

# TL061, TL061A, TL061B, TL061Y, TL062, TL062A TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

SLOS078F – NOVEMBER 1978 – REVISED JANUARY 1999

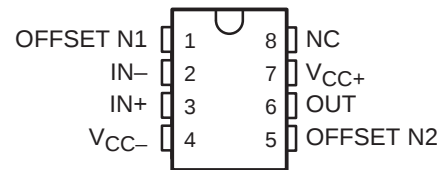
- Very Low Power Consumption
- Typical Supply Current . . . 200  $\mu$ A (Per Amplifier)
- Wide Common-Mode and Differential Voltage Ranges
- Low Input Bias and Offset Currents
- Common-Mode Input Voltage Range Includes  $V_{CC+}$
- Output Short-Circuit Protection
- High Input Impedance . . . JFET-Input Stage
- Internal Frequency Compensation
- Latch-Up-Free Operation
- High Slew Rate . . . 3.5 V/ $\mu$ s Typ

## description

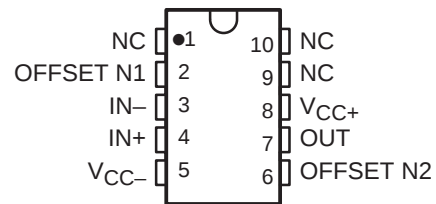
The JFET-input operational amplifiers of the TL06\_ series are designed as low-power versions of the TL08\_ series amplifiers. They feature high input impedance, wide bandwidth, high slew rate, and low input offset and input bias currents. The TL06\_ series feature the same terminal assignments as the TL07\_ and TL08\_ series. Each of these JFET-input operational amplifiers incorporates well-matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit.

The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from –40°C to 85°C, and the M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C.

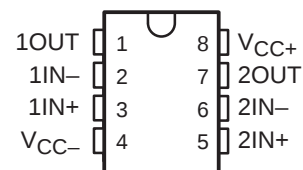
TL061, TL061A, TL061B  
D, JG, P, OR PW PACKAGE  
(TOP VIEW)



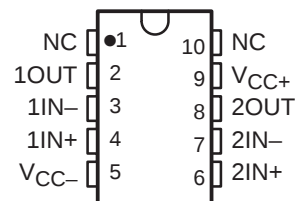
TL061 . . . U PACKAGE  
(TOP VIEW)



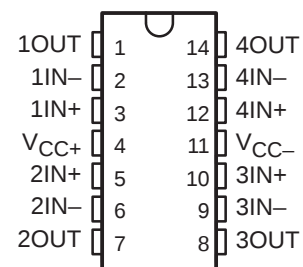
TL062, TL062A, TL062B  
D, JG, P, OR PW PACKAGE  
(TOP VIEW)



TL062 . . . U PACKAGE  
(TOP VIEW)



TL064 . . . D, J, N, PW, OR W PACKAGE  
TL064A, TL064B . . . D OR N PACKAGE  
(TOP VIEW)



NC – No internal connection



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

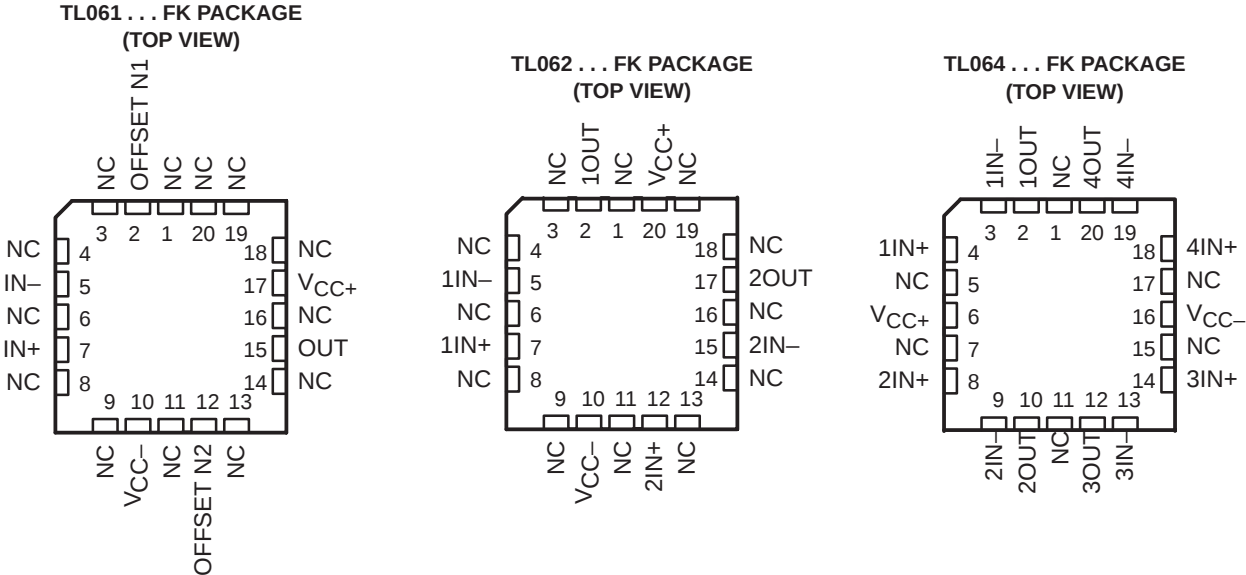
**TEXAS  
INSTRUMENTS**

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TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

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| T <sub>A</sub>    | V <sub>IO</sub> MAX<br>AT 25°C | PACKAGED DEVICES                        |                                         |                                 |                                 |               | CHIP FORM<br>(Y) |
|-------------------|--------------------------------|-----------------------------------------|-----------------------------------------|---------------------------------|---------------------------------|---------------|------------------|
|                   |                                | SMALL<br>OUTLINE<br>(D008) <sup>†</sup> | SMALL<br>OUTLINE<br>(D014) <sup>†</sup> | PLASTIC<br>DIP<br>(N)           | PLASTIC<br>DIP<br>(P)           | TSSOP<br>(PW) |                  |
| 0°C<br>to<br>70°C | 15 mV<br>6 mV<br>3 mV          | TL061CD<br>TL061ACD<br>TL061BCD         |                                         |                                 | TL061CP<br>TL061ACP<br>TL061BCP | TL061CPW      | TL061Y           |
|                   | 15 mV<br>6 mV<br>3 mV          | TL062CD<br>TL062ACD<br>TL062BCD         |                                         |                                 | TL062CP<br>TL062ACP<br>TL062BCP | TL062CPW      | TL062Y           |
|                   | 15 mV<br>6 mV<br>3 mV          |                                         | TL064CD<br>TL064ACD<br>TL064BCD         | TL064CN<br>TL064ACN<br>TL064BCN |                                 | TL064CPW      | TL064Y           |

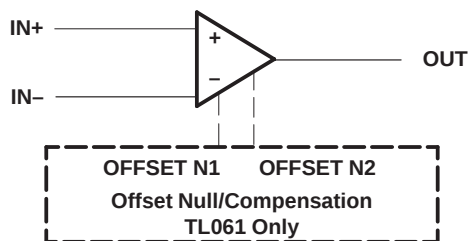
| T <sub>A</sub>       | V <sub>IO</sub> MAX<br>AT 25°C | PACKAGE                                 |                                         |                                  |                       |                        |                       |                       |                     |                     |
|----------------------|--------------------------------|-----------------------------------------|-----------------------------------------|----------------------------------|-----------------------|------------------------|-----------------------|-----------------------|---------------------|---------------------|
|                      |                                | SMALL<br>OUTLINE<br>(D008) <sup>†</sup> | SMALL<br>OUTLINE<br>(D014) <sup>†</sup> | CHIP<br>CARRIER<br>(FK)          | CERAMIC<br>DIP<br>(J) | CERAMIC<br>DIP<br>(JG) | PLASTIC<br>DIP<br>(N) | PLASTIC<br>DIP<br>(P) | FLAT<br>PACK<br>(U) | FLAT<br>PACK<br>(W) |
| –40°C<br>to<br>85°C  | 6 mV                           | TL061ID<br>TL062ID                      | TL064ID                                 |                                  |                       |                        | TL064IN               | TL061IP<br>TL062IP    |                     |                     |
| –55°C<br>to<br>125°C | 6 mV<br>6 mV<br>9 mV           |                                         |                                         | TL061MFK<br>TL062MFK<br>TL064MFK | TL064MJ               | TL061MJG<br>TL062MJG   |                       |                       | TL061MU<br>TL062MU  | TL064MW             |

<sup>†</sup> The D package is available taped and reeled. Add the suffix R to the device type (e.g., TL061CDR).

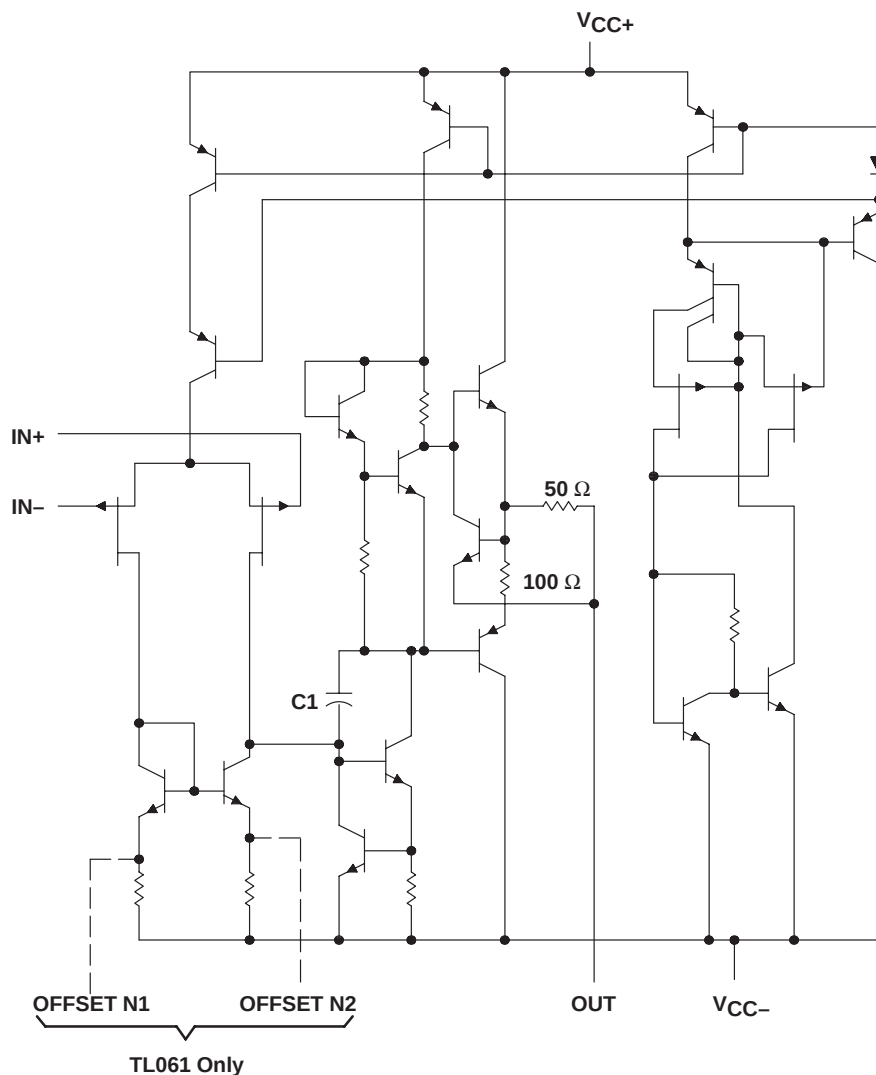
TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
 TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
 LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

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symbol (each amplifier)



schematic (each amplifier)



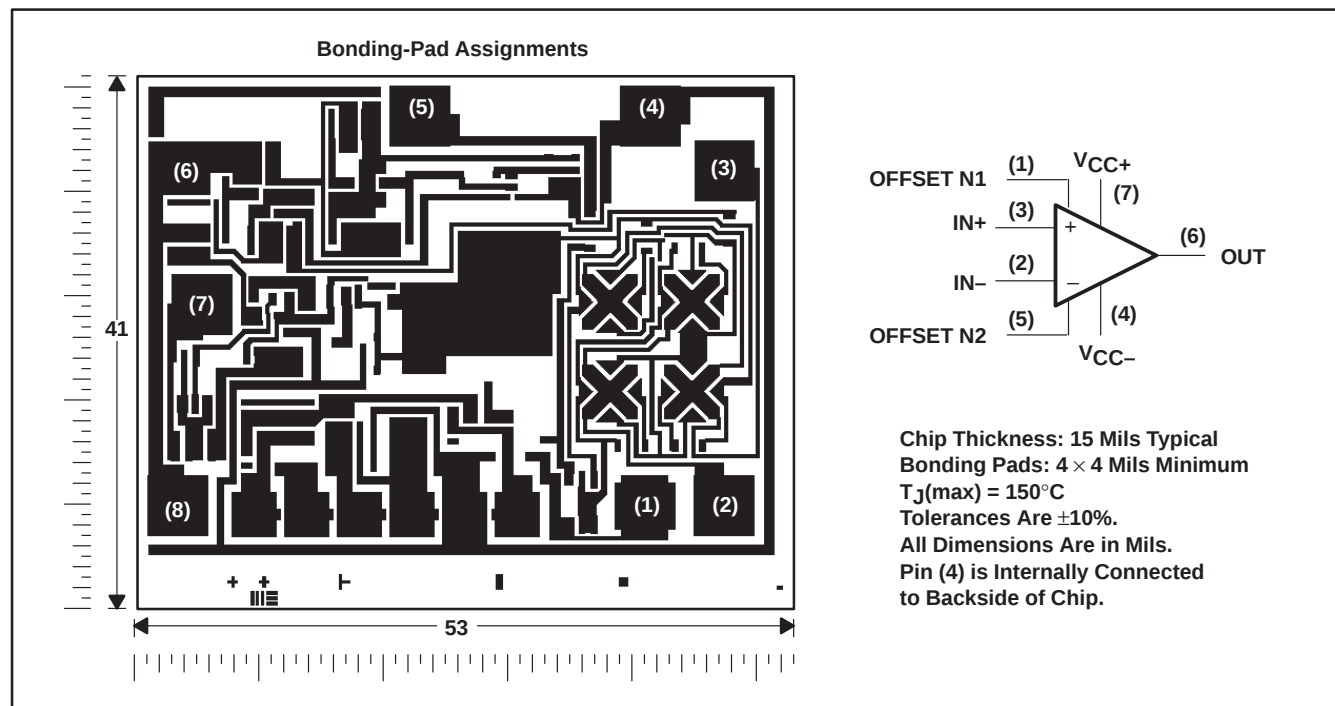
C1 = 10 pF on TL061, TL062, and TL064  
 Component values shown are nominal.

TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
 TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
**LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS**

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## TL061Y chip information

This chip, when properly assembled, has characteristics similar to the TL061. Thermal compression or ultrasonic bonding can be used on the doped-aluminum bonding pads. The chips can be mounted with conductive epoxy or a gold-silicon preform.

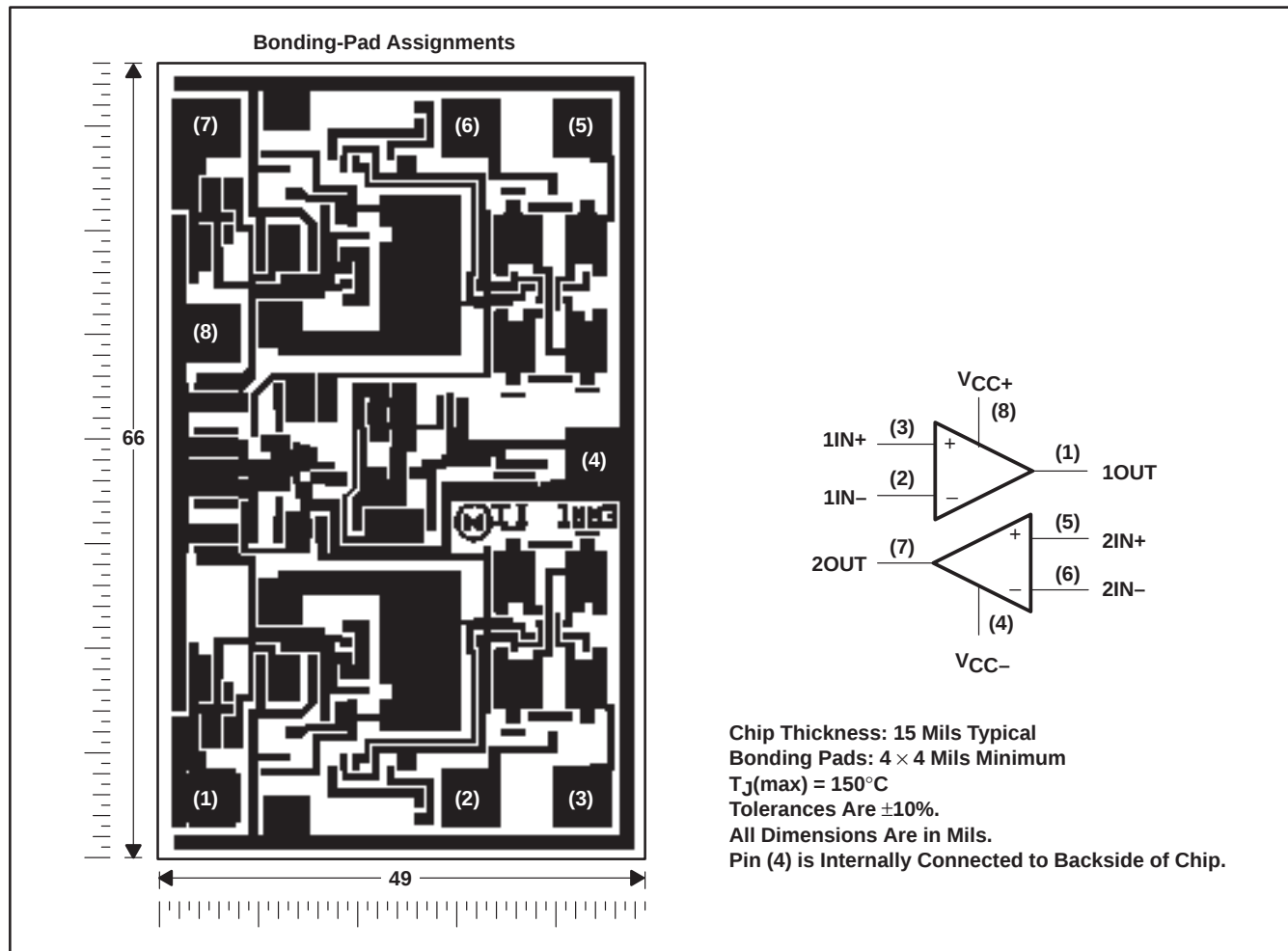


TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
 TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
 LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS

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## TL062Y chip information

This chip, when properly assembled, has characteristics similar to the TL062. Thermal compression or ultrasonic bonding can be used on the doped-aluminum bonding pads. The chips can be mounted with conductive epoxy or a gold-silicon preform.

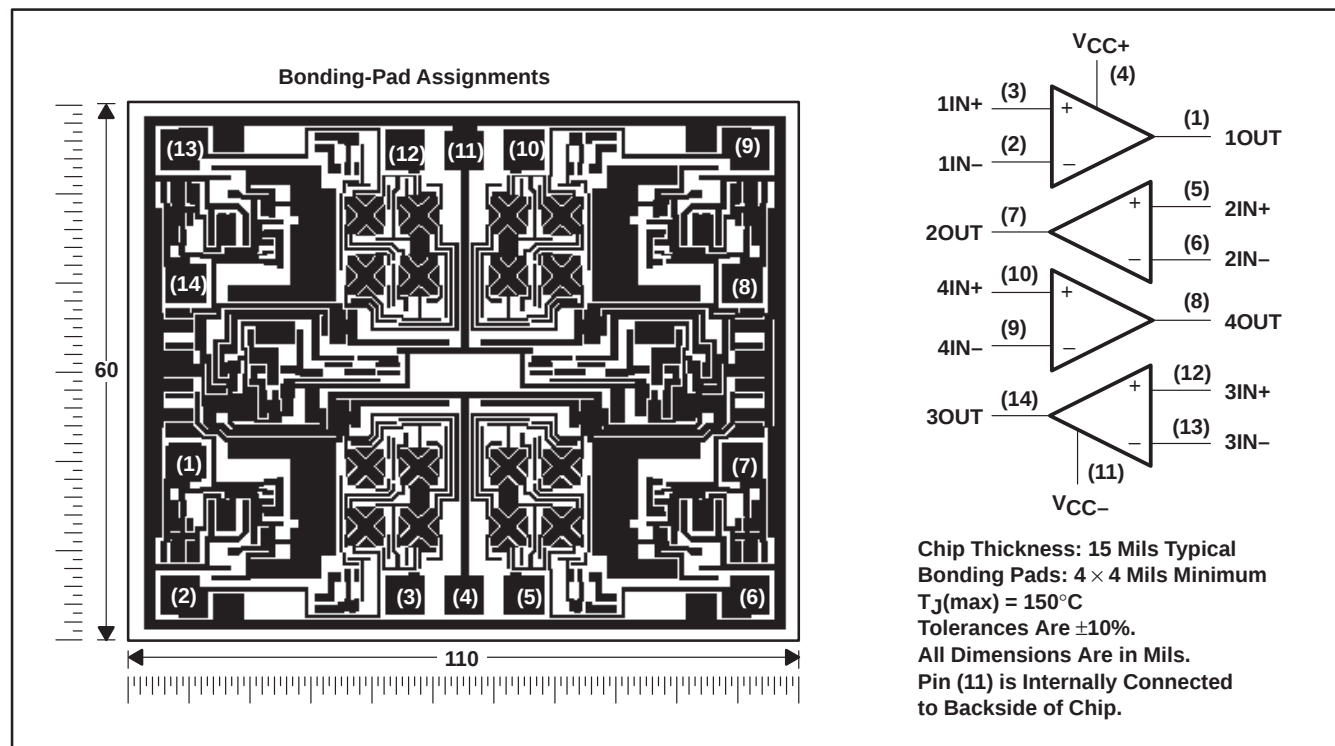


TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
 TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
**LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS**

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## TL064Y chip information

This chip, when properly assembled, has characteristics similar to the TL064. Thermal compression or ultrasonic bonding can be used on the doped-aluminum bonding pads. The chips can be mounted with conductive epoxy or a gold-silicon preform.



**TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
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**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>**

|                                                              |                           | TL06_C<br>TL06_AC<br>TL06_BC | TL06_I     | TL06_M     | UNIT |
|--------------------------------------------------------------|---------------------------|------------------------------|------------|------------|------|
| Supply voltage, $V_{CC+}$ (see Note 1)                       |                           | 18                           | 18         | 18         | V    |
| Supply voltage, $V_{CC-}$ (see Note 1)                       |                           | –18                          | –18        | –18        | V    |
| Differential input voltage, $V_{ID}$ (see Note 2)            |                           | ±30                          | ±30        | ±30        | V    |
| Input voltage, $V_I$ (see Notes 1 and 3)                     |                           | ±15                          | ±15        | ±15        | V    |
| Duration of output short circuit (see Note 4)                |                           | unlimited                    | unlimited  | unlimited  |      |
| Continuous total dissipation                                 |                           | See Dissipation Rating Table |            |            |      |
| Storage temperature range, $T_{stg}$                         |                           | –65 to 150                   | –65 to 150 | –65 to 150 | °C   |
| Case temperature for 60 seconds                              | FK package                |                              |            | 260        | °C   |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds | J, JG, U, or<br>W package |                              |            | 300        | °C   |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | D, N, P, or<br>PW package | 260                          | 260        |            | °C   |

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

- NOTES:
1. All voltage values except differential voltages are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .
  2. Differential voltages are at  $IN+$  with respect to  $IN-$ .
  3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.
  4. The output may be shorted to ground or to either supply. Temperature and/or supply voltages must be limited to ensure that the dissipation rating is not exceeded.

**DISSIPATION RATING TABLE**

| PACKAGE     | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | DERATING<br>FACTOR | DERATE<br>ABOVE $T_A$ | $T_A = 70^\circ\text{C}$<br>POWER RATING | $T_A = 85^\circ\text{C}$<br>POWER RATING | $T_A = 125^\circ\text{C}$<br>POWER RATING |
|-------------|---------------------------------------------|--------------------|-----------------------|------------------------------------------|------------------------------------------|-------------------------------------------|
| D (8 pin)   | 680 mW                                      | 5.8 mW/°C          | 33°C                  | 465 mW                                   | 378 mW                                   | N/A                                       |
| D (14 pin)  | 680 mW                                      | 7.6 mW/°C          | 60°C                  | 604 mW                                   | 490 mW                                   | N/A                                       |
| FK          | 680 mW                                      | 11.0 mW/°C         | 88°C                  | 680 mW                                   | 680 mW                                   | 273 mW                                    |
| J           | 680 mW                                      | 11.0 mW/°C         | 88°C                  | 680 mW                                   | 680 mW                                   | 273 mW                                    |
| JG          | 680 mW                                      | 8.4 mW/°C          | 69°C                  | 672 mW                                   | 546 mW                                   | 210 mW                                    |
| N           | 680 mW                                      | 9.2 mW/°C          | 76°C                  | 680 mW                                   | 597 mW                                   | N/A                                       |
| P           | 680 mW                                      | 8.0 mW/°C          | 65°C                  | 640 mW                                   | 520 mW                                   | N/A                                       |
| PW (8 pin)  | 525 mW                                      | 4.2 mW/°C          | 25°C                  | 336 mW                                   | N/A                                      | N/A                                       |
| PW (14 pin) | 700 mW                                      | 5.6 mW/°C          | 25°C                  | 448 mW                                   | N/A                                      | N/A                                       |
| U           | 675 mW                                      | 5.4 mW/°C          | 25°C                  | 432 mW                                   | 351 mW                                   | 135 mW                                    |
| W           | 680 mW                                      | 8.0 mW/°C          | 65°C                  | 640 mW                                   | 520 mW                                   | 200 mW                                    |

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TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS**

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**electrical characteristics,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS†                                                                                                   |                                                       | TL061C<br>TL062C<br>TL064C |                 |     | TL061AC<br>TL062AC<br>TL064AC |                 |     | UNIT                         |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|----------------------------|-----------------|-----|-------------------------------|-----------------|-----|------------------------------|
|                                                                               |                                                                                                                    |                                                       | MIN                        | TYP             | MAX | MIN                           | TYP             | MAX |                              |
| $V_{IO}$ Input offset voltage                                                 | $V_O = 0$ ,<br>$R_S = 50\ \Omega$                                                                                  | $T_A = 25^\circ\text{C}$<br>$T_A = \text{Full range}$ |                            | 3               | 15  |                               | 3               | 6   | mV                           |
|                                                                               |                                                                                                                    |                                                       |                            |                 | 20  |                               |                 | 7.5 |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                | $V_O = 0$ , $R_S = 50\ \Omega$ ,<br>$T_A = \text{Full range}$                                                      |                                                       |                            | 10              |     |                               | 10              |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                 | $V_O = 0$                                                                                                          | $T_A = 25^\circ\text{C}$<br>$T_A = \text{Full range}$ |                            | 5               | 200 |                               | 5               | 100 | pA                           |
|                                                                               |                                                                                                                    |                                                       |                            |                 | 5   |                               |                 | 3   | nA                           |
| $I_{IB}$ Input bias current‡                                                  | $V_O = 0$                                                                                                          | $T_A = 25^\circ\text{C}$<br>$T_A = \text{Full range}$ |                            | 30              | 400 |                               | 30              | 200 | pA                           |
|                                                                               |                                                                                                                    |                                                       |                            |                 | 10  |                               |                 | 7   | nA                           |
| $V_{ICR}$ Common-mode input voltage range                                     | $T_A = 25^\circ\text{C}$                                                                                           |                                                       | $\pm 11$                   | –12<br>to<br>15 |     | $\pm 11$                      | –12<br>to<br>15 |     | V                            |
| $V_{OM}$ Maximum peak output voltage swing                                    | $R_L = 10\ \text{k}\Omega$ , $T_A = 25^\circ\text{C}$<br>$R_L \geq 10\ \text{k}\Omega$ , $T_A = \text{Full range}$ |                                                       | $\pm 10$                   | $\pm 13.5$      |     | $\pm 10$                      | $\pm 13.5$      |     | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10\ \text{V}$ ,<br>$R_L \geq 10\ \text{k}\Omega$                                                        | $T_A = 25^\circ\text{C}$<br>$T_A = \text{Full range}$ |                            | 3               | 6   |                               | 4               | 6   | V/mV                         |
|                                                                               |                                                                                                                    |                                                       |                            | 3               |     |                               | 4               |     |                              |
| $B_1$ Unity-gain bandwidth                                                    | $R_L = 10\ \text{k}\Omega$ , $T_A = 25^\circ\text{C}$                                                              |                                                       |                            | 1               |     |                               | 1               |     | MHz                          |
| $r_i$ Input resistance                                                        | $T_A = 25^\circ\text{C}$                                                                                           |                                                       |                            | $10^{12}$       |     |                               | $10^{12}$       |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}$ , $V_O = 0$ ,<br>$R_S = 50\ \Omega$ , $T_A = 25^\circ\text{C}$                               |                                                       | 70                         | 86              |     | 80                            | 86              |     | dB                           |
| $k_{SVR}$ Supply-voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC} = \pm 9\ \text{V}$ to $\pm 15\ \text{V}$ ,<br>$V_O = 0$ , $R_S = 50\ \Omega$ ,<br>$T_A = 25^\circ\text{C}$ |                                                       | 70                         | 95              |     | 80                            | 95              |     | dB                           |
| $P_D$ Total power dissipation (each amplifier)                                | $V_O = 0$ ,<br>No load                                                                                             | $T_A = 25^\circ\text{C}$                              |                            | 6               | 7.5 |                               | 6               | 7.5 | mW                           |
| $I_{CC}$ Supply current (each amplifier)                                      | $V_O = 0$ ,<br>No load                                                                                             | $T_A = 25^\circ\text{C}$                              |                            | 200             | 250 |                               | 200             | 250 | $\mu\text{A}$                |
| $V_{O1}/V_{O2}$ Crosstalk attenuation                                         | $A_{VD} = 100$ , $T_A = 25^\circ\text{C}$                                                                          |                                                       |                            | 120             |     |                               | 120             |     | dB                           |

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range for  $T_A$  is  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for TL06\_C, TL06\_AC, and TL06\_BC and  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for TL06\_I.

‡ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 15. Pulse techniques are used to maintain the junction temperature as close to the ambient temperature as possible.

**TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS**

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**electrical characteristics,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                                                                        | TEST CONDITIONS†                                                                                                   |                                                       | TL061BC<br>TL062BC<br>TL064BC |                 |     | TL061I<br>TL062I<br>TL064I |                 |     | UNIT                         |
|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|-------------------------------|-----------------|-----|----------------------------|-----------------|-----|------------------------------|
|                                                                                  |                                                                                                                    |                                                       | MIN                           | TYP             | MAX | MIN                        | TYP             | MAX |                              |
| $V_{IO}$ Input offset voltage                                                    | $V_O = 0$ ,<br>$R_S = 50\ \Omega$                                                                                  | $T_A = 25^\circ\text{C}$<br>$T_A = \text{Full range}$ |                               | 2               | 3   |                            | 3               | 6   | mV                           |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                   | $V_O = 0$ , $R_S = 50\ \Omega$ ,<br>$T_A = \text{Full range}$                                                      |                                                       |                               | 10              |     |                            | 10              |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                    | $V_O = 0$                                                                                                          | $T_A = 25^\circ\text{C}$<br>$T_A = \text{Full range}$ |                               | 5               | 100 |                            | 5               | 100 | pA                           |
| $I_{IB}$ Input bias current‡                                                     | $V_O = 0$                                                                                                          | $T_A = 25^\circ\text{C}$<br>$T_A = \text{Full range}$ |                               | 30              | 200 |                            | 30              | 200 | pA                           |
| $V_{ICR}$ Common-mode input voltage range                                        | $T_A = 25^\circ\text{C}$                                                                                           |                                                       | $\pm 11$                      | –12<br>to<br>15 |     | $\pm 11$                   | –12<br>to<br>15 |     | V                            |
| $V_{OM}$ Maximum peak output voltage swing                                       | $R_L = 10\ \text{k}\Omega$ , $T_A = 25^\circ\text{C}$<br>$R_L \geq 10\ \text{k}\Omega$ , $T_A = \text{Full range}$ |                                                       | $\pm 10$                      | $\pm 13.5$      |     | $\pm 10$                   | $\pm 13.5$      |     | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                         | $V_O = \pm 10\ \text{V}$ ,<br>$R_L \geq 10\ \text{k}\Omega$                                                        | $T_A = 25^\circ\text{C}$<br>$T_A = \text{Full range}$ | 4                             | 6               |     | 4                          | 6               |     | V/mV                         |
| $B_1$ Unity-gain bandwidth                                                       | $R_L = 10\ \text{k}\Omega$ , $T_A = 25^\circ\text{C}$                                                              |                                                       |                               | 1               |     |                            | 1               |     | MHz                          |
| $r_i$ Input resistance                                                           | $T_A = 25^\circ\text{C}$                                                                                           |                                                       |                               | $10^{12}$       |     |                            | $10^{12}$       |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                                 | $V_{IC} = V_{ICRmin}$ , $V_O = 0$ ,<br>$R_S = 50\ \Omega$ , $T_A = 25^\circ\text{C}$                               |                                                       | 80                            | 86              |     | 80                         | 86              |     | dB                           |
| $k_{SVR}$ Supply-voltage rejection ratio<br>( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC} = \pm 9\ \text{V}$ to $\pm 15\ \text{V}$ ,<br>$V_O = 0$ , $R_S = 50\ \Omega$ ,<br>$T_A = 25^\circ\text{C}$ |                                                       | 80                            | 95              |     | 80                         | 95              |     | dB                           |
| $P_D$ Total power dissipation<br>(each amplifier)                                | $V_O = 0$ ,<br>No load                                                                                             | $T_A = 25^\circ\text{C}$                              |                               | 6               | 7.5 |                            | 6               | 7.5 | mW                           |
| $I_{CC}$ Supply current<br>(each amplifier)                                      | $V_O = 0$ ,<br>No load                                                                                             | $T_A = 25^\circ\text{C}$                              |                               | 200             | 250 |                            | 200             | 250 | $\mu\text{A}$                |
| $V_{O1}/V_{O2}$ Crosstalk attenuation                                            | $A_{VD} = 100$ , $T_A = 25^\circ\text{C}$                                                                          |                                                       |                               | 120             |     |                            | 120             |     | dB                           |

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range for  $T_A$  is  $0^\circ\text{C}$  to  $70^\circ\text{C}$  for TL06\_C, TL06\_AC, and TL06\_BC and  $-40^\circ\text{C}$  to  $85^\circ\text{C}$  for TL06\_I.

‡ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 15. Pulse techniques are used to maintain the junction temperature as close to the ambient temperature as possible.

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TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
LOW-POWER JFET-INPUT OPERATIONAL AMPLIFIERS**

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**electrical characteristics,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER                        |                                                                       | TEST CONDITIONS†                                                                                            |                                 | TL061M<br>TL062M |                 |     | TL064M           |                 |     | UNIT  |
|----------------------------------|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------|------------------|-----------------|-----|------------------|-----------------|-----|-------|
|                                  |                                                                       |                                                                                                             |                                 | MIN              | TYP             | MAX | MIN              | TYP             | MAX |       |
| V <sub>IO</sub>                  | Input offset voltage                                                  | V <sub>O</sub> = 0,<br>R <sub>S</sub> = 50 Ω                                                                | T <sub>A</sub> = 25°C           | 3                |                 | 6   | 3                |                 | 9   | mV    |
|                                  |                                                                       |                                                                                                             | T <sub>A</sub> = −55°C to 125°C |                  |                 | 9   |                  |                 | 15  |       |
| α <sub>VIO</sub>                 | Temperature coefficient of input offset voltage                       | V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω,<br>T <sub>A</sub> = −55°C to 125°C                               |                                 | 10               |                 |     | 10               |                 |     | μV/°C |
| I <sub>IO</sub>                  | Input offset current                                                  | V <sub>O</sub> = 0                                                                                          | T <sub>A</sub> = 25°C           | 5                |                 | 100 | 5                |                 | 100 | pA    |
|                                  |                                                                       |                                                                                                             | T <sub>A</sub> = −55°C          | 20*              |                 | 20* |                  | nA              |     |       |
|                                  |                                                                       |                                                                                                             | T <sub>A</sub> = 125°C          | 20               |                 | 20  |                  |                 |     |       |
| I <sub>IB</sub>                  | Input bias current‡                                                   | V <sub>O</sub> = 0                                                                                          | T <sub>A</sub> = 25°C           | 30               |                 | 200 | 30               |                 | 200 | pA    |
|                                  |                                                                       |                                                                                                             | T <sub>A</sub> = −55°C          | 50*              |                 | 50* |                  | nA              |     |       |
|                                  |                                                                       |                                                                                                             | T <sub>A</sub> = 125°C          | 50               |                 | 50  |                  |                 |     |       |
| V <sub>ICR</sub>                 | Common-mode input voltage range                                       | T <sub>A</sub> = 25°C                                                                                       |                                 | ±11.5            | −12<br>to<br>15 |     | ±11.5            | −12<br>to<br>15 |     | V     |
| V <sub>OM</sub>                  | Maximum peak output voltage swing                                     | R <sub>L</sub> = 10 kΩ, T <sub>A</sub> = 25°C                                                               |                                 | ±10              | ±13.5           |     | ±10              | ±13.5           |     | V     |
|                                  |                                                                       | R <sub>L</sub> ≥ 10 kΩ, T <sub>A</sub> = −55°C to 125°C                                                     |                                 | ±10              |                 |     | ±10              |                 |     |       |
| A <sub>VD</sub>                  | Large-signal differential voltage amplification                       | V <sub>O</sub> = ±10 V,<br>R <sub>L</sub> ≥ 10 kΩ                                                           | T <sub>A</sub> = 25°C           | 4                | 6               |     | 4                | 6               |     | V/mV  |
|                                  |                                                                       |                                                                                                             | T <sub>A</sub> = −55°C to 125°C | 4                |                 |     | 4                |                 |     |       |
| B <sub>1</sub>                   | Unity-gain bandwidth                                                  | R <sub>L</sub> = 10 kΩ, T <sub>A</sub> = 25°C                                                               |                                 |                  |                 |     |                  |                 |     | MHz   |
| r <sub>i</sub>                   | Input resistance                                                      | T <sub>A</sub> = 25°C                                                                                       |                                 | 10 <sup>12</sup> |                 |     | 10 <sup>12</sup> |                 |     | Ω     |
| CMRR                             | Common-mode rejection ratio                                           | V <sub>IC</sub> = V <sub>ICRmin</sub> , V <sub>O</sub> = 0,<br>R <sub>S</sub> = 50 Ω, T <sub>A</sub> = 25°C |                                 | 80               | 86              |     | 80               | 86              |     | dB    |
| k <sub>SVR</sub>                 | Supply-voltage rejection ratio (ΔV <sub>CC±</sub> /ΔV <sub>IO</sub> ) | V <sub>CC</sub> = ±9 V to ±15 V, V <sub>O</sub> = 0,<br>R <sub>S</sub> = 50 Ω, T <sub>A</sub> = 25°C        |                                 | 80               | 95              |     | 80               | 95              |     | dB    |
| P <sub>D</sub>                   | Total power dissipation (each amplifier)                              | V <sub>O</sub> = 0,<br>No load                                                                              | T <sub>A</sub> = 25°C,          | 6                |                 | 7.5 | 6                |                 | 7.5 | mW    |
| I <sub>CC</sub>                  | Supply current (each amplifier)                                       | V <sub>O</sub> = 0,<br>No load                                                                              | T <sub>A</sub> = 25°C,          | 200              |                 | 250 | 200              |                 | 250 | μA    |
| V <sub>O1</sub> /V <sub>O2</sub> | Crosstalk attenuation                                                 | A <sub>VD</sub> = 100, T <sub>A</sub> = 25°C                                                                |                                 | 120              |                 |     | 120              |                 |     | dB    |

\* This parameter is not production tested.

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified.

‡ Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 15. Pulse techniques are used to maintain the junction temperature as close to the ambient temperature as possible.

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

| PARAMETER      |                                      | TEST CONDITIONS                                                    |                                         | MIN | TYP | MAX | UNIT   |
|----------------|--------------------------------------|--------------------------------------------------------------------|-----------------------------------------|-----|-----|-----|--------|
| SR             | Slew rate at unity gain (see Note 5) | V <sub>I</sub> = 10 V,<br>C <sub>L</sub> = 100 pF,                 | R <sub>L</sub> = 10 kΩ,<br>See Figure 1 | 2   | 3.5 |     | V/μs   |
| t <sub>r</sub> | Rise time                            | V <sub>I</sub> = 20 V,<br>C <sub>L</sub> = 100 pF,<br>See Figure 1 | R <sub>L</sub> = 10 kΩ,<br>See Figure 1 | 0.2 |     |     | μs     |
|                | Overshoot factor                     |                                                                    |                                         | 10% |     |     |        |
| V <sub>n</sub> | Equivalent input noise voltage       | R <sub>S</sub> = 20 Ω,                                             | f = 1 kHz                               | 42  |     |     | nV/√Hz |

NOTE 5: Slew rate at  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  is 0.7 V/ $\mu\text{s}$  min.



**TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
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**electrical characteristics,  $V_{CC\pm} = \pm 15$  V,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)**

| PARAMETER                                                                     | TEST CONDITIONS <sup>†</sup>                                        | TL061Y<br>TL062Y<br>TL064Y |                 |     | UNIT                         |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------|----------------------------|-----------------|-----|------------------------------|
|                                                                               |                                                                     | MIN                        | TYP             | MAX |                              |
| $V_{IO}$ Input offset voltage                                                 | $V_O = 0$ , $R_S = 50\ \Omega$                                      |                            | 3               | 15  | mV                           |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage                | $V_O = 0$ , $R_S = 50\ \Omega$                                      |                            | 10              |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                 | $V_O = 0$                                                           |                            | 5               | 200 | pA                           |
| $I_{IB}$ Input bias current <sup>‡</sup>                                      | $V_O = 0$                                                           |                            | 30              | 400 | pA                           |
| $V_{ICR}$ Common-mode input voltage range                                     |                                                                     | $\pm 11$                   | –12<br>to<br>15 |     | V                            |
| $V_{OM}$ Maximum peak output voltage swing                                    | $R_L = 10\ \text{k}\Omega$                                          | $\pm 10$                   | $\pm 13.5$      |     | V                            |
| $A_{VD}$ Large-signal differential voltage amplification                      | $V_O = \pm 10$ V, $R_L \geq 2\ \text{k}\Omega$                      | 3                          | 6               |     | V/mV                         |
| $B_1$ Unity-gain bandwidth                                                    | $R_L = 10\ \text{k}\Omega$                                          |                            | 1               |     | MHz                          |
| $r_i$ Input resistance                                                        |                                                                     |                            | $10^{12}$       |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                              | $V_{IC} = V_{ICRmin}$ , $V_O = 0$ ,<br>$R_S = 50\ \Omega$           | 70                         | 86              |     | dB                           |
| $k_{SVR}$ Supply voltage rejection ratio ( $\Delta V_{CC\pm}/\Delta V_{IO}$ ) | $V_{CC} = \pm 9$ V to $\pm 15$ V, $V_O = 0$ ,<br>$R_S = 50\ \Omega$ | 70                         | 95              |     | dB                           |
| $P_D$ Total power dissipation (each amplifier)                                | $V_O = 0$ , No load                                                 |                            | 6               | 7.5 | mW                           |
| $I_{CC}$ Supply current (per amplifier)                                       | $V_O = 0$ , No load                                                 |                            | 200             | 250 | $\mu\text{A}$                |
| $V_{O1}/V_{O2}$ Crosstalk attenuation                                         | $A_{VD} = 100$                                                      |                            | 120             |     | dB                           |

<sup>†</sup> All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified.

<sup>‡</sup> Input bias currents of a FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive as shown in Figure 15. Pulse techniques are used to maintain the junction temperature as close to the ambient temperature as possible.

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

| PARAMETER                            | TEST CONDITIONS                                                             | TL061Y<br>TL062Y<br>TL064Y |     |     | UNIT                   |
|--------------------------------------|-----------------------------------------------------------------------------|----------------------------|-----|-----|------------------------|
|                                      |                                                                             | MIN                        | TYP | MAX |                        |
| SR Slew rate at unity gain           | $V_I = 10$ mV, $R_L = 10\ \text{k}\Omega$ ,<br>$C_L = 100$ pF, See Figure 1 | 1.5                        | 3.5 |     | V/ $\mu\text{s}$       |
| $t_r$ Rise time                      | $V_I = 20$ V, $R_L = 10\ \text{k}\Omega$ ,<br>$C_L = 100$ pF, See Figure 1  |                            | 0.2 |     | $\mu\text{s}$          |
| Overshoot factor                     |                                                                             |                            | 10% |     |                        |
| $V_n$ Equivalent input noise voltage | $R_S = 20\ \Omega$ , $f = 1$ kHz                                            |                            | 42  |     | nV/ $\sqrt{\text{Hz}}$ |

## PARAMETER MEASUREMENT INFORMATION

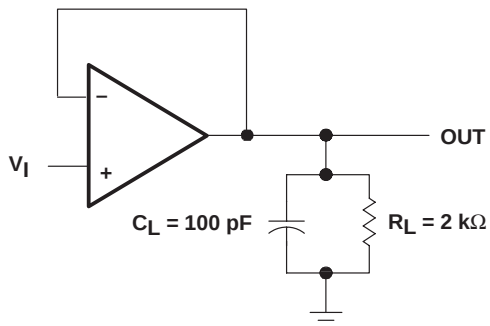


Figure 1. Unity-Gain Amplifier

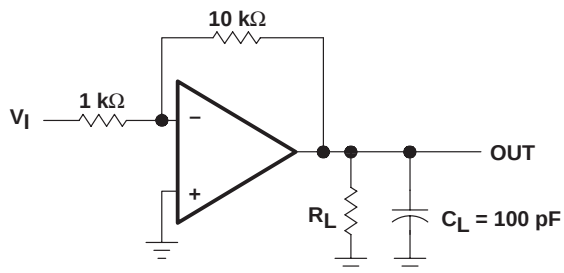


Figure 2. Gain-of-10 Inverting Amplifier

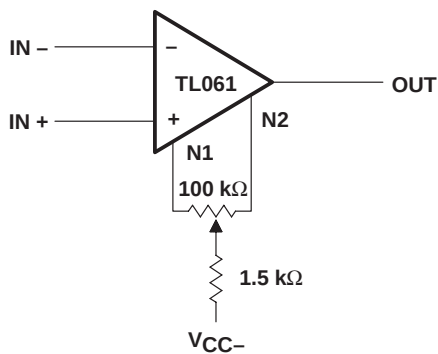


Figure 3. Input Offset-Voltage Null Circuit

## TYPICAL CHARACTERISTICS

**Table of Graphs**

|                                                              | FIGURE |
|--------------------------------------------------------------|--------|
| Maximum peak output voltage vs Supply voltage                | 4      |
| Maximum peak output voltage vs Free-air temperature          | 5      |
| Maximum peak output voltage vs Load resistance               | 6      |
| Maximum peak output voltage vs Frequency                     | 7      |
| Differential voltage amplification vs Free-air temperature   | 8      |
| Large-signal differential voltage amplification vs Frequency | 9      |
| Phase shift vs Frequency                                     | 9      |
| Supply current vs Supply voltage                             | 10     |
| Supply current vs Free-air temperature                       | 11     |
| Total power dissipation vs Free-air temperature              | 12     |
| Common-mode rejection ratio vs Free-air temperature          | 13     |
| Normalized unity-gain bandwidth vs Free-air temperature      | 14     |
| Normalized slew rate vs Free-air temperature                 | 14     |
| Normalized phase shift vs Free-air temperature               | 14     |
| Input bias current vs Free-air temperature                   | 15     |
| Voltage-follower large-signal pulse response vs Time         | 16     |
| Output voltage vs Elapsed time                               | 17     |
| Equivalent input noise voltage vs Frequency                  | 18     |

TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
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TYPICAL CHARACTERISTICS†

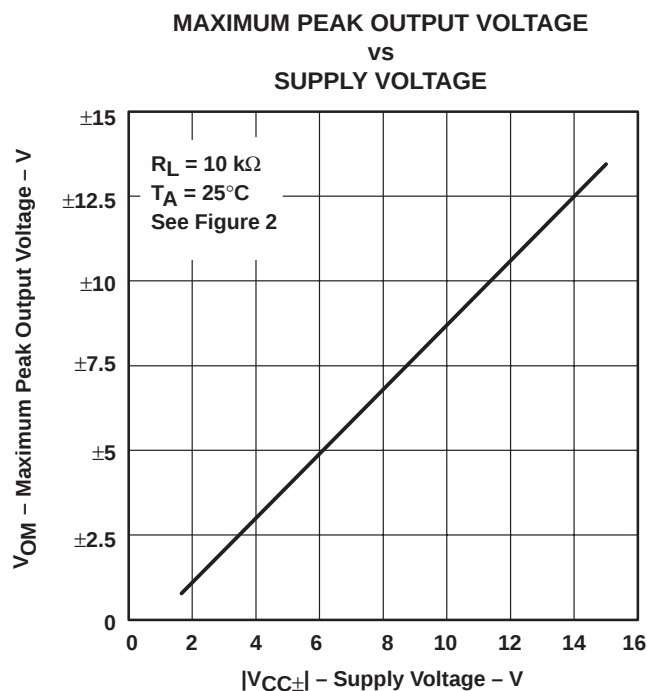


Figure 4

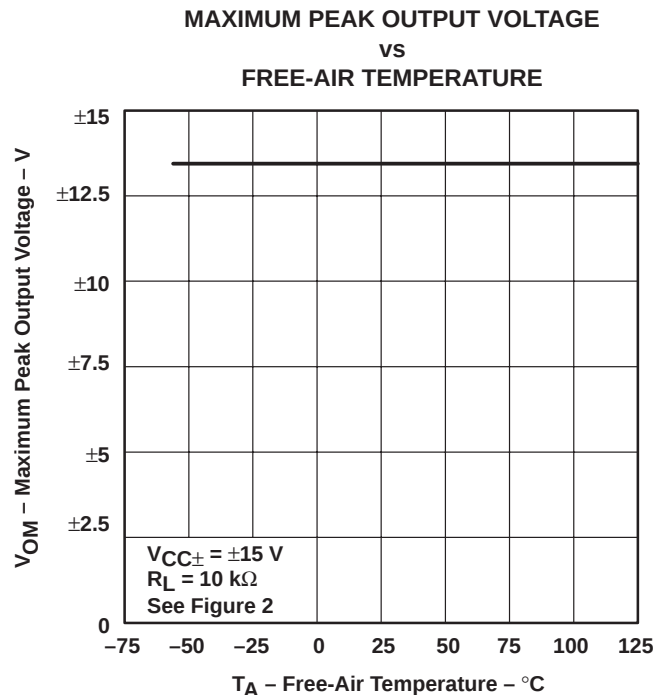


Figure 5

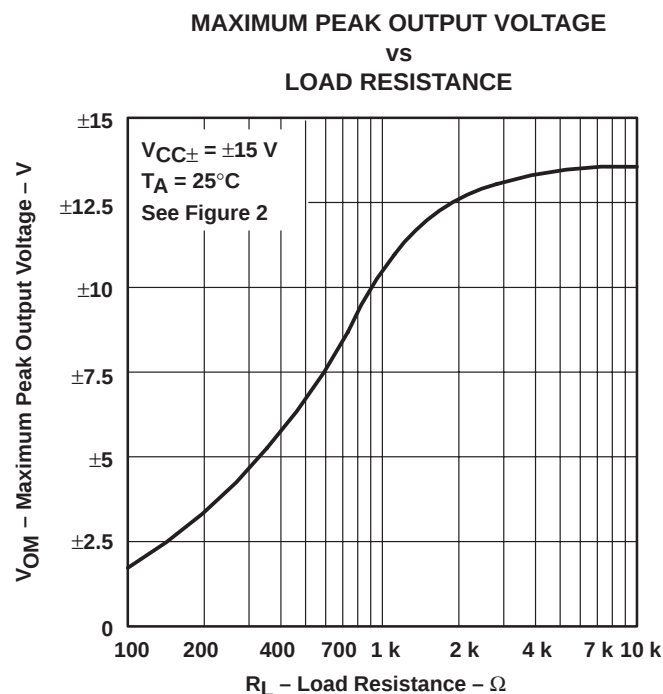


Figure 6

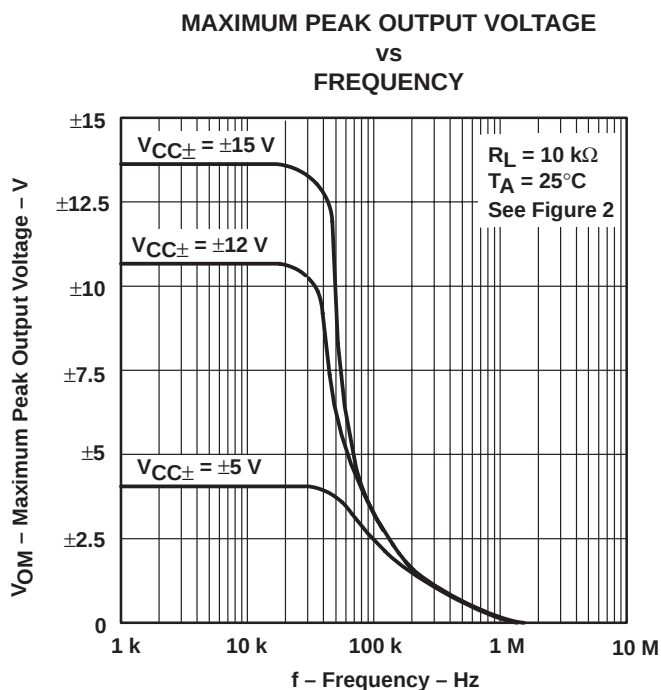


Figure 7

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

# TYPICAL CHARACTERISTICS†

## DIFFERENTIAL VOLTAGE AMPLIFICATION VS FREE-AIR TEMPERATURE

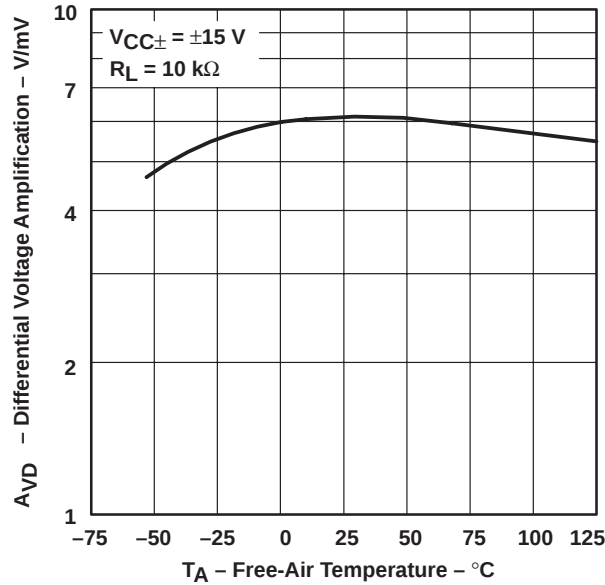


Figure 8

## LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE SHIFT VS FREQUENCY

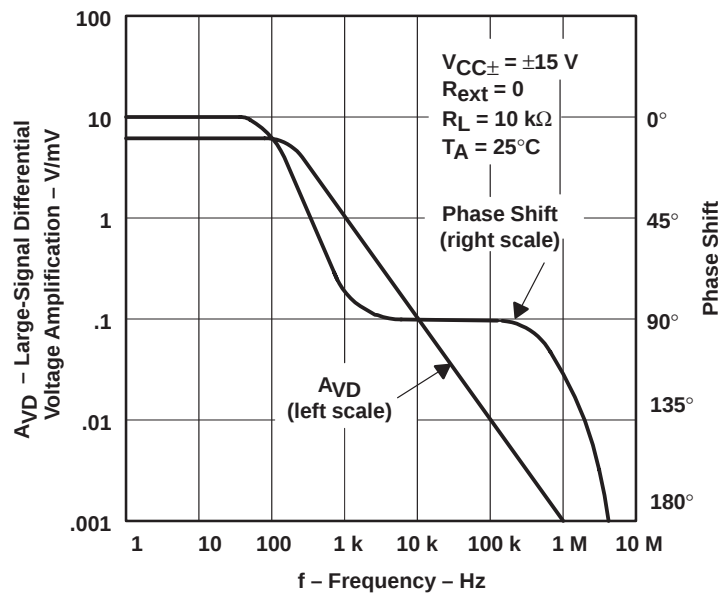


Figure 9

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

TL061, TL061A, TL061B, TL061Y, TL062, TL062A  
 TL062B, TL062Y, TL064, TL064A, TL064B, TL064Y  
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TYPICAL CHARACTERISTICS†

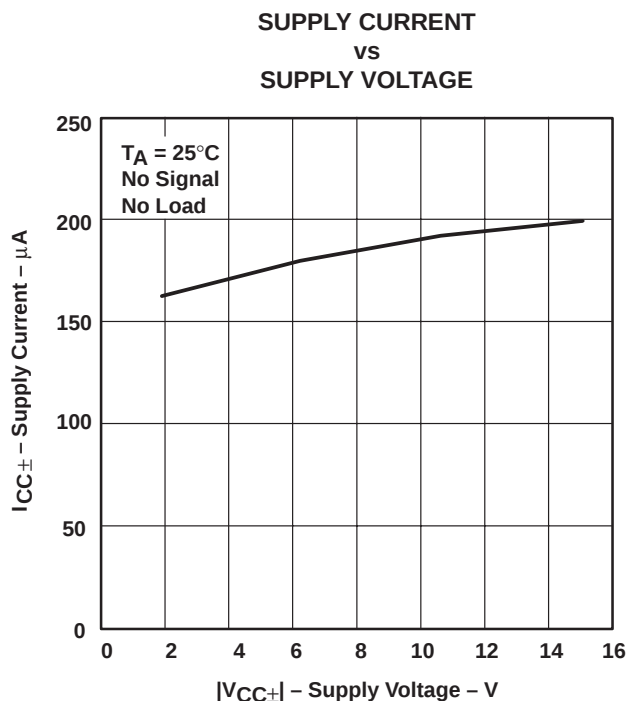


Figure 10

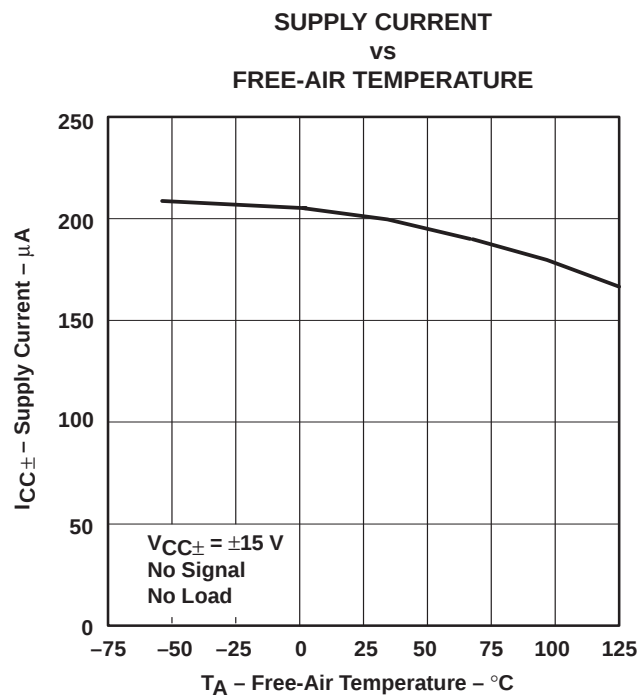


Figure 11

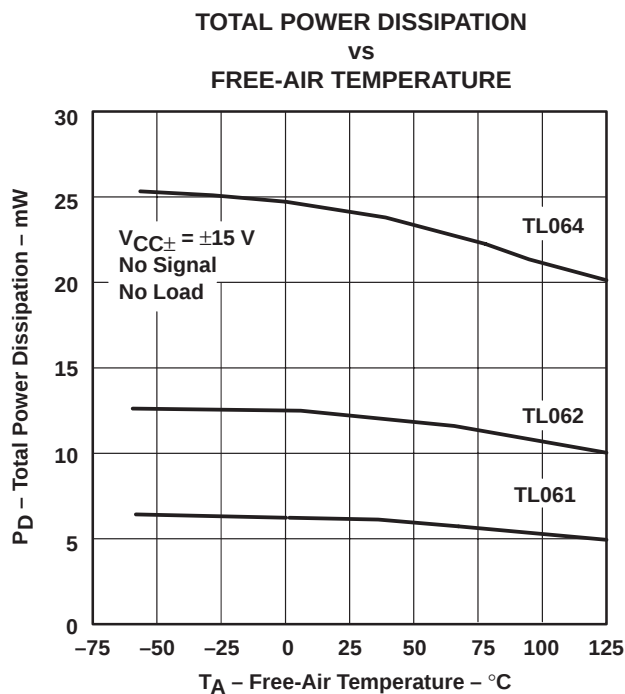


Figure 12

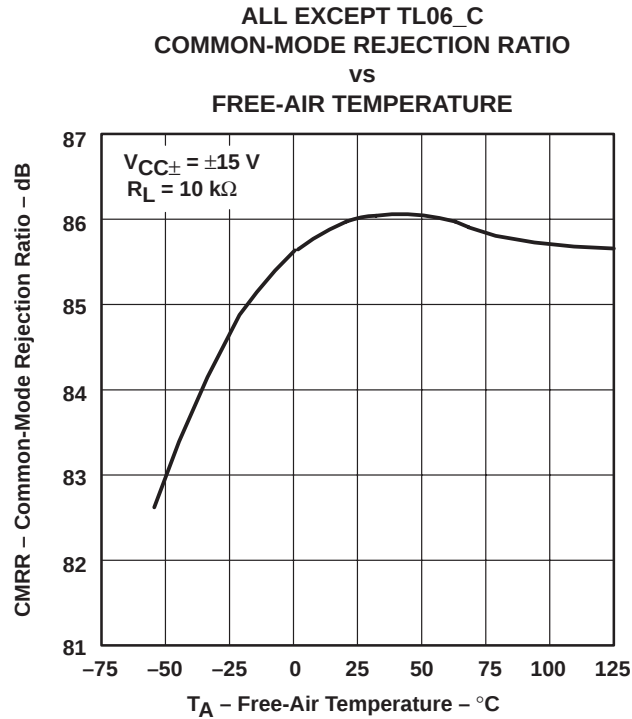


Figure 13

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

## TYPICAL CHARACTERISTICS

NORMALIZED UNITY-GAIN BANDWIDTH,  
 SLEW RATE, AND PHASE SHIFT  
 VS  
 FREE-AIR TEMPERATURE

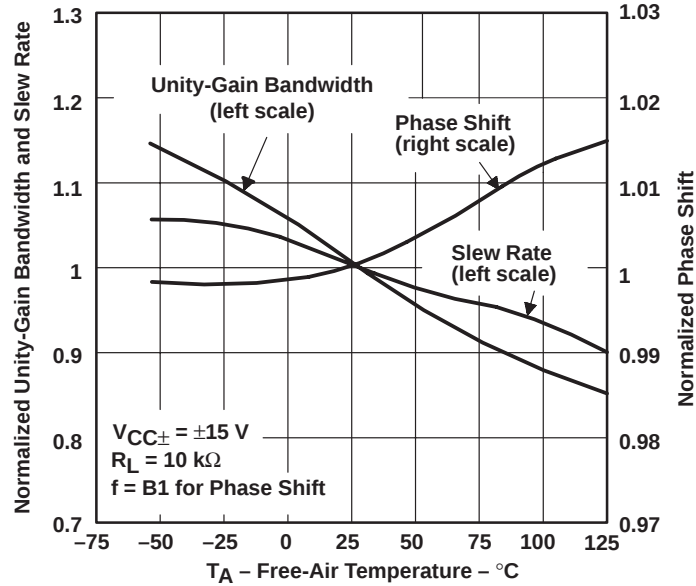


Figure 14

INPUT BIAS CURRENT  
 VS  
 FREE-AIR TEMPERATURE

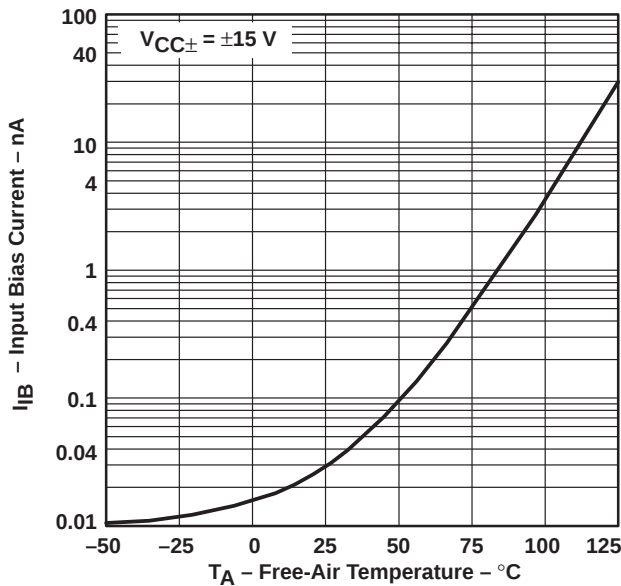


Figure 15

VOLTAGE-FOLLOWER  
 LARGE-SIGNAL PULSE RESPONSE  
 VS  
 TIME

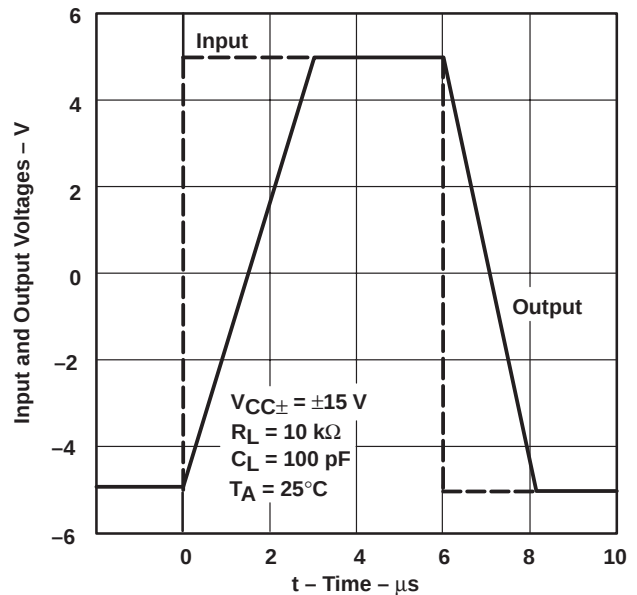


Figure 16

TYPICAL CHARACTERISTICS

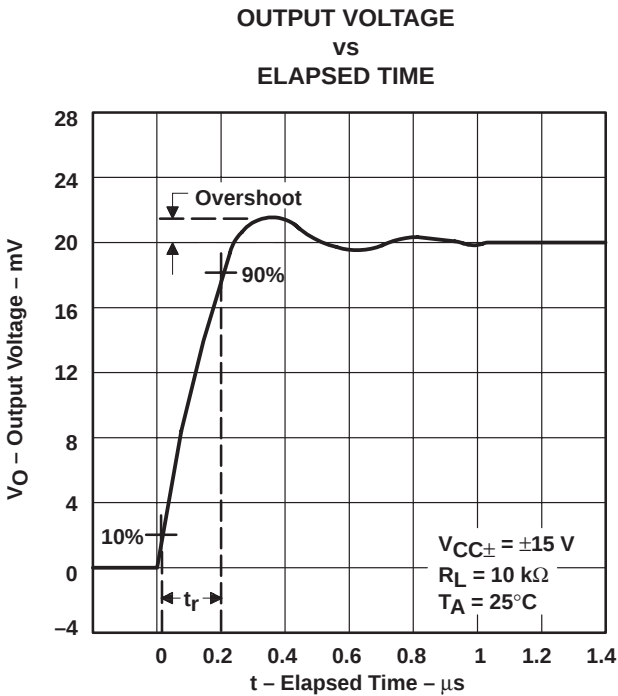


Figure 17

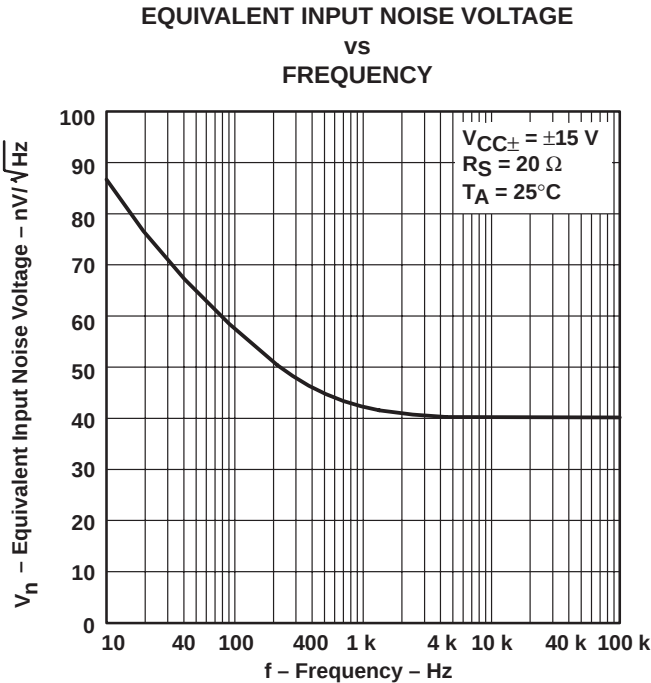


Figure 18

## APPLICATION INFORMATION

Table of Application Diagrams

| APPLICATION DIAGRAM                       | PART NUMBER | FIGURE |
|-------------------------------------------|-------------|--------|
| Instrumentation amplifier                 | TL064       | 19     |
| 0.5-Hz square-wave oscillator             | TL061       | 20     |
| High-Q notch filter                       | TL061       | 21     |
| Audio-distribution amplifier              | TL064       | 22     |
| Low-level light detector preamplifier     | TL061       | 23     |
| AC amplifier                              | TL061       | 24     |
| Microphone preamplifier with tone control | TL061       | 25     |
| Instrumentation amplifier                 | TL062       | 26     |
| IC preamplifier                           | TL062       | 27     |

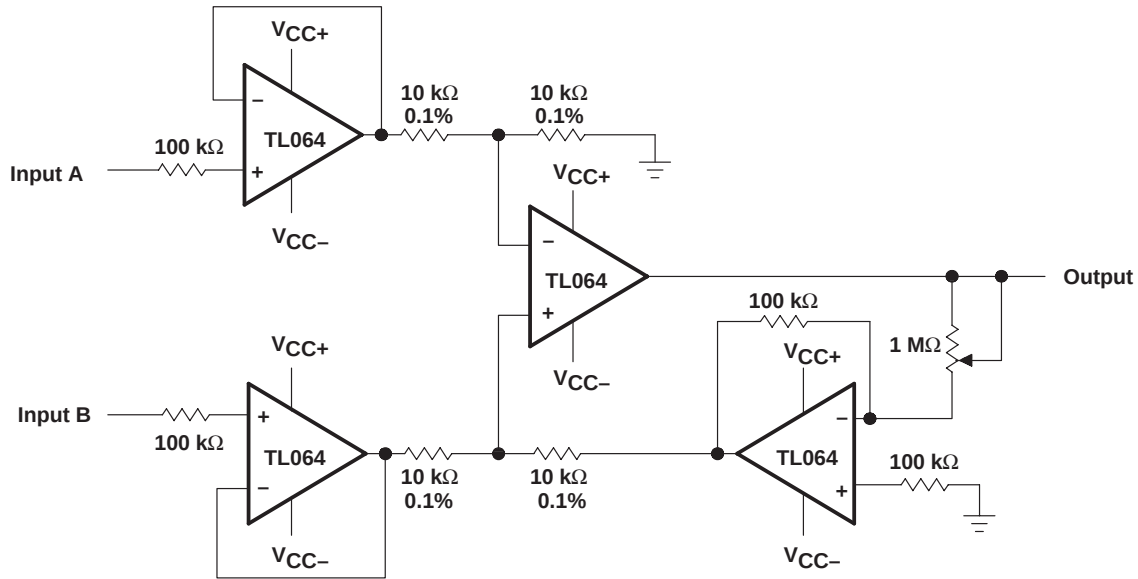


Figure 19. Instrumentation Amplifier

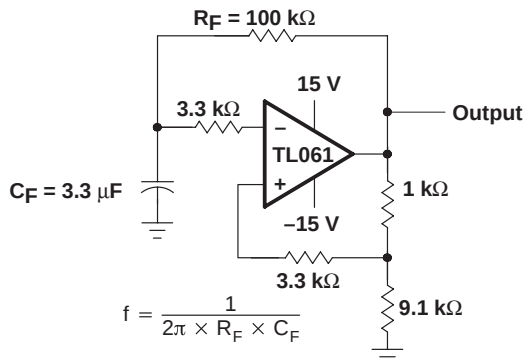


Figure 20. 0.5-Hz Square-Wave Oscillator

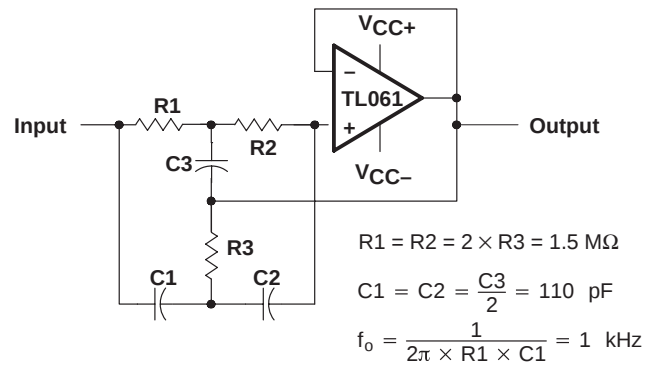


Figure 21. High-Q Notch Filter

## APPLICATION INFORMATION

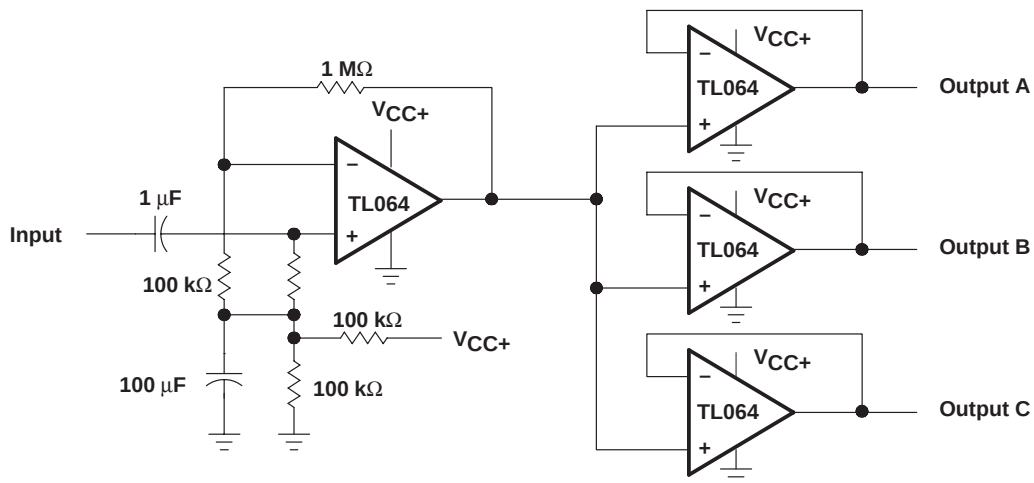


Figure 22. Audio-Distribution Amplifier

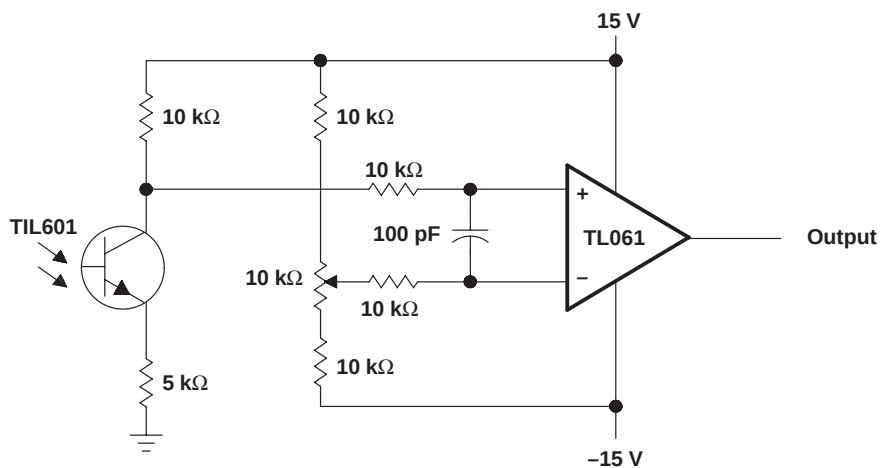


Figure 23. Low-Level Light Detector Preamplifier

## APPLICATION INFORMATION

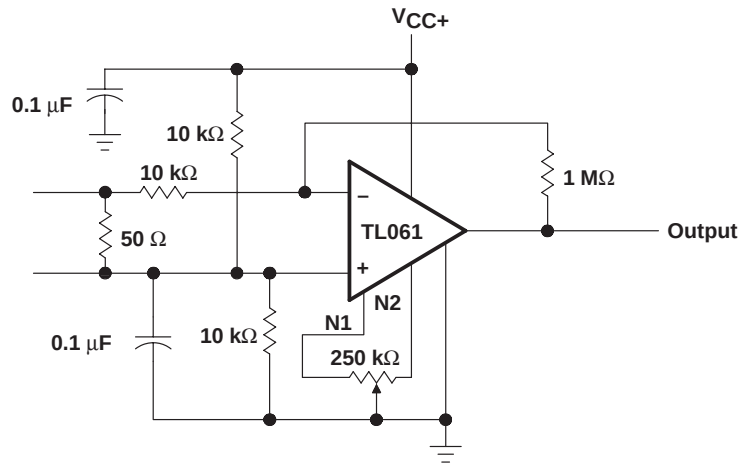


Figure 24. AC Amplifier

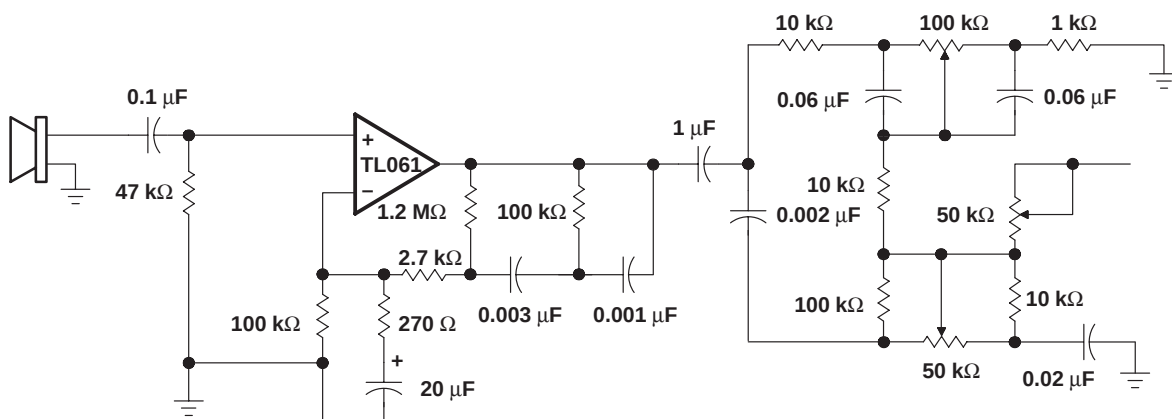


Figure 25. Microphone Preamplifier With Tone Control

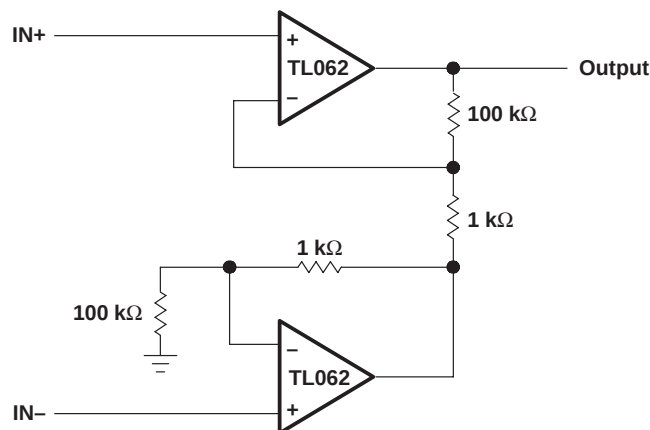


Figure 26. Instrumentation Amplifier

## APPLICATION INFORMATION

### IC PREAMPLIFIER RESPONSE CHARACTERISTICS

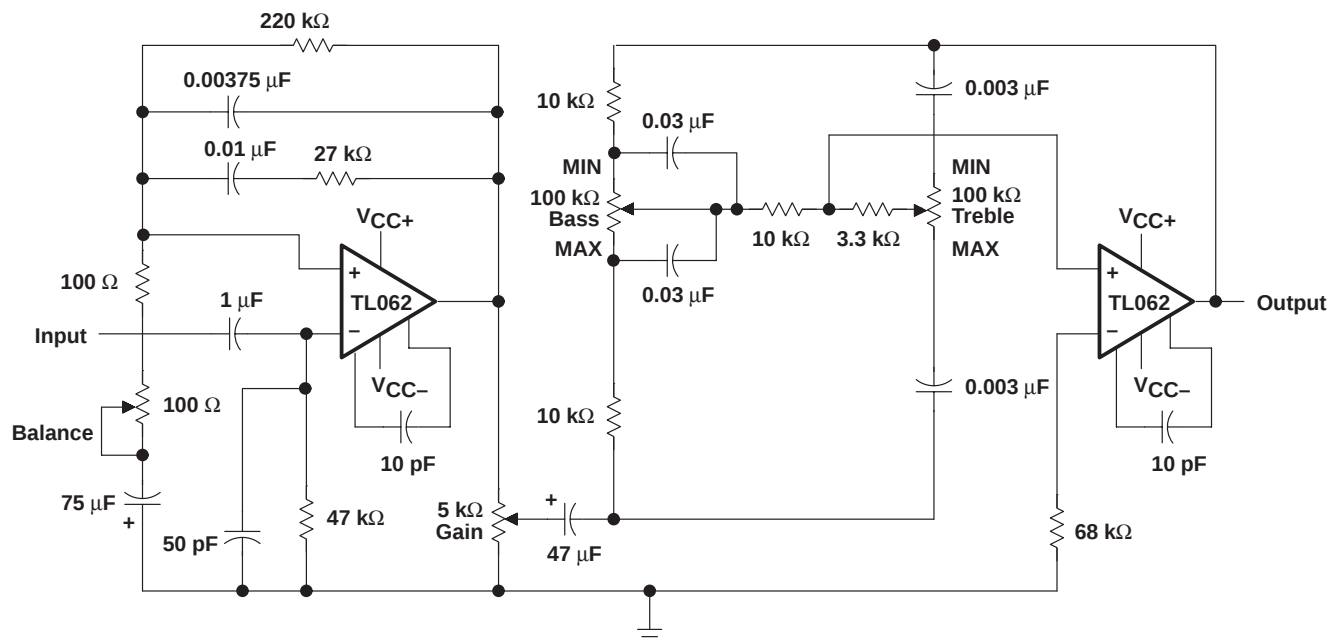
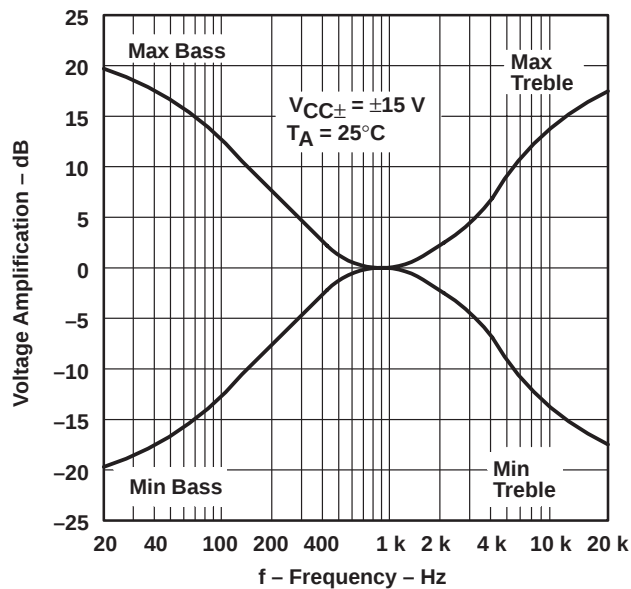


Figure 27. IC Preamplifier

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