

# LF411

## Low Offset, Low Drift JFET Input Operational Amplifier

### General Description

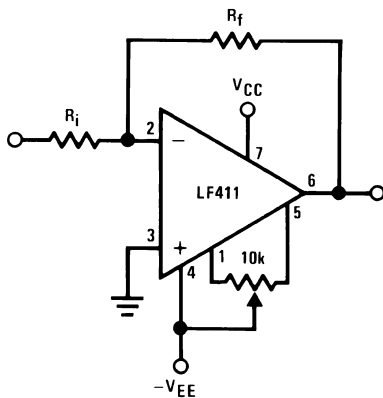
These devices are low cost, high speed, JFET input operational amplifiers with very low input offset voltage and guaranteed input offset voltage drift. They require low supply current yet maintain a large gain bandwidth product and fast slew rate. In addition, well matched high voltage JFET input devices provide very low input bias and offset currents. The LF411 is pin compatible with the standard LM741 allowing designers to immediately upgrade the overall performance of existing designs.

These amplifiers may be used in applications such as high speed integrators, fast D/A converters, sample and hold circuits and many other circuits requiring low input offset voltage and drift, low input bias current, high input impedance, high slew rate and wide bandwidth.

### Features

- Internally trimmed offset voltage: 0.5 mV(max)
- Input offset voltage drift: 10  $\mu\text{V}/^\circ\text{C}$ (max)
- Low input bias current: 50 pA
- Low input noise current: 0.01 pA/ $\sqrt{\text{Hz}}$
- Wide gain bandwidth: 3 MHz(min)
- High slew rate: 10V/ $\mu\text{s}$ (min)
- Low supply current: 1.8 mA
- High input impedance:  $10^{12}\Omega$
- Low total harmonic distortion:  $\leq 0.02\%$
- Low 1/f noise corner: 50 Hz
- Fast settling time to 0.01%: 2  $\mu\text{s}$

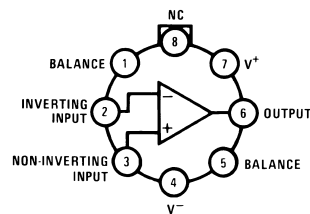
### Typical Connection



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### Connection Diagrams

#### Metal Can Package



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Note: Pin 4 connected to case.

#### Top View

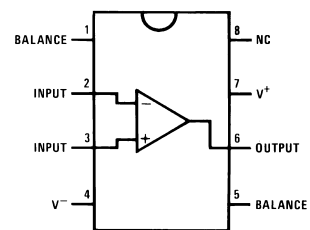
Order Number LF411ACH  
or LF411MH/883 (Note 11)  
See NS Package Number H08A

### Ordering Information

#### LF411XYZ

- X indicates electrical grade
- Y indicates temperature range
  - “M” for military
  - “C” for commercial
- Z indicates package type
  - “H” or “N”

#### Dual-In-Line Package



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#### Top View

Order Number LF411ACN, LF411CN  
See NS Package Number N08E

### Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

	LF411A	LF411		H Package	N Package
Supply Voltage	±22V	±18V	$T_{jmax}$	150°C	115°C
Differential Input Voltage	±38V	±30V	$\theta_{jA}$	162°C/W (Still Air)	120°C/W
Input Voltage Range (Note 2)	±19V	±15V		65°C/W (400 LF/min Air Flow)	
Output Short Circuit Duration	Continuous	Continuous	$\theta_{jC}$	20°C/W	
			Operating Temp. Range	(Note 4)	(Note 4)
			Storage Temp. Range	-65°C ≤ T <sub>A</sub> ≤ 150°C	-65°C ≤ T <sub>A</sub> ≤ 150°C
			Lead Temp. (Soldering, 10 sec.)	260°C	260°C
Power Dissipation (Notes 3, 10)	H Package 670 mW	N Package 670 mW	ESD Tolerance		Rating to be determined.

### DC Electrical Characteristics (Note 5)

Symbol	Parameter	Conditions	LF411A			LF411			Units
			Min	Typ	Max	Min	Typ	Max	
V <sub>OS</sub>	Input Offset Voltage	R <sub>S</sub> =10 kΩ, T <sub>A</sub> =25°C		0.3	0.5		0.8	2.0	mV
ΔV <sub>OS</sub> /ΔT	Average TC of Input Offset Voltage	R <sub>S</sub> =10 kΩ (Note 6)		7	10		7	20 (Note 6)	μV/°C
I <sub>OS</sub>	Input Offset Current	V <sub>S</sub> =±15V (Notes 5, 7)	T <sub>J</sub> =25°C	25	100		25	100	pA
			T <sub>J</sub> =70°C					2	nA
			T <sub>J</sub> =125°C					25	nA
I <sub>B</sub>	Input Bias Current	V <sub>S</sub> =±15V (Notes 5, 7)	T <sub>J</sub> =25°C	50	200		50	200	pA
			T <sub>J</sub> =70°C					4	nA
			T <sub>J</sub> =125°C					50	nA
R <sub>IN</sub>	Input Resistance	T <sub>J</sub> =25°C		10 <sup>12</sup>			10 <sup>12</sup>	Ω	
A <sub>VOL</sub>	Large Signal Voltage Gain	V <sub>S</sub> =±15V, V <sub>O</sub> =±10V, R <sub>L</sub> =2k, T <sub>A</sub> =25°C	50	200		25	200		V/mV
		Over Temperature	25	200		15	200		V/mV
V <sub>O</sub>	Output Voltage Swing	V <sub>S</sub> =±15V, R <sub>L</sub> =10k	±12	±13.5		±12	±13.5		V
V <sub>CM</sub>	Input Common-Mode Voltage Range		±16	+19.5		±11	+14.5		V
				-16.5			-11.5		V
CMRR	Common-Mode Rejection Ratio	R <sub>S</sub> ≤10k	80	100		70	100		dB
PSRR	Supply Voltage Rejection Ratio	(Note 8)	80	100		70	100		dB
I <sub>S</sub>	Supply Current			1.8	2.8		1.8	3.4	mA

### AC Electrical Characteristic (Note 5)

Symbol	Parameter	Conditions	LF411A			LF411			Units
			Min	Typ	Max	Min	Typ	Max	
SR	Slew Rate	V <sub>S</sub> =±15V, T <sub>A</sub> =25°C	10	15		8	15		V/μs
GBW	Gain-Bandwidth Product	V <sub>S</sub> =±15V, T <sub>A</sub> =25°C	3	4		2.7	4		MHz
e <sub>n</sub>	Equivalent Input Noise Voltage	T <sub>A</sub> =25°C, R <sub>S</sub> =100Ω, f=1 kHz		25			25		nV/√Hz
i <sub>n</sub>	Equivalent Input Noise Current	T <sub>A</sub> =25°C, f=1 kHz		0.01			0.01		pA/√Hz

## AC Electrical Characteristic (Note 5) (Continued)

Symbol	Parameter	Conditions	LF411A			LF411			Units
			Min	Typ	Max	Min	Typ	Max	
THD	Total Harmonic Distortion	$A_V=+10$ , $R_L=10k$ , $V_O=20$ Vp-p, $BW=20$ Hz–20 kHz		<0.02			<0.02		%

**Note 1:** "Absolute Maximum Ratings" indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits.

**Note 2:** Unless otherwise specified the absolute maximum negative input voltage is equal to the negative power supply voltage.

**Note 3:** For operating at elevated temperature, these devices must be derated based on a thermal resistance of  $\theta_{JA}$ .

**Note 4:** These devices are available in both the commercial temperature range  $0^\circ\text{C} \leq T_A \leq 70^\circ\text{C}$  and the military temperature range  $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ . The temperature range is designated by the position just before the package type in the device number. A "C" indicates the commercial temperature range and an "M" indicates the military temperature range. The military temperature range is available in "H" package only.

**Note 5:** Unless otherwise specified, the specifications apply over the full temperature range and for  $V_S = \pm 20\text{V}$  for the LF411A and for  $V_S = \pm 15\text{V}$  for the LF411.  $V_{OS}$ ,  $I_B$ , and  $I_{OS}$  are measured at  $V_{CM}=0$ .

**Note 6:** The LF411A is 100% tested to this specification. The LF411 is sample tested to insure at least 90% of the units meet this specification.

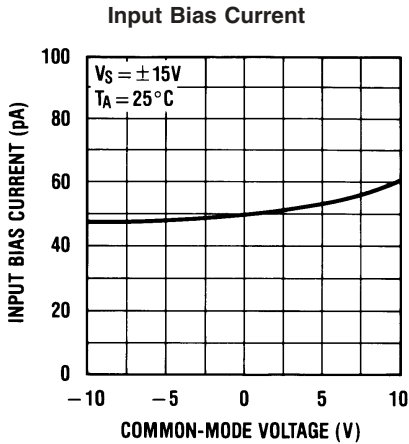
**Note 7:** The input bias currents are junction leakage currents which approximately double for every  $10^\circ\text{C}$  increase in the junction temperature,  $T_J$ . Due to limited production test time, the input bias currents measured are correlated to junction temperature. In normal operation the junction temperature rises above the ambient temperature as a result of internal power dissipation,  $P_D$ .  $T_J = T_A + \theta_{JA} P_D$  where  $\theta_{JA}$  is the thermal resistance from junction to ambient. Use of a heat sink is recommended if input bias current is to be kept to a minimum.

**Note 8:** Supply voltage rejection ratio is measured for both supply magnitudes increasing or decreasing simultaneously in accordance with common practice, from  $\pm 15\text{V}$  to  $\pm 5\text{V}$  for the LF411 and from  $\pm 20\text{V}$  to  $\pm 5\text{V}$  for the LF411A.

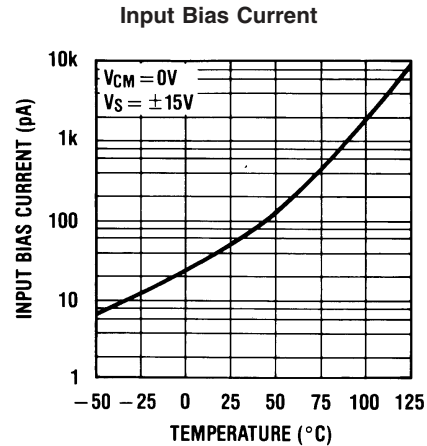
**Note 9:** RETS 411X for LF411MH and LF411MJ military specifications.

**Note 10:** Max. Power Dissipation is defined by the package characteristics. Operating the part near the Max. Power Dissipation may cause the part to operate outside guaranteed limits.

## Typical Performance Characteristics

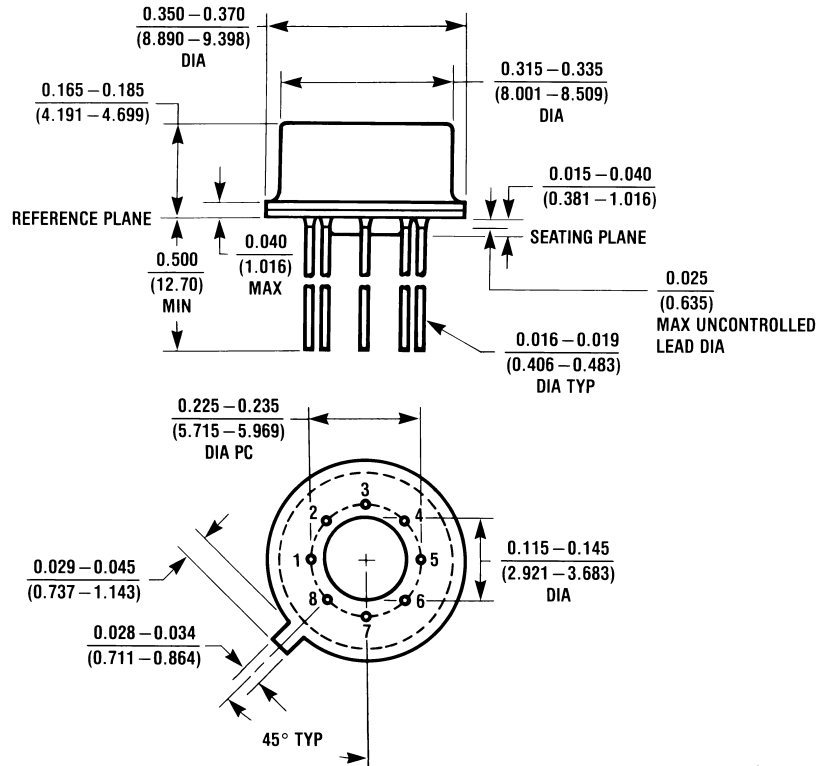


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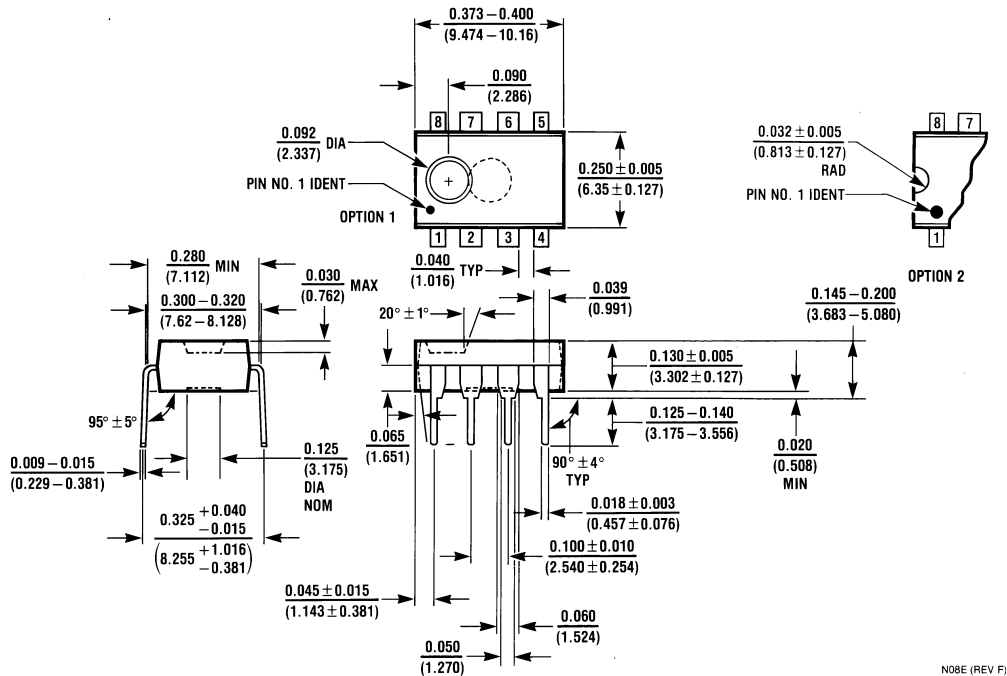


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**Physical Dimensions** inches (millimeters) unless otherwise noted



**Metal Can Package (H)**  
Order Number LF411MH/883 or LF411ACH  
NS Package Number H08A



**Molded Dual-In-Line Package (N)**  
Order Number LF411ACN or LF411CN  
NS Package Number N08E