

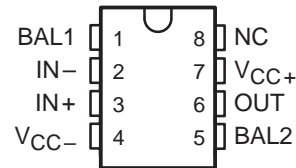
LF411

JFET-INPUT OPERATIONAL AMPLIFIER

SLOS011C – MARCH 1987 – REVISED OCTOBER 1997

- Low Input Bias Current, 50 pA Typ
- Low Input Noise Current, 0.01 pA/ $\sqrt{\text{Hz}}$ Typ
- Low Supply Current, 2 mA Typ
- High Input impedance, $10^{12} \Omega$ Typ
- Low Total Harmonic Distortion
- Low 1/f Noise Corner, 50 Hz Typ
- Package Options Include Plastic Small-Outline (D) and Standard (P) DIPs

D OR P PACKAGE
(TOP VIEW)



NC – No internal connection

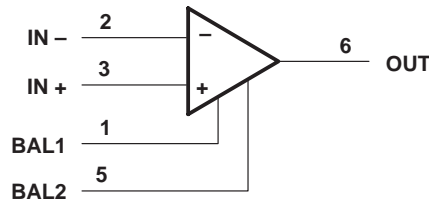
description

This device is a low-cost, high-speed, JFET-input operational amplifier with very low input offset voltage and a maximum input offset voltage drift. It requires low supply current, yet maintains a large gain-bandwidth product and a fast slew rate. In addition, the matched high-voltage JFET input provides very low input bias and offset currents.

The LF411 can be used in applications such as high-speed integrators, digital-to-analog converters, sample-and-hold circuits, and many other circuits.

The LF411C is characterized for operation from 0°C to 70°C. The LF411I is characterized for operation from –40°C to 85°C.

symbol



AVAILABLE OPTIONS

| T _A | V _{IO} max AT 25°C | PACKAGE | |
|----------------|--------------------------------|----------------------|--------------------|
| | | SMALL OUTLINE (D) | PLASTIC DIP (P) |
| 0°C to 70°C | 2 mV | LF411CD | LF411CP |
| –40°C to 85°C | 2 mV | LF411ID | LF411IP |

The D packages are available taped and reeled. Add the suffix R to the device type (i.e., LF411CDR).



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

| | |
|--|----------------|
| Supply voltage, V_{CC+} | 18 V |
| Supply voltage, V_{CC-} | –18 V |
| Differential input voltage, V_{ID} | ± 30 V |
| Input voltage, V_I (see Note 1) | ± 15 V |
| Duration of output short circuit | Unlimited |
| Continuous total power dissipation | 500 mW |
| Package thermal impedance, θ_{JA} (see Note 2): D package | 197°C/W |
| P package | 104°C/W |
| Storage temperature range, T_{stg} | –65°C to 150°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 260°C |

NOTES: 1. Unless otherwise specified, the absolute maximum negative input voltage is equal to the negative power supply voltage.
2. The package thermal impedance is calculated in accordance with JESD 51, except for through-hole packages, which use a trace length of zero.

recommended operating conditions

| | C SUFFIX | | I SUFFIX | | UNIT |
|---------------------------------------|----------|-----|----------|-----|------|
| | MIN | MAX | MIN | MAX | |
| Supply voltage, V_{CC+} | 3.5 | 18 | 3.5 | 18 | V |
| Supply voltage, V_{CC-} | –3.5 | –18 | –3.5 | –18 | V |
| Operating free-air temperature, T_A | 0 | 70 | –40 | –85 | °C |

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

| PARAMETER | | TEST CONDITIONS | T_A | | MIN | TYP | MAX | UNIT |
|----------------|---|--|-------------|---------------|----------|------------------|-----|------------------|
| | | | LF411C | LF411I | | | | |
| V_{IO} | Input offset voltage | $V_{IC} = 0$, $R_S = 10$ k Ω | 25°C | 25°C | 0.8 | | 2 | mV |
| α_{VIO} | Average temperature coefficient of input offset voltage | $V_{IC} = 0$, $R_S = 10$ k Ω | | | 10 | | 20† | $\mu V/^\circ C$ |
| I_{IO} | Input offset current‡ | $V_{IC} = 0$ | 25°C | 25°C | 25 | | 100 | pA |
| | | | 70°C | 85°C | | | 2 | nA |
| I_{IB} | Input bias current‡ | $V_{IC} = 0$ | 25°C | 25°C | 50 | | 200 | pA |
| | | | 70°C | 85°C | | | 4 | nA |
| V_{ICR} | Common-mode input voltage range | | | | ± 11 | –11.5 to 14.5 | | V |
| V_{OM} | Maximum peak output-voltage swing | $R_L = 10$ k Ω | | | ± 12 | ± 13.5 | | V |
| A_{VD} | Large-signal differential voltage | $V_O = \pm 10$ V, $R_L = 2$ k Ω | 25°C | 25°C | 25 | 200 | | V/mV |
| | | | 0°C to 70°C | –40°C to 85°C | 15 | 200 | | |
| r_i | Input resistance | $T_J = 25^\circ C$ | | | | 10 ¹² | | Ω |
| CMR R | Common-mode rejection ratio | $R_S \leq 10$ k Ω | | | 70 | 100 | | dB |
| k_{SVR} | Supply-voltage rejection ratio | See Note 3 | | | 70 | 100 | | dB |
| I_{CC} | Supply current | | | | 2 | 3.4 | | mA |

† At least 90% of the devices meet this limit for α_{VIO} .

‡ Input bias currents of an FET-input operational amplifier are normal junction reverse currents, which are temperature sensitive. Pulse techniques must be used that will maintain the junction temperatures as close to the ambient temperature as possible.

NOTE 3: Supply-voltage rejection ratio is measured for both supply magnitudes increasing or decreasing simultaneously.



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

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|----------------|--------------------------------|---|-----|------|-----|------------------------|
| SR | Slew rate | | 8 | 13 | | V/ μs |
| B ₁ | Unity-gain bandwidth | | 2.7 | 3 | | MHz |
| V _n | Equivalent input noise voltage | f = 1 kHz, R _S = 20 Ω | | 18 | | nV/ $\sqrt{\text{Hz}}$ |
| I _n | Equivalent input noise current | f = 1 kHz | | 0.01 | | pA/ $\sqrt{\text{Hz}}$ |



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PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| LF411CD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LF411CDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LF411CDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LF411CDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LF411CDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LF411CDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| LF411CP | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| LF411CPE4 | ACTIVE | PDIP | P | 8 | 50 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| LF411ID | OBSOLETE | SOIC | D | 8 | | TBD | Call TI | Call TI |
| LF411IDR | OBSOLETE | SOIC | D | 8 | | TBD | Call TI | Call TI |
| LF411IP | OBSOLETE | PDIP | P | 8 | | TBD | Call TI | Call TI |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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TAPE AND REEL INFORMATION



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|----------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| LF411CDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

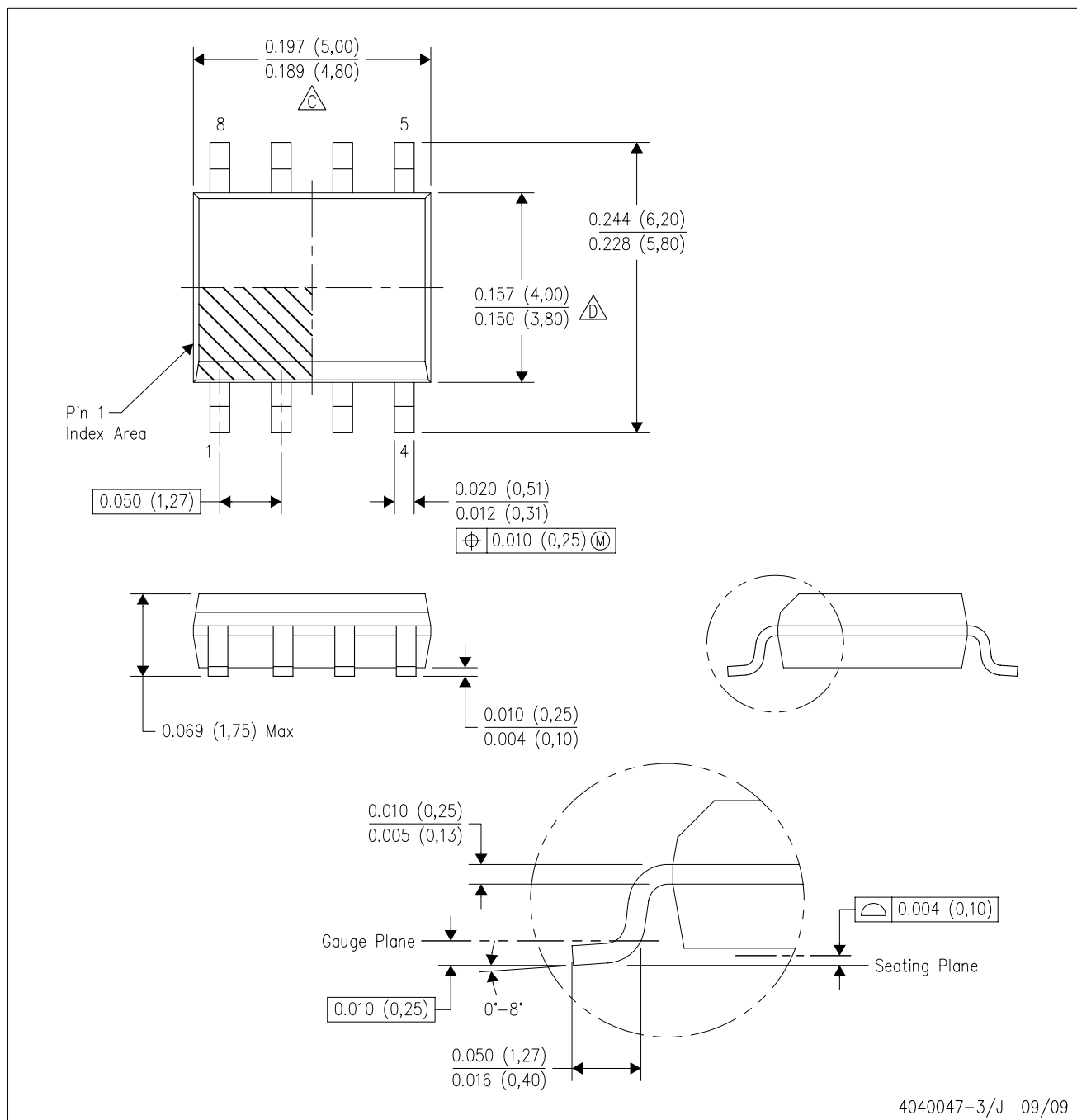


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|----------|--------------|-----------------|------|------|-------------|------------|-------------|
| LF411CDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |

D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
 - $\triangle D$ Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - E. Reference JEDEC MS-012 variation AA.

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Falls within JEDEC MS-001

For the latest package information, go to http://www.ti.com/sc/docs/package/pkg_info.htm