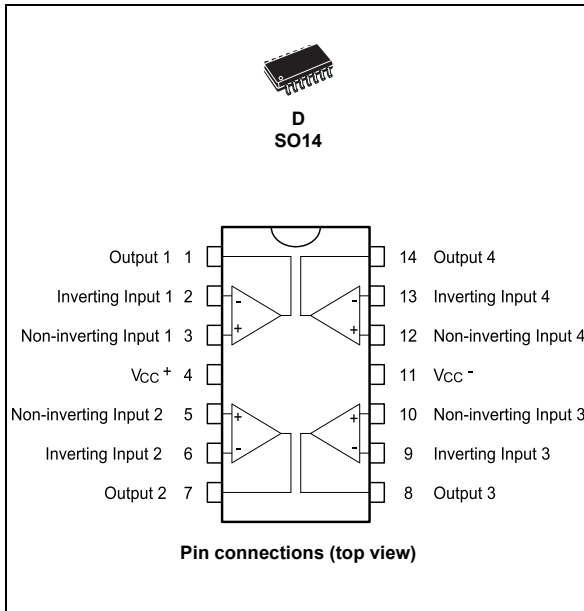


## Four UA741 quad bipolar operational amplifiers

Datasheet - production data



### Description

The LM248 and LM348 consist of four independent, high-gain internally-compensated, low-power operational amplifiers which have been designed to provide functional characteristics identical to those of the familiar UA741 operational amplifier. In addition, the total supply current for all four amplifiers is compatible with the supply current of a single UA741 type operational amplifier. Other features include input offset current and input bias current which are much less than those of a standard UA741. Also, excellent isolation between amplifiers has been achieved by independently biasing each amplifier and using layout techniques which minimize thermal coupling.

The LM248 and LM348 can be used where multiple UA741 type amplifiers are being used and in applications where amplifier matching or high packaging density is required.

### Features

- Low supply current: 0.53 mA per amplifier
- Class AB output stage: no crossover distortion
- Pin compatibility with LM124, LM224, LM324
- Low input offset voltage: 1 mV
- Low input offset current: 2 nA
- Low input bias current: 30 nA
- Gain bandwidth product: 1.3 MHz
- High degree of isolation between amplifiers: 120 dB
- Overload protection for inputs and outputs

**Table 1. Device summary**

| Part number                                | Temperature range | Package          |
|--|-------------------|------------------|
| LM248                                      | -40 °C to 105 °C  | D <sup>(1)</sup> |
| LM348                                      | 0 °C to 70 °C     |                  |
| Order code example: LM348DT <sup>(2)</sup> |                   |                  |

1. D = Small outline package (SO)

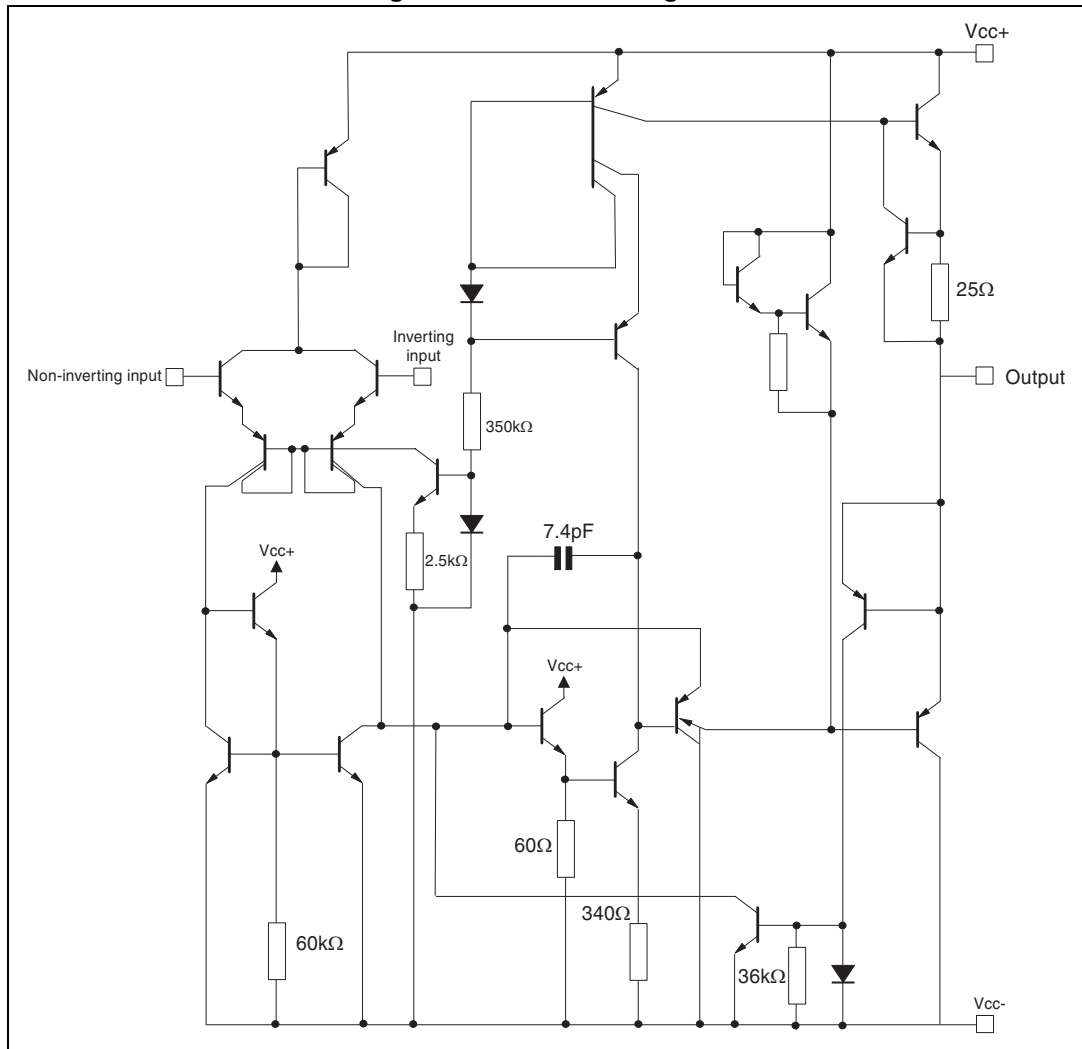
2. See [Table 5: Order codes](#)

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# 1 Schematic diagram

Figure 1. Schematic diagram



## 2 Absolute maximum ratings

**Table 2. Absolute maximum ratings**

| Symbol     | Parameters                                   | LM248      | LM348     | Unit |
|------------|--|------------|-----------|------|
| $V_{CC}$   | Supply voltage                               | ±22        |           | V    |
| $V_i$      | Input voltage <sup>(1)</sup>                 |            |           |      |
| $V_{id}$   | Differential input voltage                   | ±44        |           |      |
|            | Output short-circuit duration <sup>(2)</sup> | Infinite   |           | -    |
| $P_{tot}$  | Power dissipation                            | 500        |           | mW   |
| $T_{oper}$ | Operating free-air temperature range         | -40 to 105 | 0 to 70 C | °C   |
| $T_{stg}$  | Storage temperature range                    | -65 to 150 |           |      |
| ESD        | HBM: human body model <sup>(3)</sup>         | 200        |           | V    |
|            | MM: machine model <sup>(4)</sup>             | 50         |           |      |
|            | CDM: charged device model <sup>(5)</sup>     | 1.5        |           | kV   |

1. For supply voltages less than the maximum value, the absolute maximum input voltage is equal to the supply voltage.
2. Any of the amplifier outputs can be shorted to ground indefinitely, however, more than one should not be simultaneously shorted as the maximum junction will be exceeded.
3. Human body model: 100pF discharged through a 1.5kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
4. 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 < 5Ω), done for all couples of pin combinations with other pins floating.
5. Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

### 3 Electrical characteristics

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

| Symbol        | Parameter  | Min.     | Typ. | Max. | Unit             |
|---------------|--|----------|------|------|------------------|
| $V_{io}$      | Input offset voltage ( $R_s \leq 10\text{ k}\Omega$ ), $T_{amb} = 25\text{ }^\circ\text{C}$                            |          | 1    | 5    | mV               |
|               | Input offset voltage ( $R_s \leq 10\text{ k}\Omega$ ), $T_{min} \leq T_{amb} \leq T_{max}$                             |          |      | 6    |                  |
| $I_{io}$      | Input offset current, $T_{amb} = 25\text{ }^\circ\text{C}$   |          | 2    | 25   | nA               |
|               | Input offset current, $T_{min} \leq T_{amb} \leq T_{max}$  |          |      | 75   |                  |
| $I_{ib}$      | Input bias current, $T_{amb} = 25\text{ }^\circ\text{C}$   |          | 30   | 100  | nA               |
|               | Input bias current, $T_{min} \leq T_{amb} \leq T_{max}$  |          |      | 300  |                  |
| $A_{vd}$      | Large signal voltage gain ( $V_o = \pm 10\text{ V}$ , $R_L = 2\text{ k}\Omega$ ), $T_{amb} = 25\text{ }^\circ\text{C}$ | 50       | 160  |      | V/mV             |
|               | Large signal voltage gain ( $V_o = \pm 10\text{ V}$ , $R_L = 2\text{ k}\Omega$ ), $T_{min} \leq T_{amb} \leq T_{max}$  | 25       |      |      |                  |
| SVR           | Supply voltage rejection ratio ( $R_s \leq 10\text{ k}\Omega$ ), $T_{amb} = 25\text{ }^\circ\text{C}$                  | 77       | 100  |      | dB               |
|               | Supply voltage rejection ratio ( $R_s \leq 10\text{ k}\Omega$ ), $T_{min} \leq T_{amb} \leq T_{max}$                   |          |      |      |                  |
| $I_{cc}$      | Supply current, all amp, no load, $T_{amb} = 25\text{ }^\circ\text{C}$   |          | 2.1  | 3.6  | mA               |
|               | Supply current, all amp, no load, $T_{min} \leq T_{amb} \leq T_{max}$  |          |      | 4.8  |                  |
| $V_{icm}$     | Input common mode voltage range, $T_{amb} = 25\text{ }^\circ\text{C}$  | $\pm 12$ |      |      | V                |
|               | Input common mode voltage range, $T_{min} \leq T_{amb} \leq T_{max}$   |          |      |      |                  |
| CMR           | Common mode rejection ratio ( $R_s \leq 10\text{ k}\Omega$ ), $T_{amb} = 25\text{ }^\circ\text{C}$                     | 70       | 110  |      | dB               |
|               | Common mode rejection ratio ( $R_s \leq 10\text{ k}\Omega$ ), $T_{min} \leq T_{amb} \leq T_{max}$                      |          |      |      |                  |
| $I_{os}$      | Output short-circuit current, $T_{amb} = 25\text{ }^\circ\text{C}$   | 10       | 25   | 35   | mA               |
| $\pm V_{opp}$ | Output voltage swing, $T_{amb} = 25\text{ }^\circ\text{C}$ , $R_L \leq 10\text{ k}\Omega$                              | 12       | 13   |      | V                |
|               | Output voltage swing, $T_{amb} = 25\text{ }^\circ\text{C}$ , $R_L \leq 2\text{ k}\Omega$                               | 10       | 12   |      |                  |
|               | Output voltage swing, $T_{min} \leq T_{amb} \leq T_{max}$ , $R_L \leq 10\text{ k}\Omega$                               | 12       |      |      |                  |
|               | Output voltage swing, $T_{min} \leq T_{amb} \leq T_{max}$ , $R_L \leq 2\text{ k}\Omega$                                | 10       |      |      |                  |
| SR            | Slew rate<br>( $V_I = \pm 10\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , unity gain)               | 0.25     | 0.5  |      | V/ $\mu\text{s}$ |

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

| Symbol          | Parameter   | Min. | Typ. | Max. | Unit                                 |
|-----------------|---|------|------|------|--------------------------------------|
| $t_r$           | Rise time<br>( $V_I = \pm 10\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , unity gain)  |      | 0.3  |      | $\mu\text{s}$                        |
| $K_{OV}$        | Overshoot<br>( $V_I = \pm 10\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , unity gain)  |      | 5    |      | %                                    |
| $R_I$           | Input resistance  | 0.8  | 2.5  |      | $\text{M}\Omega$                     |
| GBP             | Gain bandwidth product<br>( $V_I = 10\text{ mV}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$ , $f = 100\text{ kHz}$ )                               | 0.7  | 1.3  |      | $\text{MHz}$                         |
| THD             | Total harmonic distortion<br>( $f = 1\text{ kHz}$ , $A_v = 20\text{ dB}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$ ,<br>$V_o = 2\text{ V}_{pp}$ ) |      | 0.08 |      | %                                    |
| $e_n$           | Equivalent Input noise voltage<br>( $f = 1\text{ kHz}$ , $R_S = 100\text{ }\Omega$ )  |      | 40   |      | $\frac{\text{nV}}{\sqrt{\text{Hz}}}$ |
| $V_{O1}/V_{O2}$ | Channel separation  |      | 120  |      | $\text{dB}$                          |

## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 SO14 package information

Figure 2. SO14 package mechanical drawing

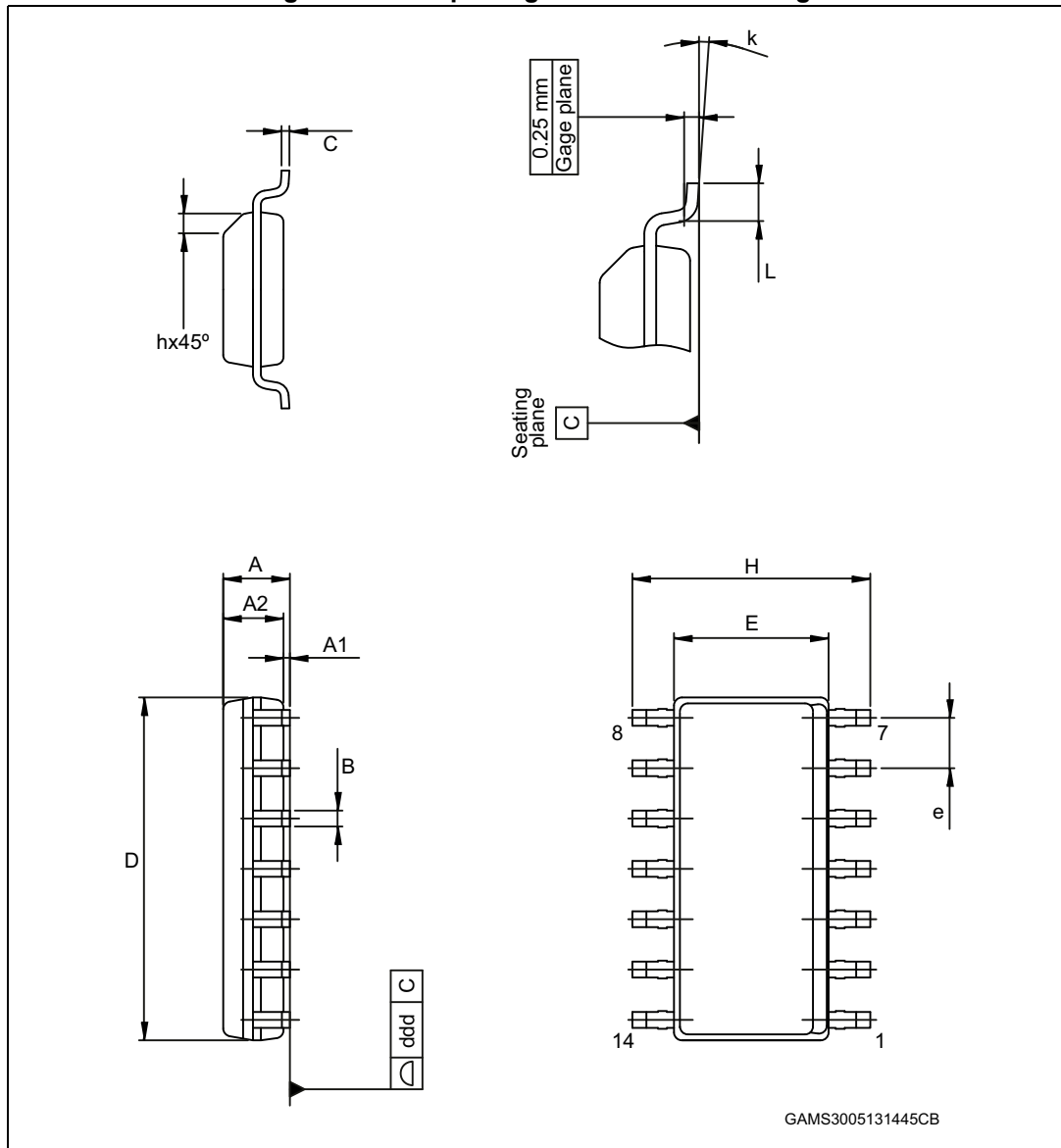


Table 4. SO14 package mechanical data

| Ref              | Dimensions  |      |      |        |      |       |
|------------------|-------------|------|------|--------|------|-------|
|                  | Millimeters |      |      | Inches |      |       |
|                  | Min.        | Typ. | Max. | Min.   | Typ. | Max.  |
| A                | 1.35        |      | 1.75 | 0.053  |      | 0.069 |
| A1               | 0.10        |      | 0.25 | 0.004  |      | 0.010 |
| A2               | 1.10        |      | 1.65 | 0.043  |      | 0.065 |
| B                | 0.33        |      | 0.51 | 0.013  |      | 0.020 |
| C                | 0.19        |      | 0.25 | 0.007  |      | 0.010 |
| D <sup>(1)</sup> | 8.55        |      | 8.75 | 0.337  |      | 0.344 |
| E                | 3.80        |      | 4.00 | 0.150  |      | 0.157 |
| e                | 1.27        |      |      | 0.050  |      |       |
| H                | 5.80        |      | 6.20 | 0.228  |      | 0.244 |
| h                | 0.25        |      | 0.50 | 0.010  |      | 0.020 |
| L                | 0.40        |      | 1.27 | 0.016  |      | 0.050 |
| k                | 0           |      | 8    | 0      |      | 0.315 |
| ddd              |             |      | 0.10 |        |      | 0.004 |

1. Dimension "D" does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions or gate burrs should not exceed 0.15 mm per side.



## 5 Ordering information

Table 5. Order codes

| Order code | Temperature range | Package | Packaging     | Marking |
|------------|-------------------|---------|---------------|---------|
| LM248D     | -40 °C to 105 °C  | SO14    | Tube          | 248     |
| LM248DT    |                   |         | Tape and reel |         |
| LM348DT    | 0 °C to 70° C     | SO14    | Tape and reel | 348     |

## 6 Revision history

Table 6. Document revision history

| Date        | Revision | Changes   |
|-------------|----------|---|
| 05-Jun-2013 | 4        | <p><i>Description</i>: small text changes</p> <p><i>Table 1: Device summary</i>: updated layout</p> <p>Replaced <i>Figure 2: DIP14 package mechanical drawing</i>, <i>Figure 2: SO14 package mechanical drawing</i>, <i>Table 4: DIP14 package mechanical data</i>, and <i>Table 4: SO14 package mechanical data</i>.</p> <p>Added <i>Section 5: Ordering information</i></p> |
| 06-Dec-2013 | 5        | <p>Removed LM148 - product obsolete</p> <p>Removed DIP14 package (not recommended for new design) and order codes relating to it (LM148N, LM348N).</p> <p><i>Table 2: Absolute maximum ratings</i>: added ESD data</p>  |

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