

## Low noise JFET quad operational amplifier

### Features

- Wide common-mode (up to  $V_{CC}^+$ ) and differential voltage range
- Low input bias and offset current
- Low noise  $e_n = 15 \text{ nV}/\sqrt{\text{Hz}}$  (typ)
- Output short-circuit protection
- High input impedance JFET input stage
- Low harmonic distortion : 0.01% (typical)
- Internal frequency compensation
- Latch up free operation
- High slew rate: 16 V/ $\mu\text{s}$  (typical)

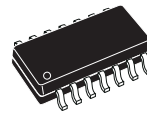
### Description

The TL074, TL074A and TL074B are high-speed JFET input single operational amplifiers. Each of these JFET input operational amplifiers incorporates well matched, high-voltage JFET and bipolar transistors in a monolithic integrated circuit.

The devices feature high slew rates, low input bias and offset currents, and low offset voltage temperature coefficient.

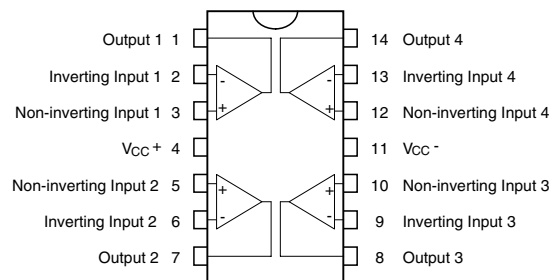


**N**  
**DIP14**  
(Plastic package)



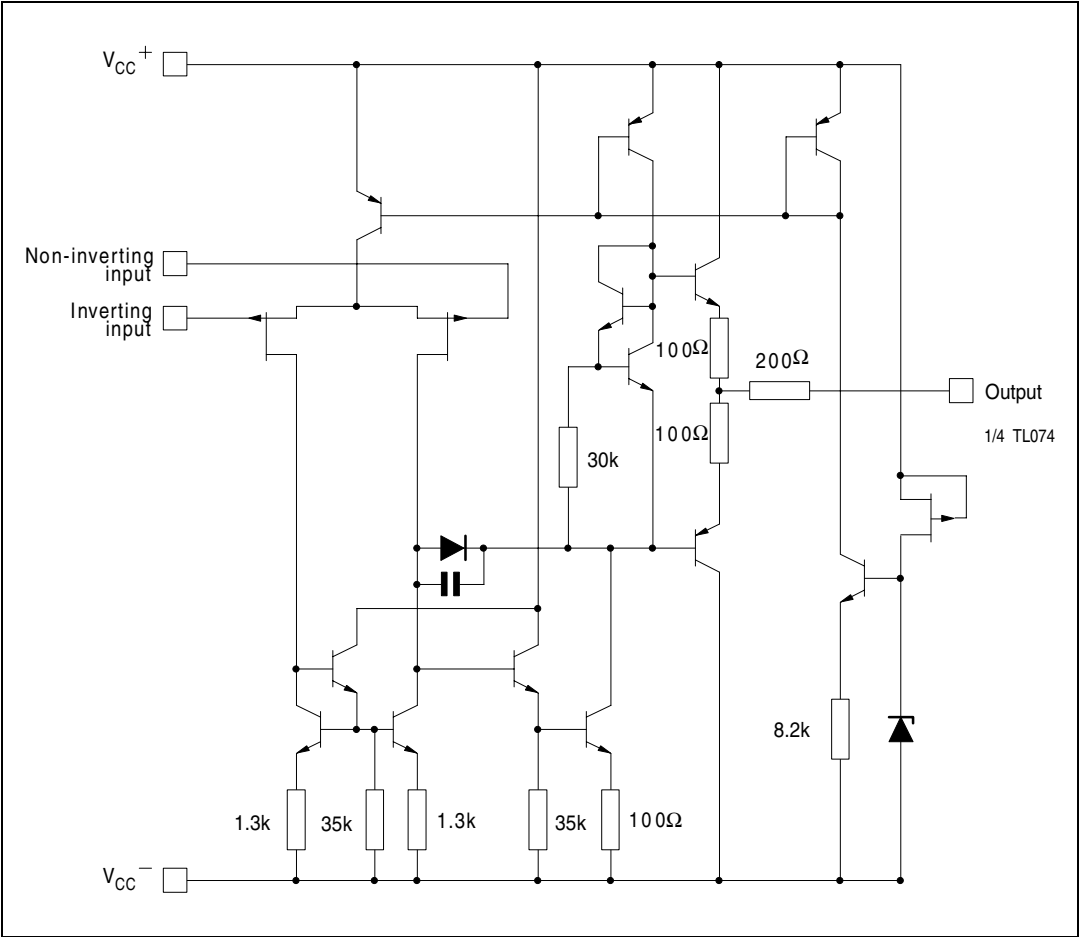
**D**  
**SO-14**  
(Plastic micropackage)

### Pin connections (Top view)



# 1 Schematic diagram

Figure 1. Circuit schematics



## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol            | Parameter                                                 | Value          |                | Unit |
|-------------------|-----------------------------------------------------------|----------------|----------------|------|
|                   |                                                           | TL074I, AI, BI | TL074C, AC, BC |      |
| V <sub>CC</sub>   | Supply voltage <sup>(1)</sup>                             | ±18            |                | V    |
| V <sub>i</sub>    | Input voltage <sup>(2)</sup>                              | ±15            |                | V    |
| V <sub>id</sub>   | Differential input voltage <sup>(3)</sup>                 | ±30            |                | V    |
| P <sub>tot</sub>  | Power dissipation                                         | 680            |                | mW   |
| R <sub>thja</sub> | Thermal resistance junction to ambient <sup>(4) (5)</sup> |                |                | °C/W |
|                   | DIP14                                                     | 80             |                |      |
|                   | SO-14                                                     | 105            |                |      |
| R <sub>thjc</sub> | Thermal resistance junction to case <sup>(4) (5)</sup>    |                |                | °C/W |
|                   | DIP14                                                     | 33             |                |      |
|                   | SO-14                                                     | 31             |                |      |
|                   | Output short-circuit duration <sup>(6)</sup>              | Infinite       |                |      |
| T <sub>oper</sub> | Operating free-air temperature range                      | -40 to +105    | 0 to +70       | °C   |
| T <sub>stg</sub>  | Storage temperature range                                 | -65 to +150    |                | °C   |
| ESD               | HBM: human body model <sup>(7)</sup>                      | 1              |                | kV   |
|                   | MM: machine model <sup>(8)</sup>                          | 200            |                | V    |
|                   | CDM: charged device model <sup>(9)</sup>                  | 1.5            |                | kV   |

1. All voltage values, except differential voltage, are with respect to the zero reference level (ground) of the supply voltages where the zero reference level is the midpoint between  $V_{CC}^{+}$  and  $V_{CC}^{-}$ .
2. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 volts, whichever is less.
3. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
4. Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
5.  $R_{th}$  are typical values.
6. 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.
7. Human body model: 100pF discharged through a 1.5k $\Omega$  resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
8. Machine model: a 200pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 $\Omega$ ), done for all couples of pin combinations with other pins floating.
9. Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

**Table 2. Operating conditions**

| Symbol     | Parameter                            | TL074I, AI, BI | TL074C, AC, BC | Unit               |
|------------|--------------------------------------|----------------|----------------|--------------------|
| $V_{CC}$   | Supply voltage                       | 6 to 36        |                | V                  |
| $T_{oper}$ | Operating free-air temperature range | -40 to +105    | 0 to +70       | $^{\circ}\text{C}$ |

### 3 Electrical characteristics

Table 3.  $V_{CC} = \pm 15V$ ,  $T_{amb} = +25^{\circ}C$  (unless otherwise specified)

| Symbol        | Parameter                                                      | TL074I, AC, AI, BC, BI |            |      | TL074C   |            |      | Unit              |
|---------------|----------------------------------------------------------------|------------------------|------------|------|----------|------------|------|-------------------|
|               |                                                                | Min.                   | Typ.       | Max. | Min.     | Typ.       | Max. |                   |
| $V_{io}$      | Input offset voltage ( $R_S = 50\Omega$ )                      |                        |            |      |          |            |      |                   |
|               | $T_{amb} = +25^{\circ}C$                                       |                        | 3          | 10   |          | 3          | 10   |                   |
|               | TL074                                                          |                        | 3          | 6    |          |            |      |                   |
|               | TL074A                                                         |                        | 1          | 3    |          |            |      |                   |
|               | TL074B                                                         |                        |            | 13   |          |            | 13   | mV                |
|               | $T_{min} \leq T_{amb} \leq T_{max}$                            |                        |            | 7    |          |            |      |                   |
|               | TL074A                                                         |                        |            | 5    |          |            |      |                   |
|               | TL074B                                                         |                        |            |      |          |            |      |                   |
| $DV_{io}$     | Input offset voltage drift                                     |                        | 10         |      |          | 10         |      | $\mu V/^{\circ}C$ |
| $I_{io}$      | Input offset current                                           |                        |            |      |          |            |      |                   |
|               | $T_{amb} = +25^{\circ}C$                                       |                        | 5          | 100  |          | 5          | 100  | pA                |
|               | $T_{min} \leq T_{amb} \leq T_{max}$                            |                        |            | 4    |          |            | 10   | nA                |
| $I_{ib}$      | Input bias current -note <sup>(1)</sup>                        |                        |            |      |          |            |      |                   |
|               | $T_{amb} = +25^{\circ}C$                                       |                        | 20         | 200  |          | 30         | 200  | pA                |
|               | $T_{min} \leq T_{amb} \leq T_{max}$                            |                        |            | 20   |          |            | 20   | nA                |
| $A_{vd}$      | Large signal voltage gain $R_L = 2k\Omega$ , $V_O = \pm 10V$   |                        |            |      |          |            |      |                   |
|               | $T_{amb} = +25^{\circ}C$                                       | 50                     | 200        |      | 25       | 200        |      | V/mV              |
|               | $T_{min} \leq T_{amb} \leq T_{max}$                            | 25                     |            |      | 15       |            |      |                   |
| SVR           | Supply voltage rejection ratio ( $R_S = 50\Omega$ )            |                        |            |      |          |            |      |                   |
|               | $T_{amb} = +25^{\circ}C$                                       | 80                     | 86         |      | 70       | 86         |      | dB                |
|               | $T_{min} \leq T_{amb} \leq T_{max}$                            | 80                     |            |      | 70       |            |      |                   |
| $I_{CC}$      | Supply current, no load                                        |                        |            |      |          |            |      |                   |
|               | $T_{amb} = +25^{\circ}C$                                       |                        | 1.4        | 2.5  |          | 1.4        | 2.5  | mA                |
|               | $T_{min} \leq T_{amb} \leq T_{max}$                            |                        |            | 2.5  |          |            | 2.5  |                   |
| $V_{icm}$     | Input common mode voltage range                                | $\pm 11$               | +15<br>-12 |      | $\pm 11$ | +15<br>-12 |      | V                 |
| CMR           | Common mode rejection ratio ( $R_S = 50\Omega$ )               |                        |            |      |          |            |      |                   |
|               | $T_{amb} = +25^{\circ}C$                                       | 80                     | 86         |      | 70       | 86         |      | dB                |
|               | $T_{min} \leq T_{amb} \leq T_{max}$                            | 80                     |            |      | 70       |            |      |                   |
| $I_{os}$      | Output short-circuit current                                   |                        |            |      |          |            |      |                   |
|               | $T_{amb} = +25^{\circ}C$                                       | 10                     | 40         | 60   | 10       | 40         | 60   | mA                |
|               | $T_{min} \leq T_{amb} \leq T_{max}$                            | 10                     |            | 60   | 10       |            | 60   |                   |
| $\pm V_{opp}$ | Output voltage swing                                           |                        |            |      |          |            |      |                   |
|               | $T_{amb} = +25^{\circ}C$                                       |                        |            |      |          |            |      |                   |
|               | $RL = 2k\Omega$                                                | 10                     | 12         |      | 10       | 12         |      | V                 |
|               | $RL = 10k\Omega$                                               | 12                     | 13.5       |      | 12       | 13.5       |      |                   |
|               | $T_{min} \leq T_{amb} \leq T_{max}$                            |                        |            |      |          |            |      |                   |
|               | $RL = 2k\Omega$                                                | 10                     |            |      | 10       |            |      |                   |
|               | $RL = 10k\Omega$                                               | 12                     |            |      | 12       |            |      |                   |
| SR            | Slew rate                                                      |                        |            |      |          |            |      |                   |
|               | $V_{in} = 10V$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , unity gain | 8                      | 13         |      | 8        | 13         |      | V/ $\mu s$        |

Table 3.  $V_{CC} = \pm 15V$ ,  $T_{amb} = +25^{\circ}C$  (unless otherwise specified) (continued)

| Symbol          | Parameter                                                                                                   | TL074I, AC, AI, BC, BI |           |      | TL074C |           |      | Unit                   |
|-----------------|-------------------------------------------------------------------------------------------------------------|------------------------|-----------|------|--------|-----------|------|------------------------|
|                 |                                                                                                             | Min.                   | Typ.      | Max. | Min.   | Typ.      | Max. |                        |
| $t_r$           | Rise time<br>$V_{in} = 20mV$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , unity gain                                |                        | 0.1       |      |        | 0.1       |      | $\mu s$                |
| $K_{ov}$        | Overshoot<br>$V_{in} = 20mV$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , unity gain                                |                        | 10        |      |        | 10        |      | %                      |
| GBP             | Gain bandwidth product<br>$V_{in} = 10mV$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , $f = 100kHz$                 | 2                      | 3         |      | 2      | 3         |      | MHz                    |
| $R_i$           | Input resistance                                                                                            |                        | $10^{12}$ |      |        | $10^{12}$ |      | $\Omega$               |
| THD             | Total harmonic distortion<br>$f = 1kHz$ , $R_L = 2k\Omega$ , $C_L = 100pF$ , $A_v = 20dB$ , $V_o = 2V_{pp}$ |                        | 0.01      |      |        | 0.01      |      | %                      |
| $e_n$           | Equivalent input noise voltage<br>$R_S = 100\Omega$ , $f = 1kHz$                                            |                        | 15        |      |        | 15        |      | $\frac{nV}{\sqrt{Hz}}$ |
| $\phi_m$        | Phase margin                                                                                                |                        | 45        |      |        | 45        |      | degrees                |
| $V_{o1}/V_{o2}$ | Channel separation<br>$A_v = 100$                                                                           |                        | 120       |      |        | 120       |      | dB                     |

1. The input bias currents are junction leakage currents which approximately double for every  $10^{\circ}C$  increase in the junction temperature.

Figure 2. Maximum peak-to-peak output voltage versus frequency

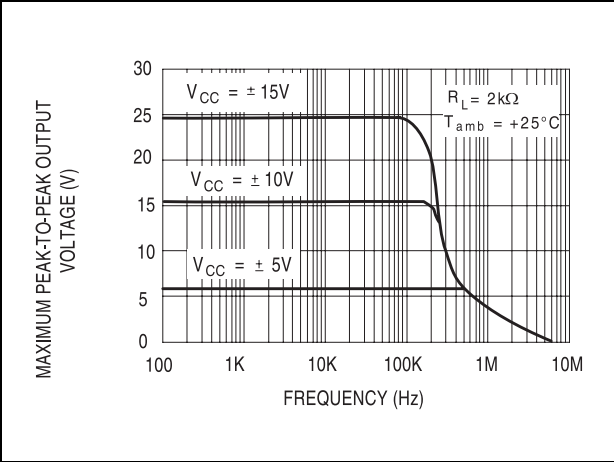


Figure 3. Maximum peak-to-peak output voltage versus frequency

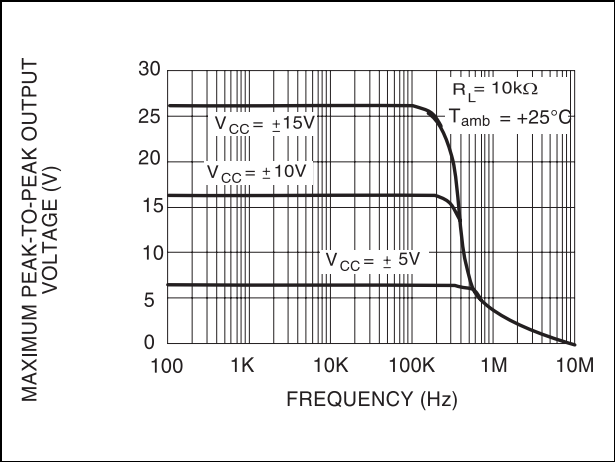


Figure 4. Maximum peak-to-peak output voltage versus frequency

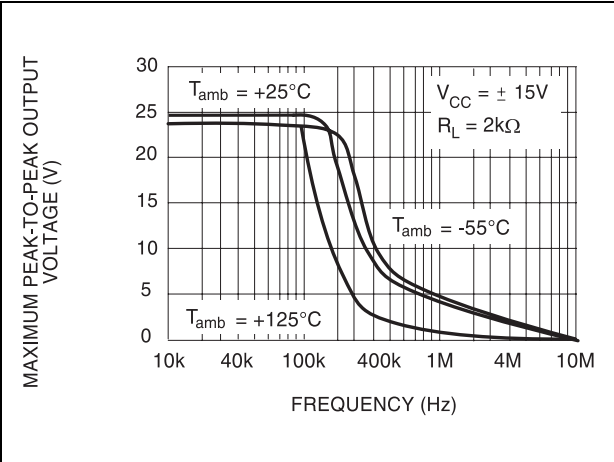


Figure 5. Maximum peak-to-peak output voltage versus free air temperature

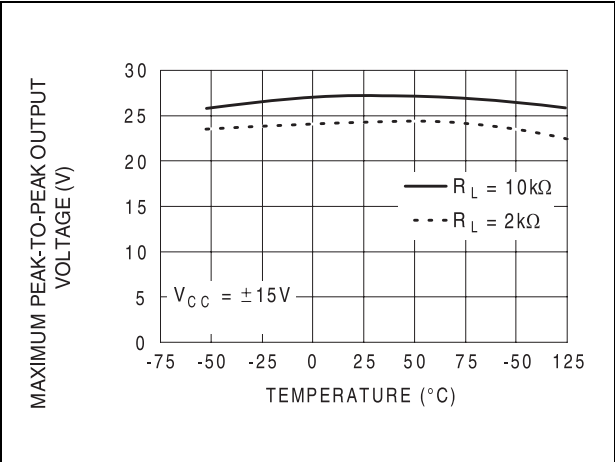


Figure 6. Maximum peak-to-peak output voltage versus load resistance

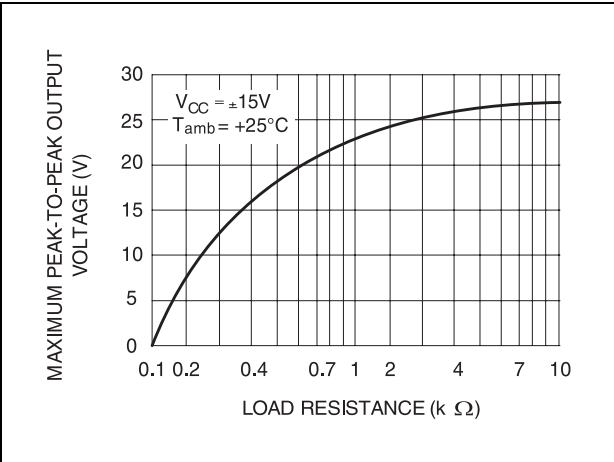


Figure 7. Maximum peak-to-peak output voltage versus supply voltage

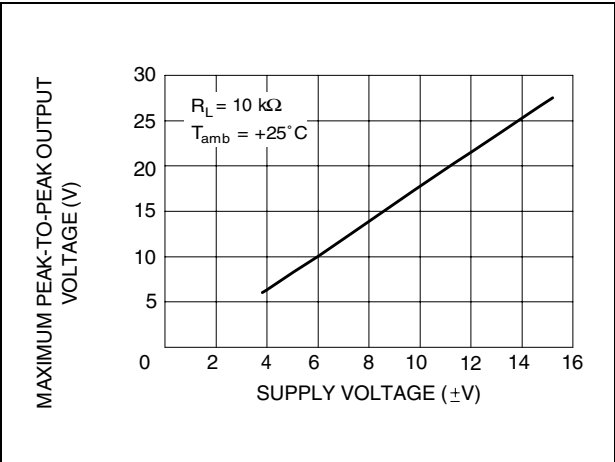


Figure 8. Input bias current versus free air temperature

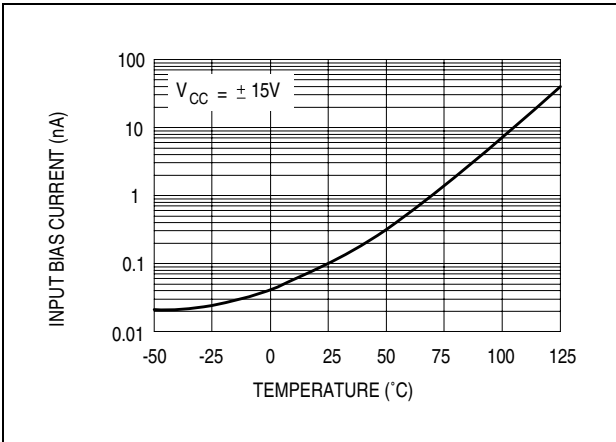


Figure 9. Large signal differential voltage amplification versus free air temperature

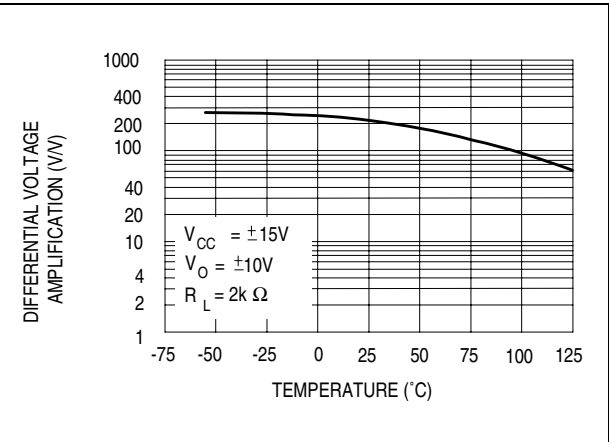


Figure 10. Large signal differential voltage amplification and phase shift versus frequency

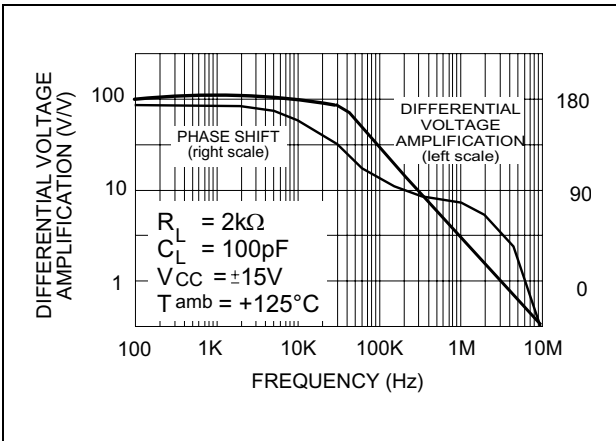


Figure 11. Total power dissipation versus free air temperature

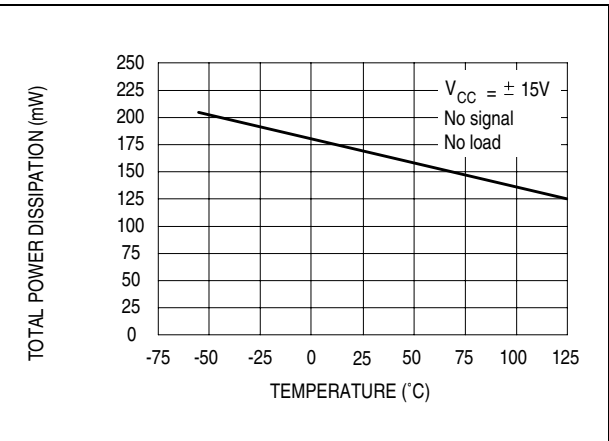


Figure 12. Supply current per amplifier versus free air temperature

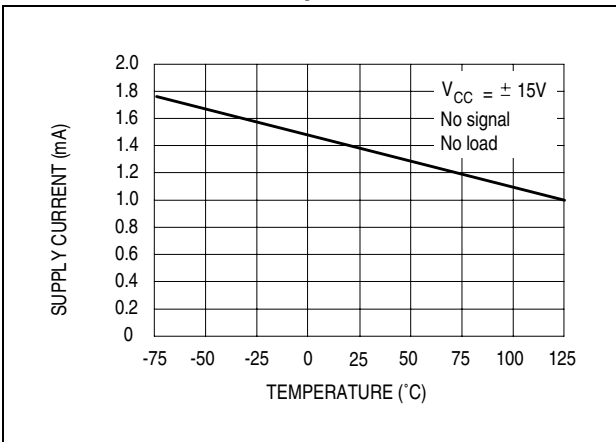


Figure 13. Common mode rejection ratio versus free air temperature

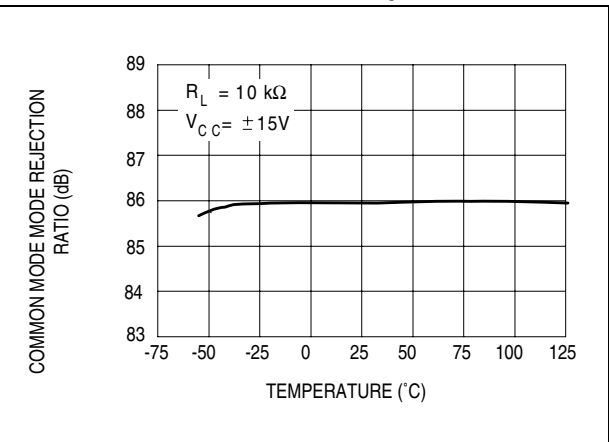


Figure 14. Voltage follower large signal pulse response

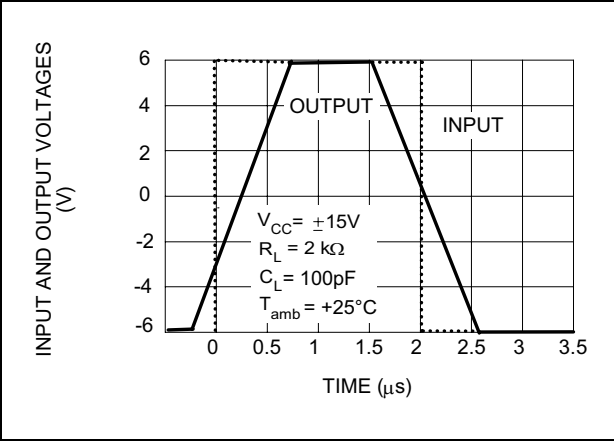


Figure 15. Output voltage versus elapsed time response

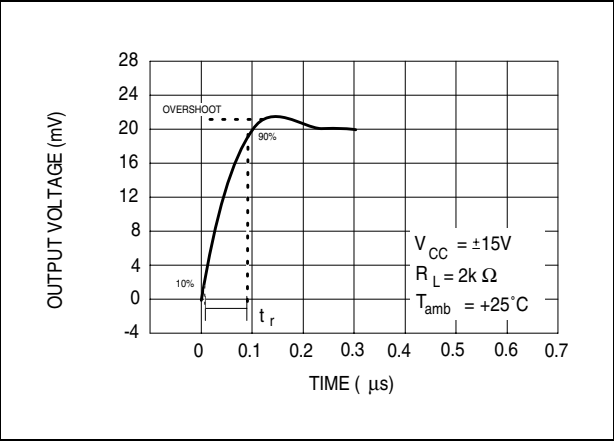


Figure 16. Equivalent input noise voltage versus frequency

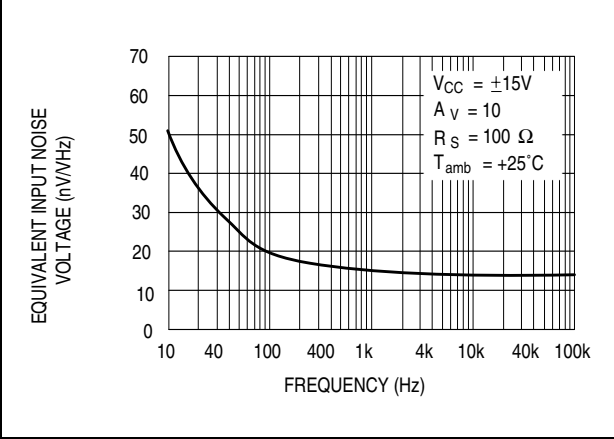
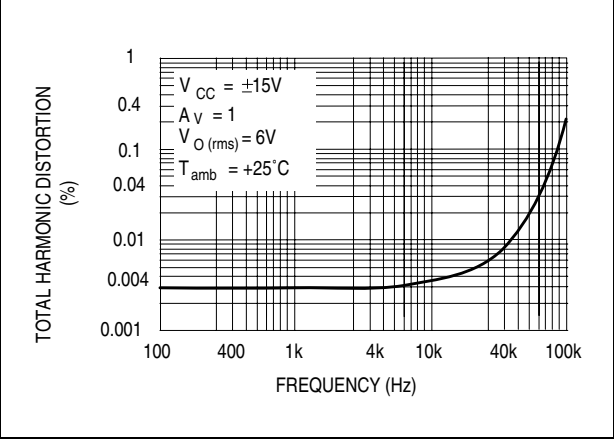
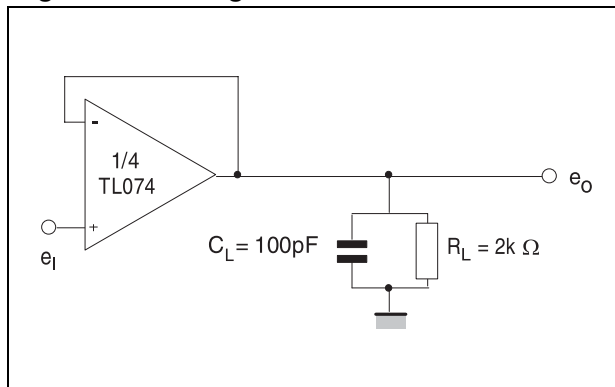
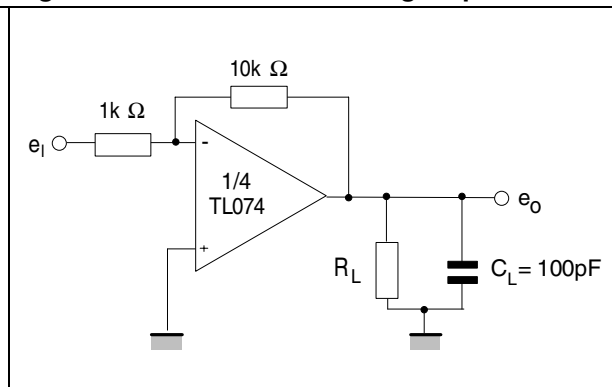


Figure 17. Total harmonic distortion versus frequency



## 4 Parameter measurement information

**Figure 18. Voltage follower****Figure 19. Gain-of-10 inverting amplifier**

## 5 Typical applications

Figure 20. Audio distribution amplifier

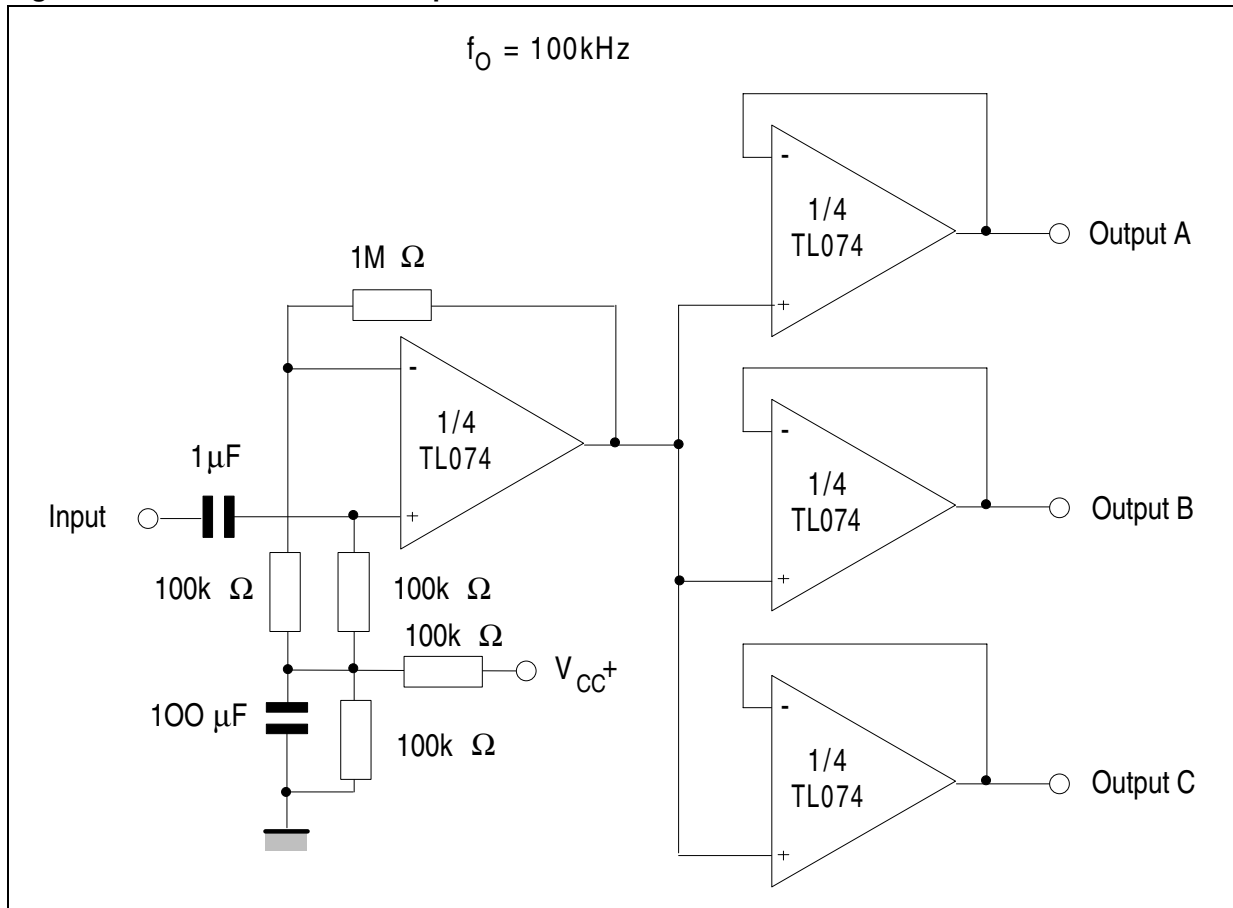


Figure 21. Positive feedback bandpass filter

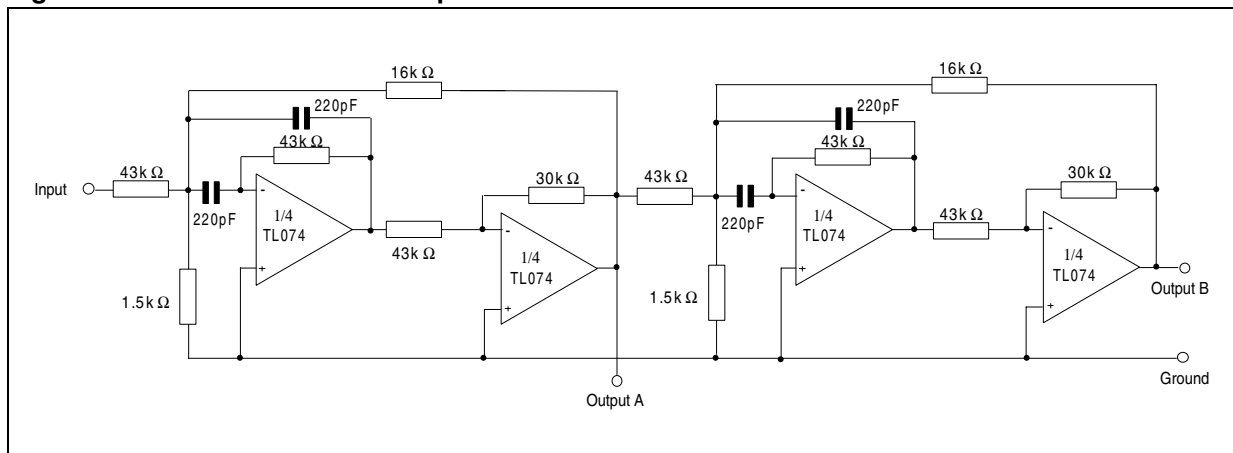
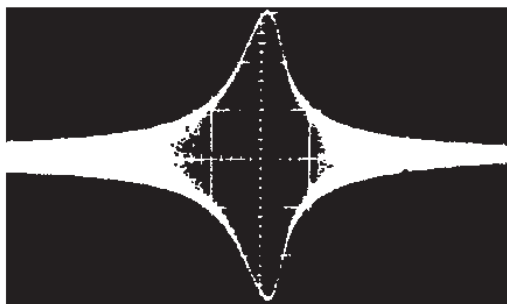
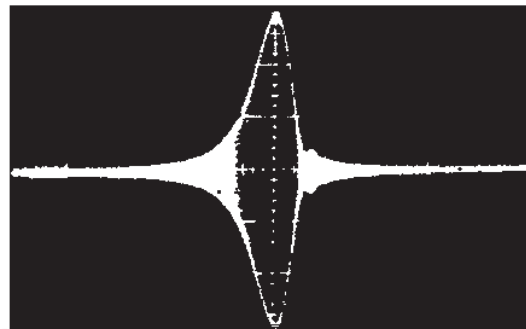


Figure 22. Output A



**SECOND ORDER BANDPASS FILTER**  
fo = 100 kHz; Q = 30; Gain = 16

Figure 23. Output B



**CASCADED BANDPASS FILTER**  
fo = 100 kHz; Q = 69; Gain = 16

## 6 Package information

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

### 6.1 DIP14 package information

Figure 24. DIP14 package mechanical drawing

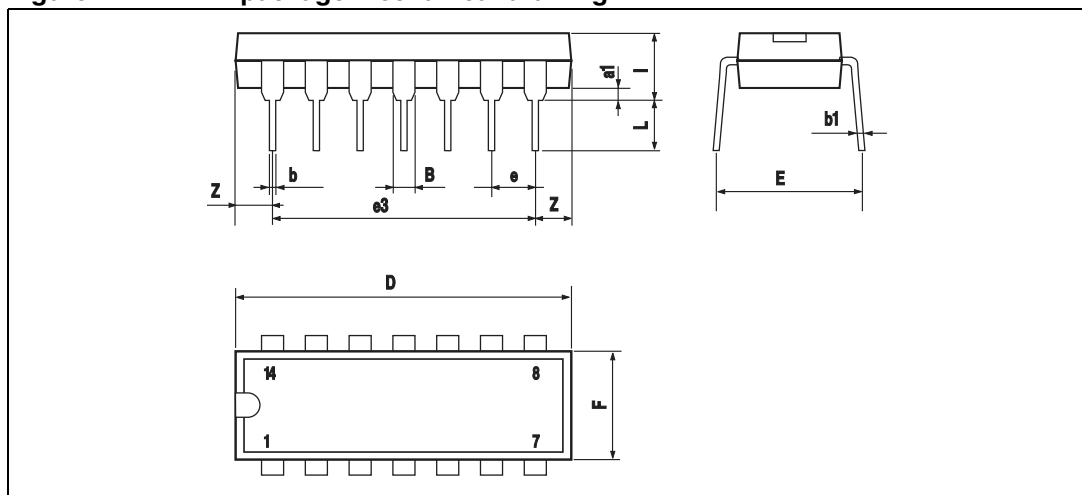


Table 4. DIP14 package mechanical data

| Ref. | Millimeters |       |      | Inches |       |       |
|------|-------------|-------|------|--------|-------|-------|
|      | Min.        | Typ.  | Max. | Min.   | Typ.  | Max.  |
| a1   | 0.51        |       |      | 0.020  |       |       |
| B    | 1.39        |       | 1.65 | 0.055  |       | 0.065 |
| b    |             | 0.5   |      |        | 0.020 |       |
| b1   |             | 0.25  |      |        | 0.010 |       |
| D    |             |       | 20   |        |       | 0.787 |
| E    |             | 8.5   |      |        | 0.335 |       |
| e    |             | 2.54  |      |        | 0.100 |       |
| e3   |             | 15.24 |      |        | 0.600 |       |
| F    |             |       | 7.1  |        |       | 0.280 |
| I    |             |       | 5.1  |        |       | 0.201 |
| L    |             | 3.3   |      |        | 0.130 |       |
| Z    | 1.27        |       | 2.54 | 0.050  |       | 0.100 |

## 6.2 SO-14 package information

Figure 25. SO-14 package mechanical drawing

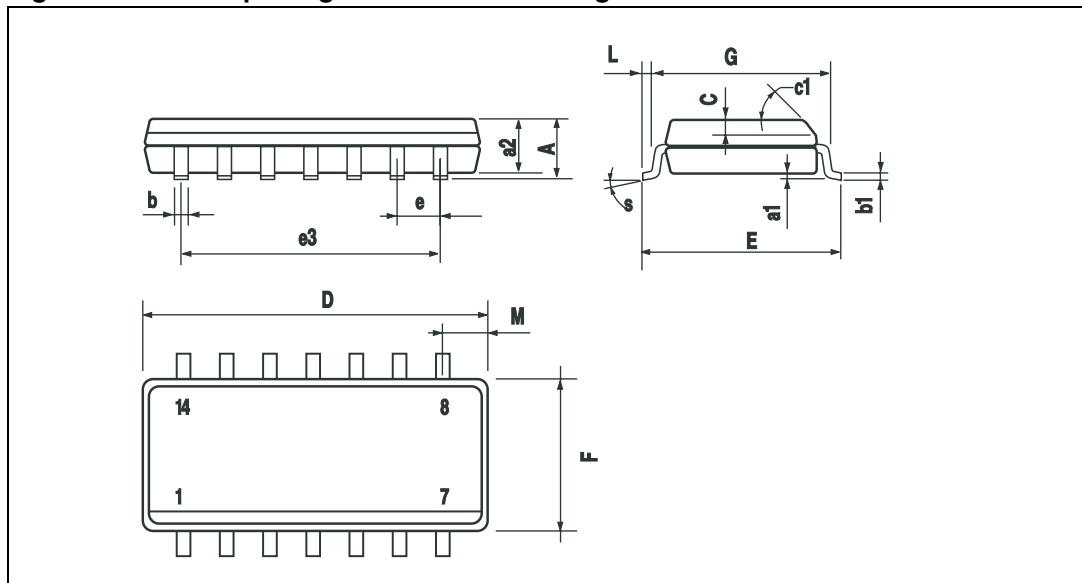


Table 5. SO-14 package mechanical data

| Ref. | Dimensions  |      |      |        |       |       |
|------|-------------|------|------|--------|-------|-------|
|      | Millimeters |      |      | Inches |       |       |
|      | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A    |             |      | 1.75 |        |       | 0.068 |
| a1   | 0.1         |      | 0.2  | 0.003  |       | 0.007 |
| a2   |             |      | 1.65 |        |       | 0.064 |
| b    | 0.35        |      | 0.46 | 0.013  |       | 0.018 |
| b1   | 0.19        |      | 0.25 | 0.007  |       | 0.010 |
| C    |             | 0.5  |      |        | 0.019 |       |
| c1   | 45° (typ.)  |      |      |        |       |       |
| D    | 8.55        |      | 8.75 | 0.336  |       | 0.344 |
| E    | 5.8         |      | 6.2  | 0.228  |       | 0.244 |
| e    |             | 1.27 |      |        | 0.050 |       |
| e3   |             | 7.62 |      |        | 0.300 |       |
| F    | 3.8         |      | 4.0  | 0.149  |       | 0.157 |
| G    | 4.6         |      | 5.3  | 0.181  |       | 0.208 |
| L    | 0.5         |      | 1.27 | 0.019  |       | 0.050 |
| M    |             |      | 0.68 |        |       | 0.026 |
| S    | 8° (max.)   |      |      |        |       |       |

## 7 Ordering information

**Table 6. Order codes**

| Order code                                                                                       | Temperature range | Package | Packing                | Marking                         |
|--------------------------------------------------------------------------------------------------|-------------------|---------|------------------------|---------------------------------|
| TL074IN<br>TL074AIN<br>TL074BIN                                                                  | -40°C, +105°C     | DIP14   | Tube                   | TL074IN<br>TL074AIN<br>TL074BIN |
| TL074ID/IDT<br>TL074AID/AIDT<br>TL074BID/BIDT                                                    |                   | SO-14   | Tube or<br>tape & reel | 074I<br>074AI<br>074BI          |
| TL074IYD/IYDT <sup>(1)</sup><br>TL074AIYD/AIYDT <sup>(1)</sup><br>TL074BIYD/BIYDT <sup>(1)</sup> |                   | SO-14   | Tube or<br>tape & reel | 074IY<br>074AIY<br>074BIY       |
| TL074CN<br>TL074ACN<br>TL074BCN                                                                  | 0°C, +70°C        | DIP14   | Tube                   | TL074CN<br>TL074ACN<br>TL074BCN |
| TL074CD/CDT<br>TL074ACD/ACDT<br>TL074BCD/BCDT                                                    |                   | SO-14   | Tube or<br>tape & reel | 074C<br>074AC<br>074BC          |

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

## 8 Revision history

**Table 7. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                               |
|-------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 28-Mar-2001 | 1        | Initial release.                                                                                                                                                                                                                      |
| 30-Jul-2007 | 2        | Added values for $R_{thja}$ , $R_{thjc}$ and ESD in <a href="#">Table 1: Absolute maximum ratings</a> .<br>Added <a href="#">Table 2: Operating conditions</a> .<br>Expanded <a href="#">Table 6: Order codes</a> .<br>Format update. |
| 07-Jul-2008 | 3        | Removed information concerning military temperature ranges (TL074Mx, TL074AMx, TL074BMx).<br>Added automotive grade order codes in <a href="#">Table 6: Order codes</a> .                                                             |

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