

# JFET Input Operational Amplifiers

These low cost JFET input operational amplifiers combine two state-of-the-art analog technologies on a single monolithic integrated circuit. Each internally compensated operational amplifier has well matched high voltage JFET input devices for low input offset voltage. The JFET technology provides wide bandwidths and fast slew rates with low input bias currents, input offset currents, and supply currents.

These devices are available in single, dual and quad operational amplifiers which are pin-compatible with the industry standard MC1741, MC1458, and the MC3403/LM324 bipolar devices.

- Input Offset Voltage of 5.0 mV Max (LF347B)
- Low Input Bias Current: 50 pA
- Low Input Noise Voltage:  $16 \text{ nV}/\sqrt{\text{Hz}}$
- Wide Gain Bandwidth: 4.0 MHz
- High Slew Rate:  $13\text{V}/\mu\text{s}$
- Low Supply Current: 1.8 mA per Amplifier
- High Input Impedance:  $10^{12} \Omega$
- High Common Mode and Supply Voltage Rejection Ratios: 100 dB

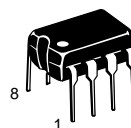
## MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Supply Voltage	$V_{CC}$ $V_{EE}$	+18 -18	V
Differential Input Voltage	$V_{ID}$	$\pm 30$	V
Input Voltage Range (Note 1)	$V_{IDR}$	$\pm 15$	V
Output Short Circuit Duration (Note 2)	$t_{SC}$	Continuous	
Power Dissipation at $T_A = +25^\circ\text{C}$ Derate above $T_A = +25^\circ\text{C}$	$P_D$ $1/\theta_{JA}$	900 10	mW mW/ $^\circ\text{C}$
Operating Ambient Temperature Range	$T_A$	0 to +70	$^\circ\text{C}$
Operating Junction Temperature Range	$T_J$	115	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to +150	$^\circ\text{C}$

- NOTES:**
1. Unless otherwise specified, the absolute maximum negative input voltage is limited to the negative power supply.
  2. Any amplifier output can be shorted to ground indefinitely. However, if more than one amplifier output is shorted simultaneously, maximum junction temperature rating may be exceeded.

## LF347, B LF351 LF353

## FAMILY OF JFET OPERATIONAL AMPLIFIERS

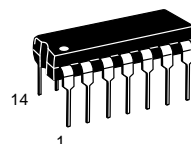
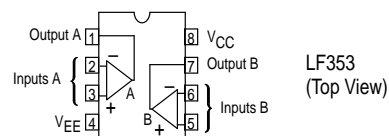
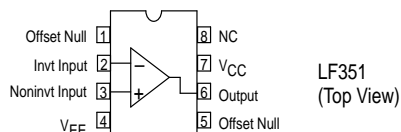


**N SUFFIX**  
PLASTIC PACKAGE  
CASE 626



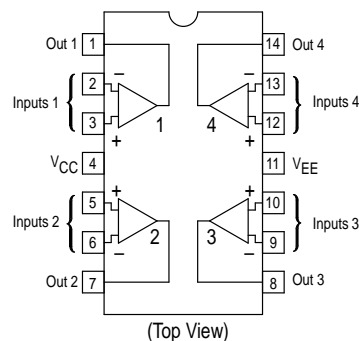
**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751  
(SO-8)

### PIN CONNECTIONS



**N SUFFIX**  
PLASTIC PACKAGE  
CASE 646

### PIN CONNECTIONS



## ORDERING INFORMATION

Device	Function	Operating Temperature Range	Package
LF351D LF351N	Single Single	$T_A = 0^\circ \text{ to } +70^\circ\text{C}$	SO-8 Plastic DIP
LF353D LF353N	Dual Dual		SO-8 Plastic DIP
LF347BN LF347N	Quad Quad		Plastic DIP Plastic DIP

# LF347, B LF351 LF353

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = +15$ V, $V_{EE} = -15$ V, $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

Characteristic	Symbol	LF347B			LF347, LF351, LF353			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage ( $R_S \leq 10$ k, $V_{CM} = 0$ ) $T_A = +25^\circ\text{C}$ $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$	$V_{IO}$	— —	1.0 —	5.0 8.0	— —	5.0 —	10 13	mV
Avg. Temperature Coefficient of Input Offset Voltage $R_S \leq 10$ k, $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$	$\Delta V_{IO}/\Delta T$	—	10	—	—	10	—	$\mu\text{V}/^\circ\text{C}$
Input Offset Current ( $V_{CM} = 0$ , Note 3) $T_A = +25^\circ\text{C}$ $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$	$I_{IO}$	— —	25 —	100 4.0	— —	25 —	100 4.0	pA nA
Input Bias Current ( $V_{CM} = 0$ , Note 3) $T_A = +25^\circ\text{C}$ $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$	$I_{IB}$	— —	50 —	200 8.0	— —	50 —	200 8.0	pA nA
Input Resistance	$r_i$	—	$10^{12}$	—	—	$10^{12}$	—	$\Omega$
Common Mode Input Voltage Range	$V_{ICR}$	$\pm 11$	$+15$ $-12$	—	$\pm 11$	$+15$ $-12$	—	V
Large-Signal Voltage Gain ( $V_O = \pm 10$ V, $R_L = 2.0$ k) $T_A = +25^\circ\text{C}$ $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$	$A_{VOL}$	50 25	100 —	— —	25 15	100 —	— —	V/mV
Output Voltage Swing ( $R_L = 10$ k)	$V_O$	$\pm 12$	$\pm 14$	—	$\pm 12$	$\pm 14$	—	V
Common Mode Rejection ( $R_S \leq 10$ k)	CMR	80	100	—	70	100	—	dB
Supply Voltage Rejection ( $R_S \leq 10$ k)	PSRR	80	100	—	70	100	—	dB
Supply Current LF347 LF351 LF353	$I_D$	— — —	7.2 — —	11 — —	— — —	7.2 1.8 3.6	11 3.4 6.5	mA
Short Circuit Current	$I_{SC}$	—	25	—	—	25	—	mA
Slew Rate ( $A_V = +1$ )	SR	—	13	—	—	13	—	V/ $\mu\text{s}$
Gain-Bandwidth Product	BWp	—	4.0	—	—	4.0	—	MHz
Equivalent Input Noise Voltage ( $R_S = 100$ $\Omega$ , $f = 1000$ Hz)	$e_n$	—	24	—	—	24	—	$\text{nV}/\sqrt{\text{Hz}}$
Equivalent Input Noise Current ( $f = 1000$ Hz)	$i_n$	—	0.01	—	—	0.01	—	$\text{pA}/\sqrt{\text{Hz}}$
Channel Separation (LF347, LF353) $1.0$ Hz $\leq f \leq 20$ kHz (Input Referred)	—	—	$-120$	—	—	$-120$	—	dB

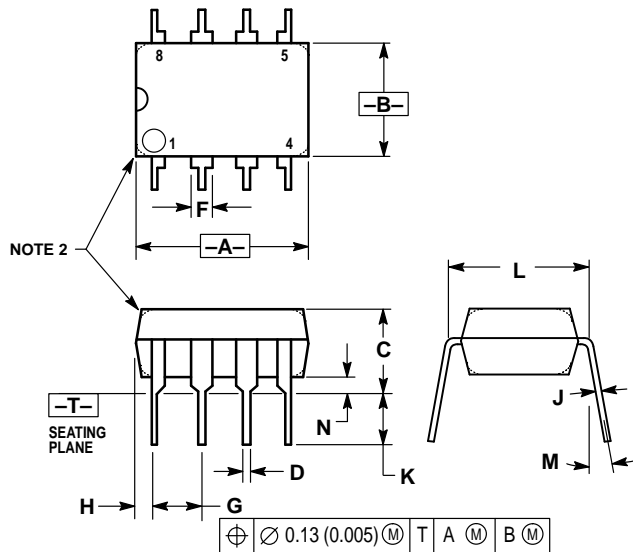
For Typical Characteristic Performance Curves, refer to MC34001, 34002, 34004 data sheet.

**NOTE:** 3. Input bias currents of JFET input op amps approximately double for every  $10^\circ\text{C}$  rise in junction temperature. To maintain junction temperatures as close to ambient as is possible, pulse techniques are utilized during test.

# LF347, B LF351 LF353

## OUTLINE DIMENSIONS

### N SUFFIX PLASTIC PACKAGE CASE 626-05 ISSUE K

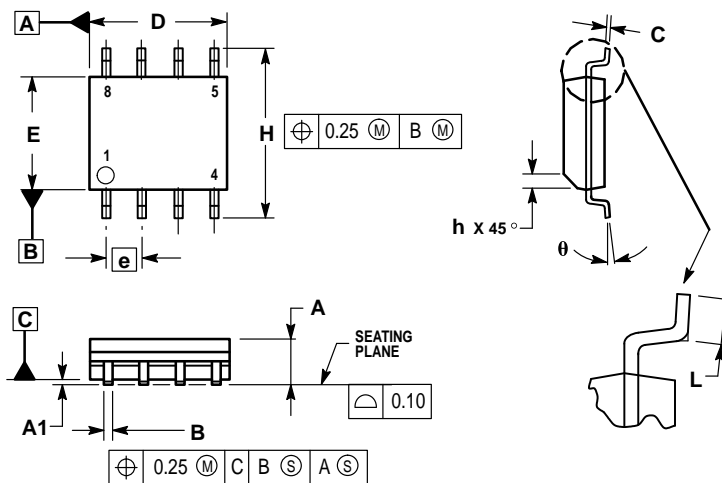


#### NOTES:

1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	10.16	0.370	0.400
B	6.10	6.60	0.240	0.260
C	3.94	4.45	0.155	0.175
D	0.38	0.51	0.015	0.020
E	1.02	1.78	0.040	0.070
F	2.54 BSC		0.100 BSC	
G	0.76	1.27	0.030	0.050
H	0.20	0.30	0.008	0.012
J	2.92	3.43	0.115	0.135
K	7.62 BSC		0.300 BSC	
L	— 10°		— 10°	
M	0.76	1.01	0.030	0.040

### D SUFFIX PLASTIC PACKAGE CASE 751-05 (SO-8) ISSUE R



#### NOTES:

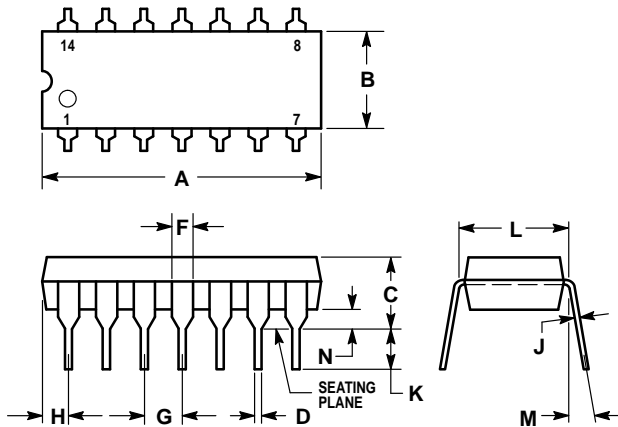
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS	
	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.35	0.49
C	0.18	0.25
D	4.80	5.00
E	3.80	4.00
F	1.27 BSC	
G	5.80	6.20
H	0.25	0.50
I	0.40	1.25
J	0°	7°

# LF347, B LF351 LF353

## OUTLINE DIMENSIONS


### N SUFFIX PLASTIC PACKAGE CASE 646-06 ISSUE L



#### NOTES:

1. LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
4. ROUNDED CORNERS OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	19.56
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.300 BSC		7.62 BSC	
M	0°	10°	0°	10°
N	0.015	0.039	0.39	1.01

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters which may be provided in Motorola data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

#### How to reach us:

**USA/EUROPE/Locations Not Listed:** Motorola Literature Distribution;  
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447 or 602-303-5454

**MFAX:** RMFAX0@email.sps.mot.com - TOUCHTONE 602-244-6609  
**INTERNET:** <http://Design-NET.com>

**JAPAN:** Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, 6F Seibu-Butsuryu-Center,  
3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

**ASIA/PACIFIC:** Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,  
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

