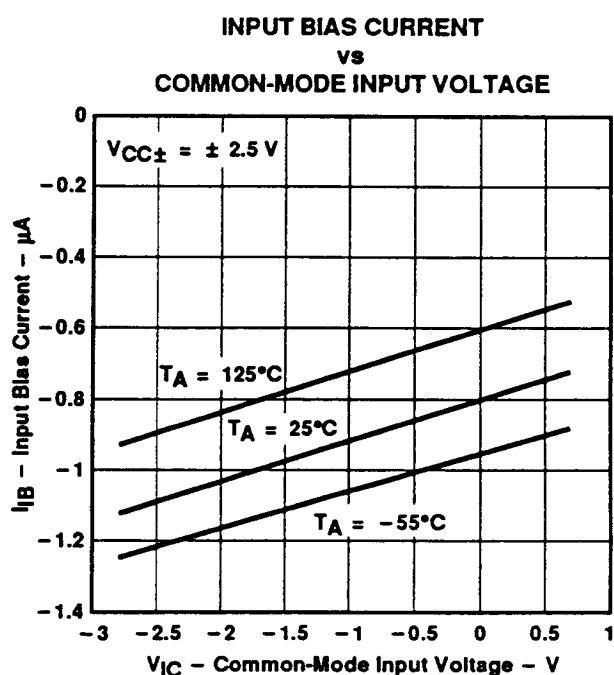
**Figure 1**



**Figure 2**



**Figure 3**



**Figure 4**

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

TYPICAL CHARACTERISTICS†

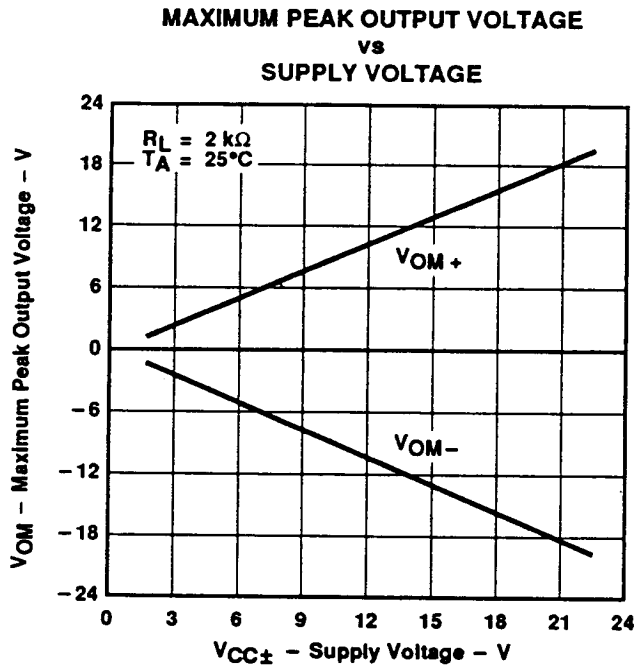


Figure 5

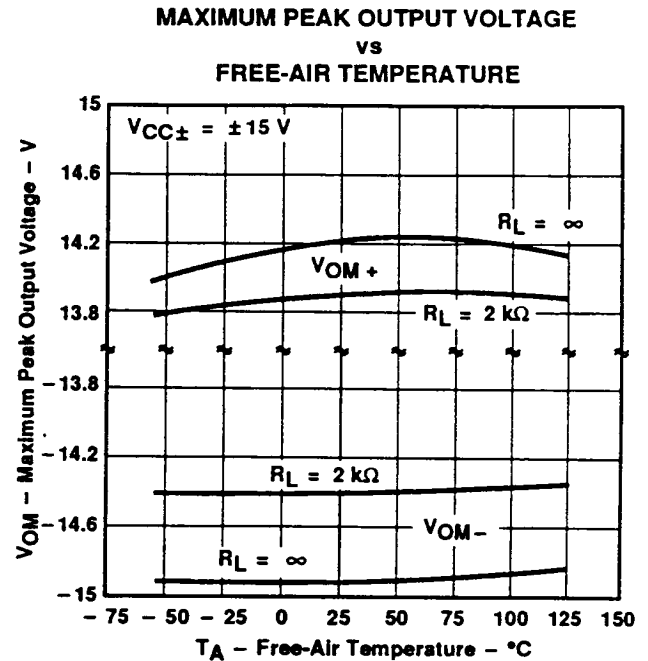


Figure 6

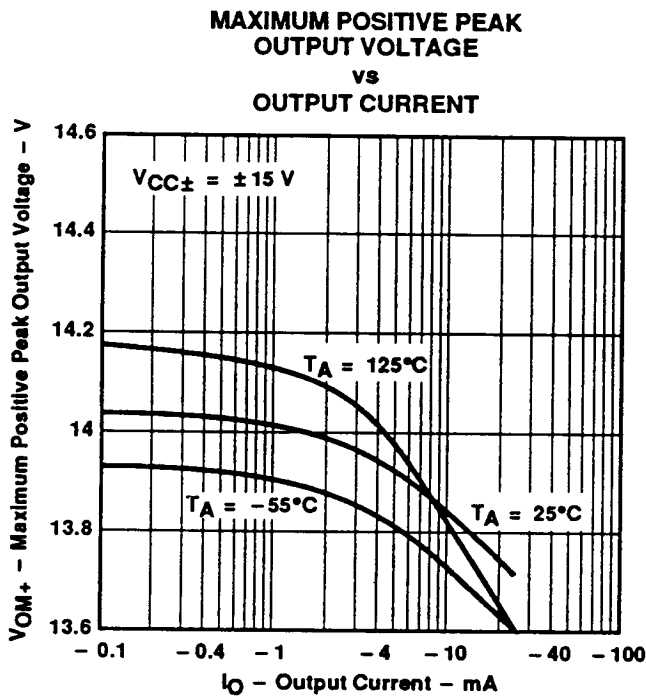


Figure 7

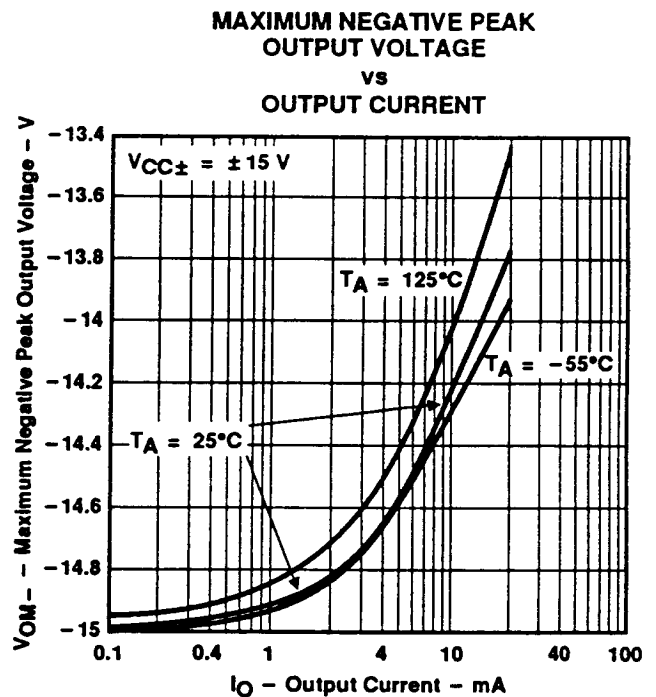
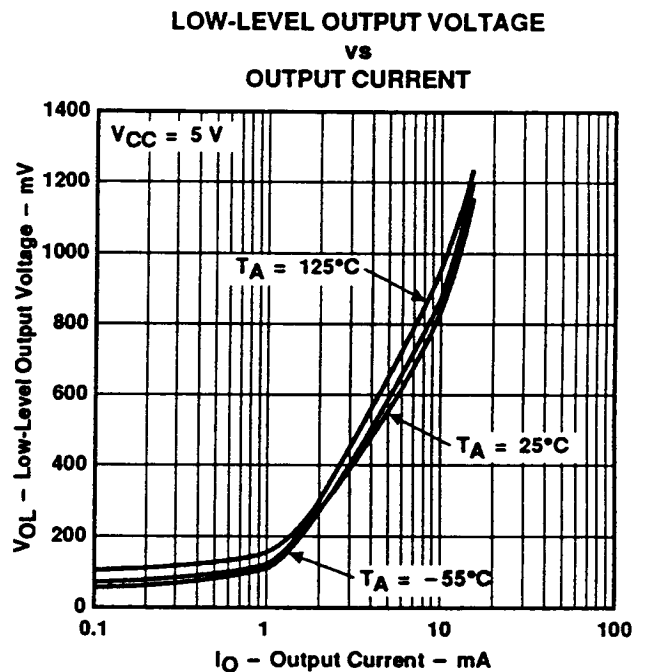
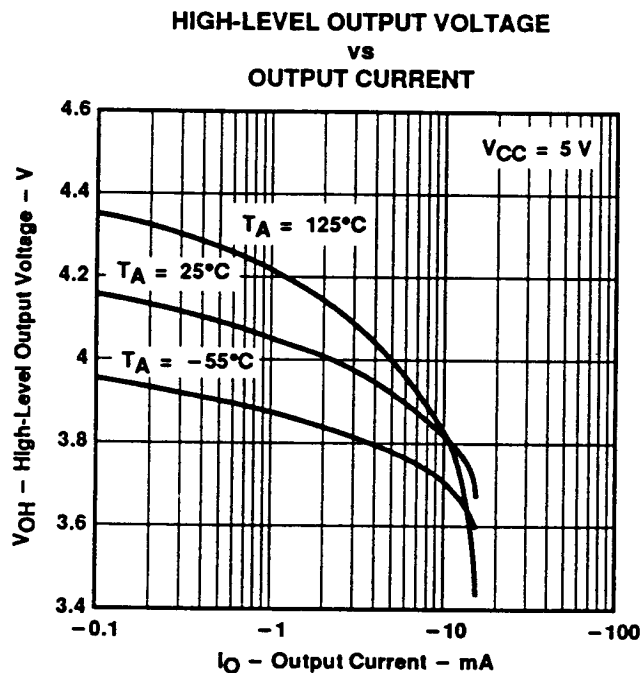
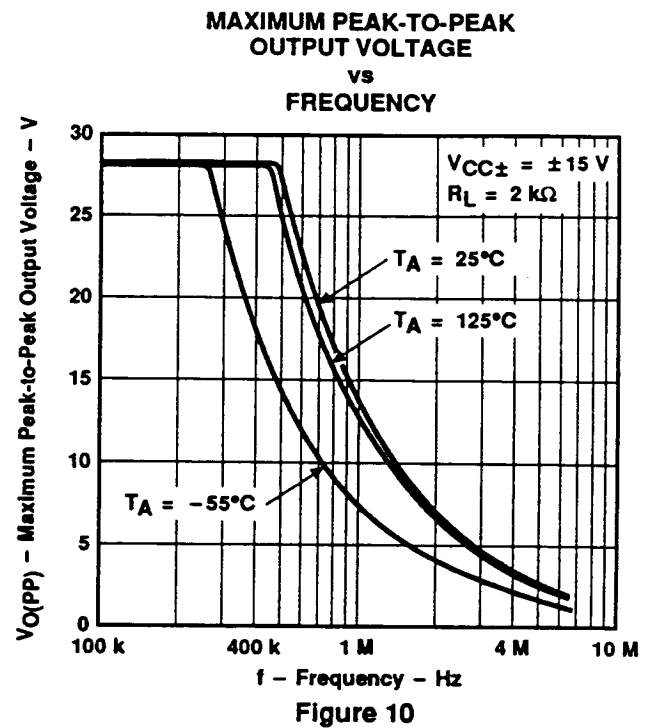
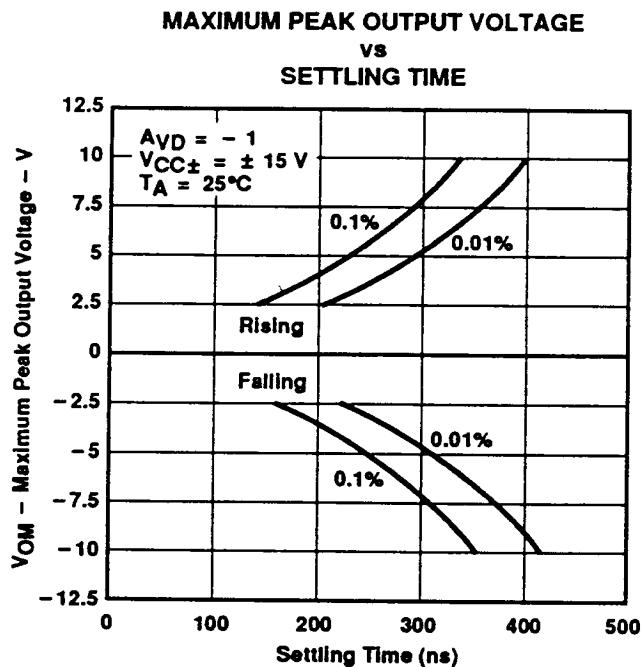


Figure 8

†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†

**LARGE-SIGNAL DIFFERENTIAL  
VOLTAGE AMPLIFICATION**  
vs  
**FREE-AIR TEMPERATURE**

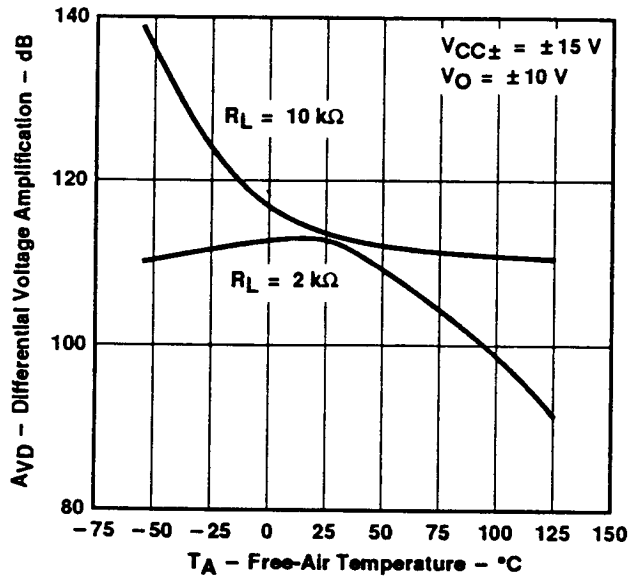


Figure 13

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE  
AMPLIFICATION AND PHASE SHIFT**  
vs  
**FREQUENCY**

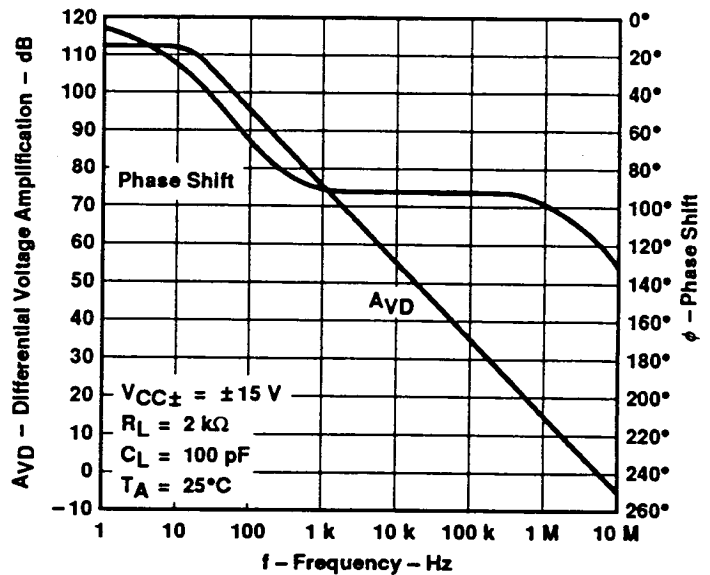


Figure 14

**CLOSED-LOOP OUTPUT IMPEDANCE**  
vs  
**FREQUENCY**

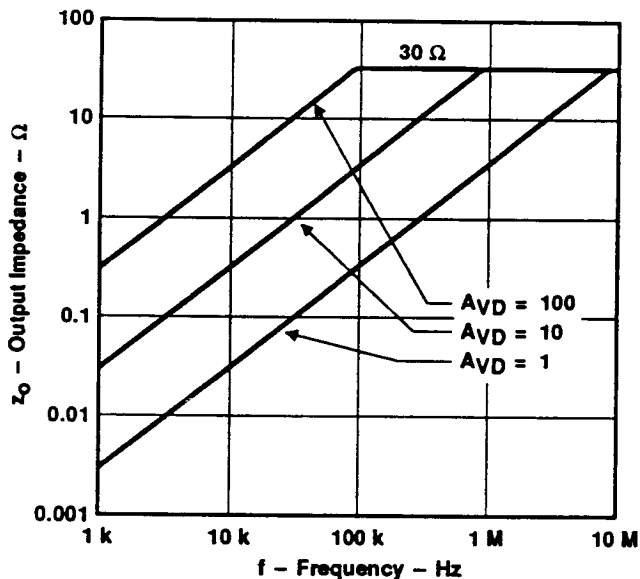


Figure 15

**SHORT-CIRCUIT OUTPUT CURRENT**  
vs  
**FREE-AIR TEMPERATURE**

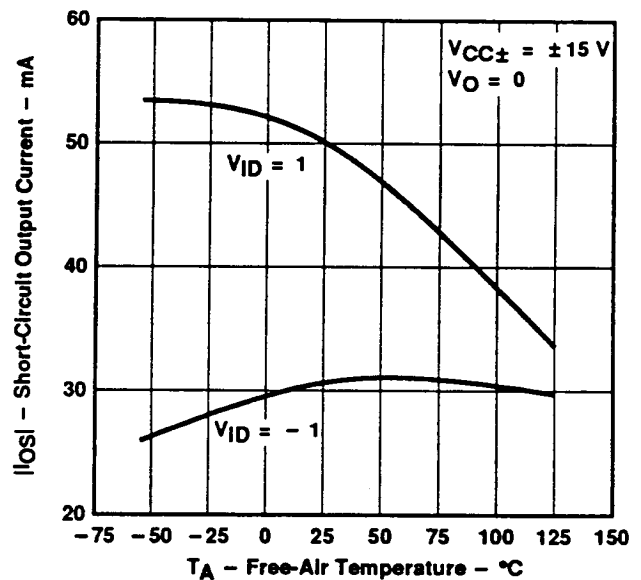
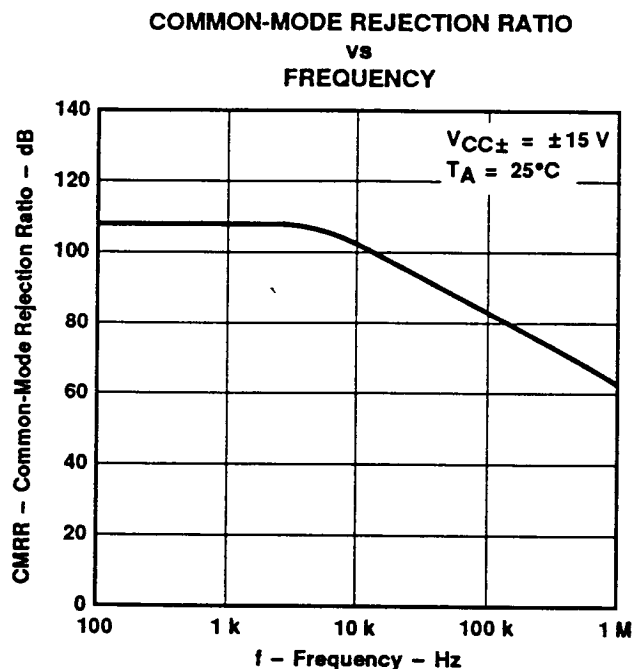


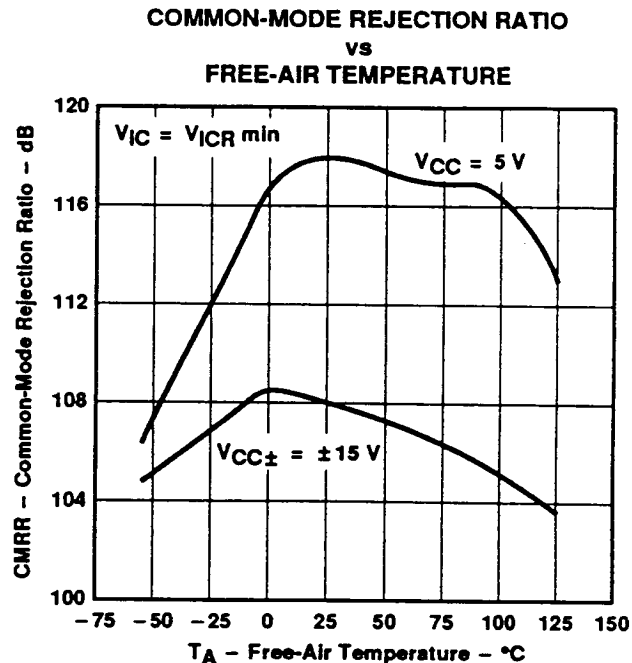
Figure 16

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

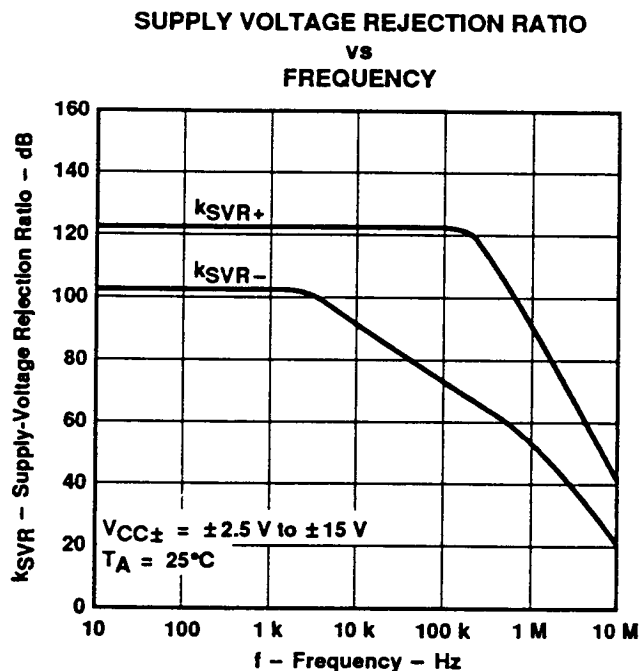
**TYPICAL CHARACTERISTICS†**



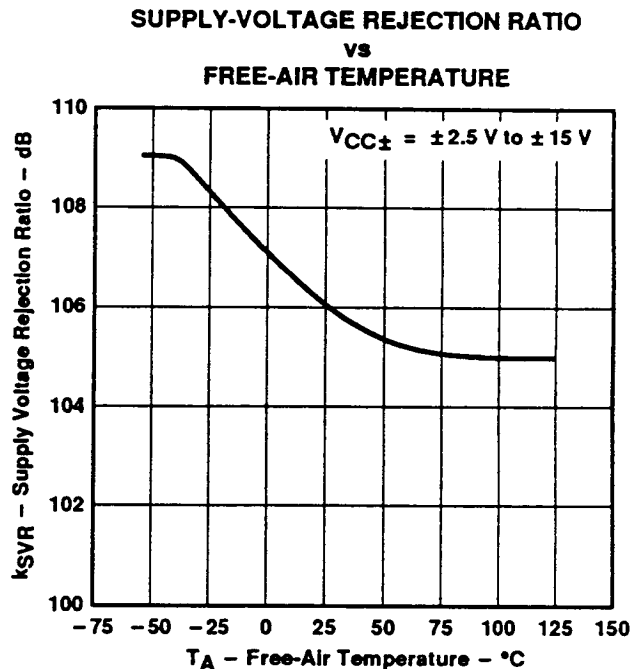
**Figure 17**



**Figure 18**



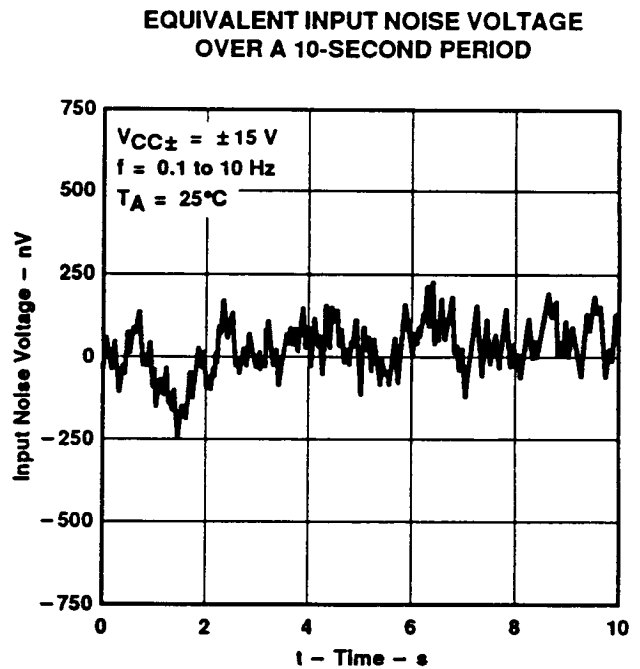
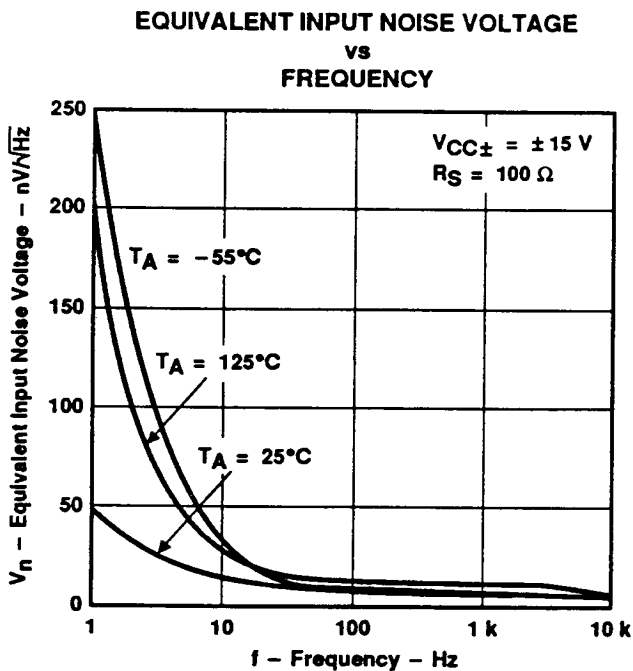
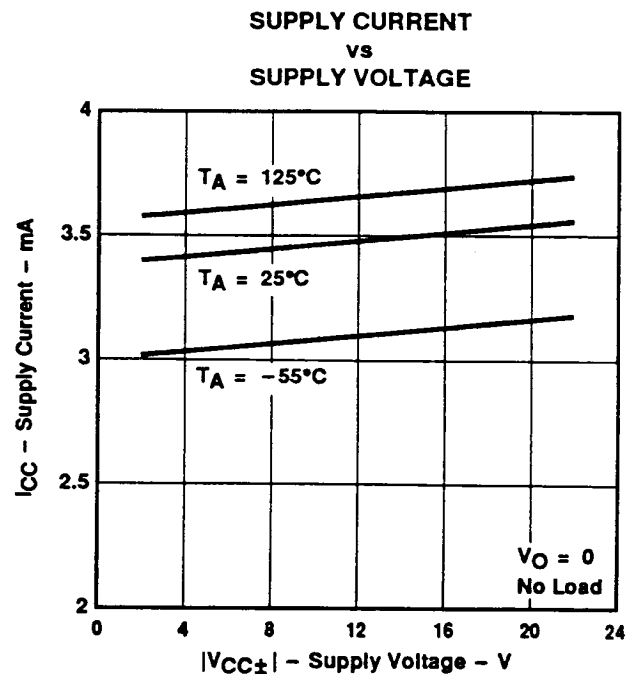
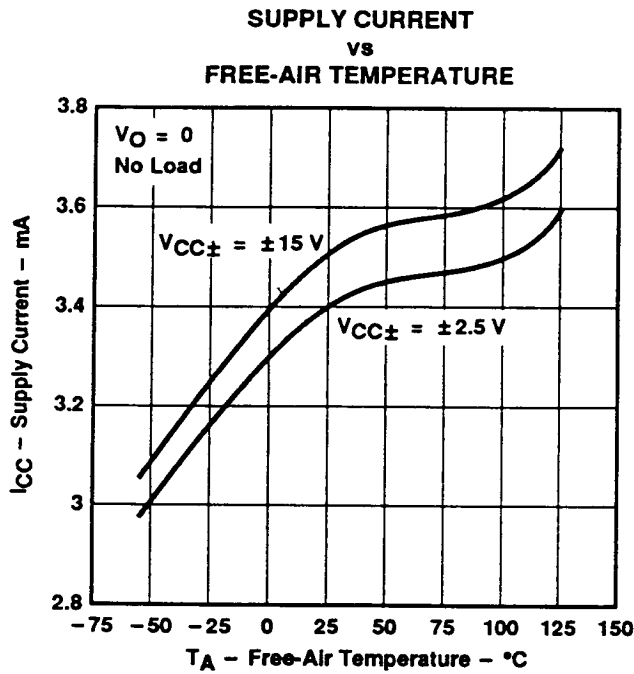
**Figure 19**



**Figure 20**

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

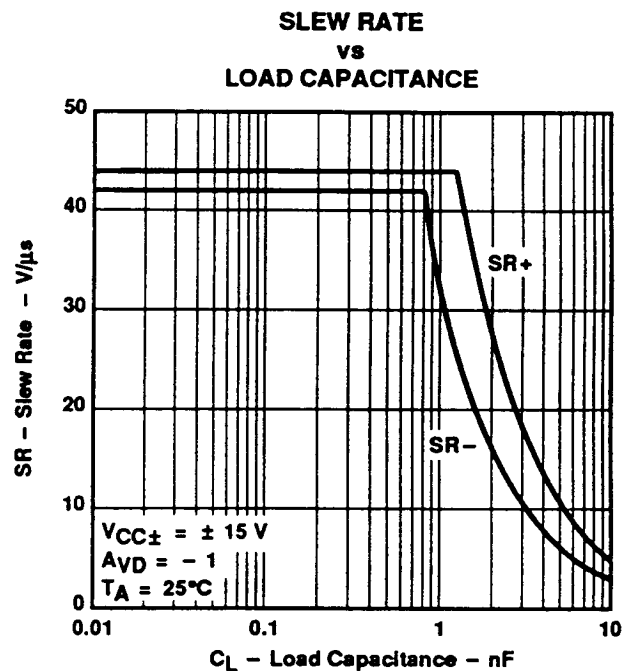
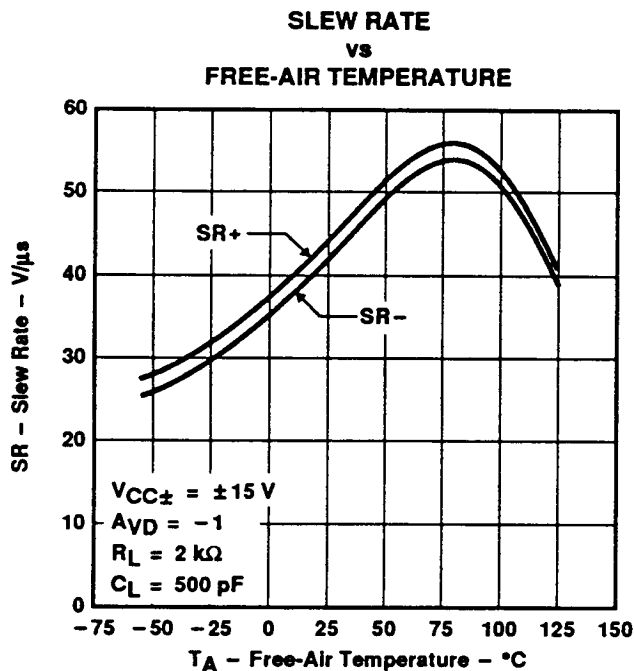
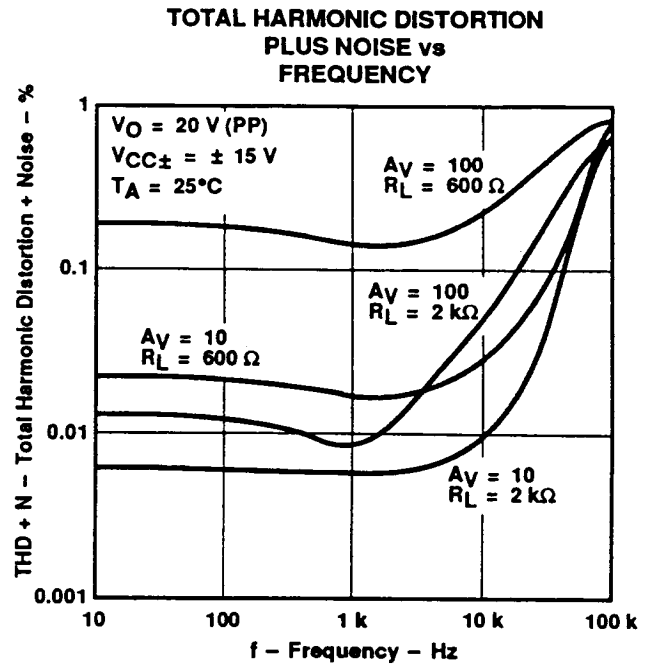
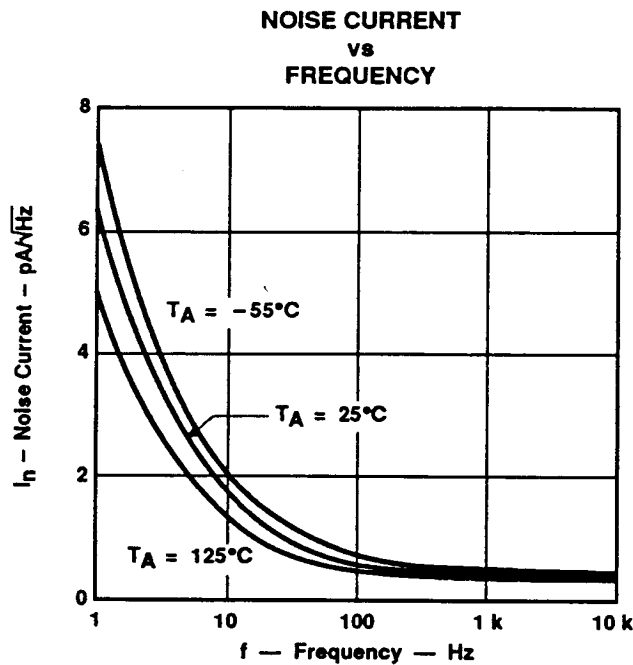
TYPICAL CHARACTERISTICS†



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

**TLE2141, TLE2141A**  
**EXCALIBUR LOW-NOISE HIGH-SPEED**  
**PRECISION OPERATIONAL AMPLIFIERS**

**TYPICAL CHARACTERISTICS†**



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

**TEXAS**  
**INSTRUMENTS**

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TYPICAL CHARACTERISTICS†

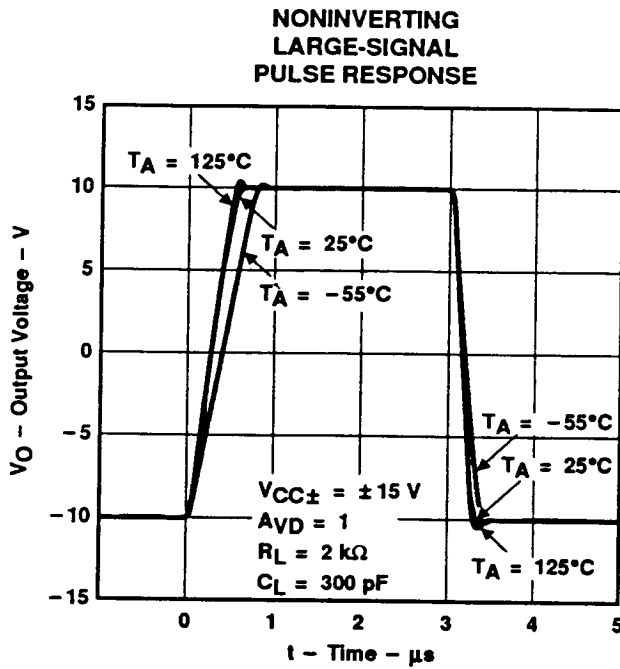


Figure 29

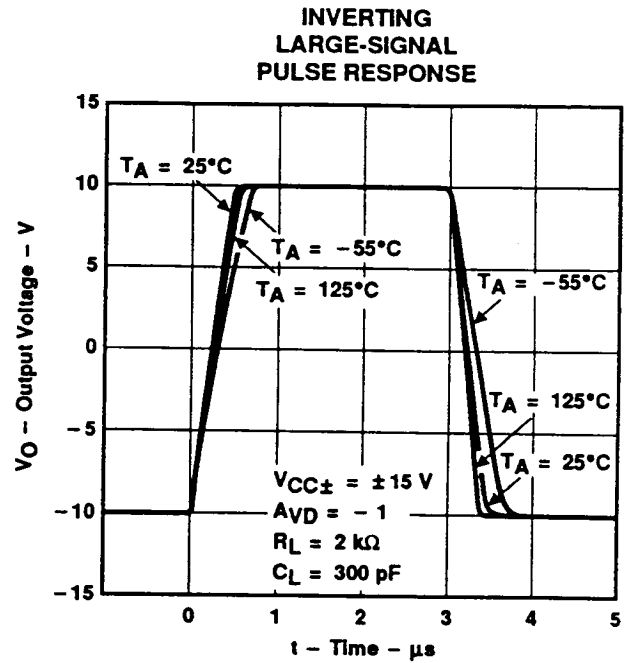


Figure 30

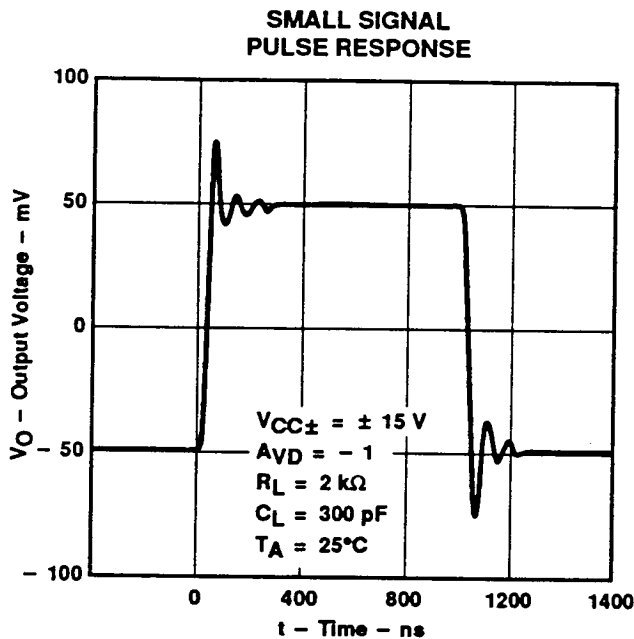


Figure 31

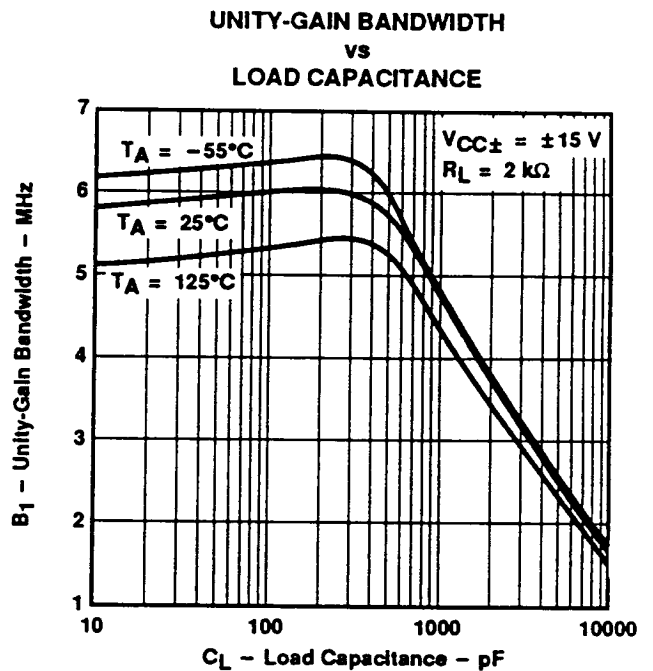


Figure 32

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

TYPICAL CHARACTERISTICS†

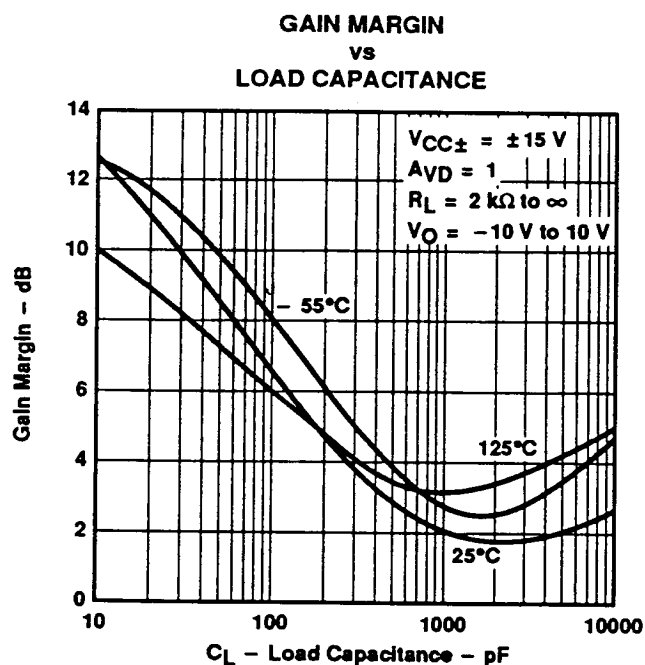


Figure 33

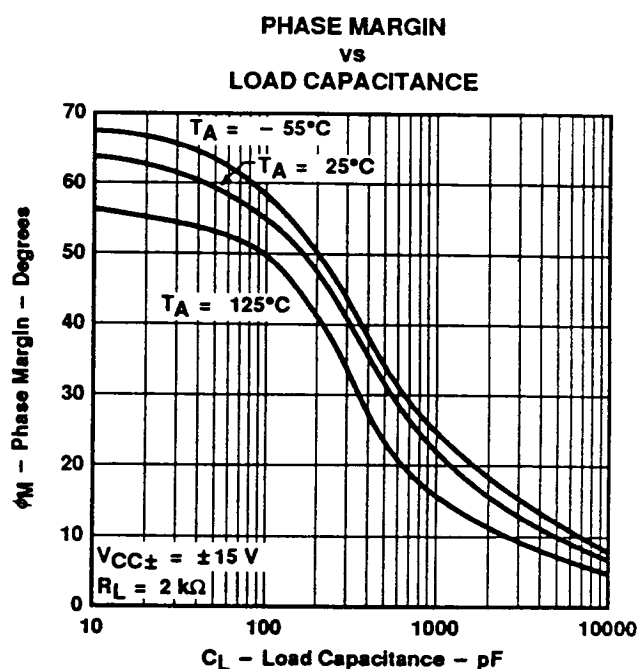


Figure 34

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