

# Low Noise, JFET Input Operational Amplifiers

These low noise 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 device for low input offset voltage. The BIFET technology provides wide bandwidths and fast slew rates with low input bias currents, input offset currents, and supply currents. Moreover, the devices exhibit low noise and low harmonic distortion, making them ideal for use in high fidelity audio amplifier applications.

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 products.

- Low Input Noise Voltage: 18 nV/ $\sqrt{\text{Hz}}$  Typ
- Low Harmonic Distortion: 0.01% Typ
- Low Input Bias and Offset Currents
- High Input Impedance:  $10^{12} \Omega$  Typ
- High Slew Rate: 13 V/ $\mu\text{s}$  Typ
- Wide Gain Bandwidth: 4.0 MHz Typ
- Low Supply Current: 1.4 mA per Amp

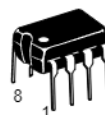
## ORDERING INFORMATION

Op Amp Function	Device	Operating Temperature Range	Package
Single	TL071CD	$T_A = 0^\circ \text{ to } +70^\circ\text{C}$	SO-8
	TL071ACP		Plastic DIP
Dual	TL072CD	$T_A = 0^\circ \text{ to } +70^\circ\text{C}$	SO-8
	TL072ACP		Plastic DIP
Quad	TL074CN, ACN	$T_A = 0^\circ \text{ to } +70^\circ\text{C}$	Plastic DIP

# TL071C,AC TL072C,AC TL074C,AC

## LOW NOISE, JFET INPUT OPERATIONAL AMPLIFIERS

### SEMICONDUCTOR TECHNICAL DATA

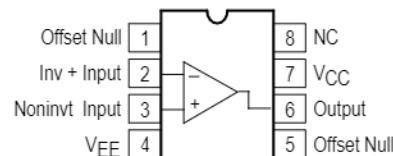


**P SUFFIX**  
PLASTIC PACKAGE  
CASE 626

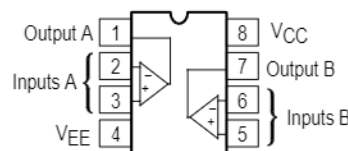


**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751  
(SO-8)

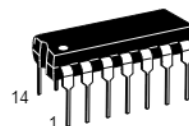
### PIN CONNECTIONS



TL071 (Top View)

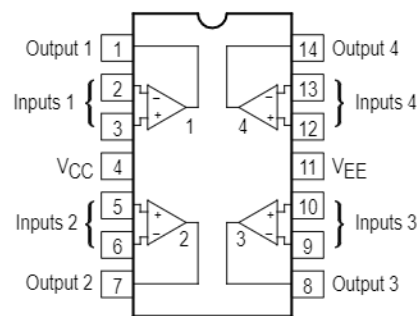


TL072 (Top View)



**N SUFFIX**  
PLASTIC PACKAGE  
CASE 646  
(TL074 Only)

### PIN CONNECTIONS



TL074 (Top View)

# TL071C,AC TL072C,AC TL074C,AC

## 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 Plastic Package (N, P) Derate above $T_A = 47^\circ\text{C}$	$P_D$ $1.0/\theta_{JA}$	680 10	mW mW/ $^\circ\text{C}$
Operating Ambient Temperature Range	$T_A$	0 to $+70$	$^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	-65 to $+150$	$^\circ\text{C}$

- NOTES:** 1. The magnitude of the input voltage must not exceed the magnitude of the supply voltage or 15 V, whichever is less.  
2. The output may be shorted to ground or either supply. Temperature and/or supply voltages must be limited to ensure that power dissipation ratings are not exceeded.  
3. ESD data available upon request.

## ELECTRICAL CHARACTERISTICS ( $V_{CC} = 15\text{ V}$ , $V_{EE} = -15\text{ V}$ , $T_A = T_{\text{high}}$ to $T_{\text{low}}$ [Note 1])

Characteristics	Symbol	Min	Typ	Max	Unit
Input Offset Voltage ( $R_S \leq 10\text{ k}$ , $V_{CM} = 0$ ) TL071C, TL072C TL074C TL07_AC	$V_{IO}$	- - -	- - -	13 13 7.5	mV
Input Offset Current ( $V_{CM} = 0$ ) (Note 2) TL07_C TL07_AC	$I_{IO}$	- -	- -	2.0 2.0	nA
Input Bias Current ( $V_{CM} = 0$ ) (Note 2) TL07_C TL07_AC	$I_{IB}$	- -	- -	7.0 7.0	nA
Large-Signal Voltage Gain ( $V_O = \pm 10\text{ V}$ , $R_L \geq 2.0\text{ k}$ ) TL07_C TL07_AC	$A_{VOL}$	15 25	- -	- -	V/mV
Output Voltage Swing (Peak-to-Peak) ( $R_L \geq 10\text{ k}$ ) ( $R_L \geq 2.0\text{ k}$ )	$V_O$	24 20	- -	- -	V

- NOTES:** 1.  $T_{\text{low}} = 0^\circ\text{C}$  for TL071C,AC TL072C,AC TL074C,AC  $T_{\text{high}} = 70^\circ\text{C}$  for TL071C,AC TL072C,AC TL074C,AC  
2. Input Bias currents of JFET input op amps approximately double for every  $10^\circ\text{C}$  rise in junction temperature as shown in Figure 3. To maintain junction temperature as close to ambient temperature as possible, pulse techniques must be used during testing.

Figure 1. Unity Gain Voltage Follower

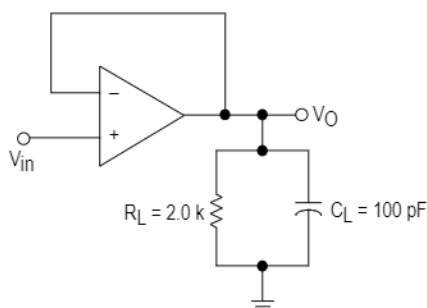
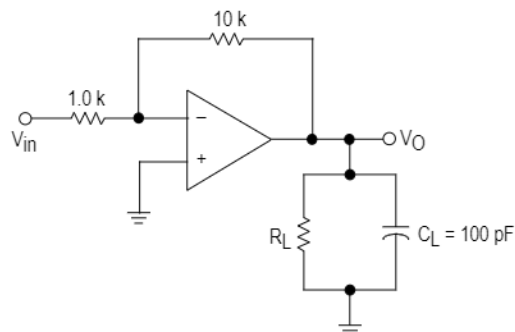


Figure 2. Inverting Gain of 10 Amplifier



# TL071C,AC TL072C,AC TL074C,AC

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

Characteristics	Symbol	Min	Typ	Max	Unit
Input Offset Voltage ( $R_S \leq 10\text{ k}$ , $V_{CM} = 0$ ) TL071C, TL072C TL074C TL07_AC	$V_{IO}$	– – –	3.0 3.0 3.0	10 10 6.0	mV
Average Temperature Coefficient of Input Offset Voltage $R_S = 50\text{ }\Omega$ , $T_A = T_{low}$ to $T_{high}$ (Note 1)	$\Delta V_{IO}/\Delta T$	–	10	–	$\mu\text{V}/^\circ\text{C}$
Input Offset Current ( $V_{CM} = 0$ ) (Note 2) TL07_C TL07_AC	$I_{IO}$	– –	5.0 5.0	50 50	pA
Input Bias Current ( $V_{CM} = 0$ ) (Note 2) TL07_C TL07_AC	$I_{IB}$	– –	30 30	200 200	pA
Input Resistance	$r_i$	–	$10^{12}$	–	$\Omega$
Common Mode Input Voltage Range TL07_C TL07_AC	$V_{ICR}$	$\pm 10$ $\pm 11$	15, –12 15, –12	– –	V
Large-Signal Voltage Gain ( $V_O = \pm 10\text{ V}$ , $R_L \geq 2.0\text{ k}$ ) TL07_C TL07_AC	$A_{VOL}$	25 50	150 150	– –	V/mV
Output Voltage Swing (Peak-to-Peak) ( $R_L = 10\text{ k}$ )	$V_O$	24	28	–	V
Common Mode Rejection Ratio ( $R_S \leq 10\text{ k}$ ) TL07_C TL07_AC	CMRR	70 80	100 100	– –	dB
Supply Voltage Rejection Ratio ( $R_S \leq 10\text{ k}$ ) TL07_C TL07_AC	PSRR	70 80	100 100	– –	dB
Supply Current (Each Amplifier)	$I_D$	–	1.4	2.5	mA
Unity Gain Bandwidth	BW	–	4.0	–	MHz
Slew Rate (See Figure 1) $V_{in} = 10\text{ V}$ , $R_L = 2.0\text{ k}$ , $C_L = 100\text{ pF}$	SR	–	13	–	V/ $\mu\text{s}$
Rise Time (See Figure 1)	$t_r$	–	0.1	–	$\mu\text{s}$
Overshoot ( $V_{in} = 20\text{ mV}$ , $R_L = 2.0\text{ k}$ , $C_L = 100\text{ pF}$ )	OS	–	10	–	%
Equivalent Input Noise Voltage $R_S = 100\text{ }\Omega$ , $f = 1000\text{ Hz}$	$e_n$	–	18	–	$\text{nV}/\sqrt{\text{Hz}}$
Equivalent Input Noise Current $R_S = 100\text{ }\Omega$ , $f = 1000\text{ Hz}$	$i_n$	–	0.01	–	$\text{pA}/\sqrt{\text{Hz}}$
Total Harmonic Distortion $V_O$ (RMS) = 10 V, $R_S \leq 1.0\text{ k}$ , $R_L \geq 2.0\text{ k}$ , $f = 1000\text{ Hz}$	THD	–	0.01	–	%
Channel Separation $A_V = 100$	CS	–	120	–	dB

**NOTES:** 1.  $T_{low} = 0^\circ\text{C}$  for TL071C,AC TL072C,AC TL074C,AC  
 $T_{high} = 70^\circ\text{C}$  for TL071C,AC TL072C,AC TL074C,AC

2. Input Bias currents of JFET input op amps approximately double for every  $10^\circ\text{C}$  rise in junction temperature as shown in Figure 3. To maintain junction temperature as close to ambient temperature as possible, pulse techniques must be used during testing.

Figure 3. Input Bias Current versus Temperature

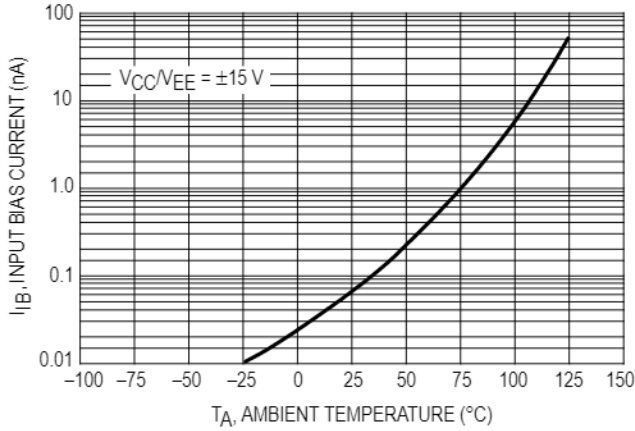


Figure 4. Output Voltage Swing versus Frequency

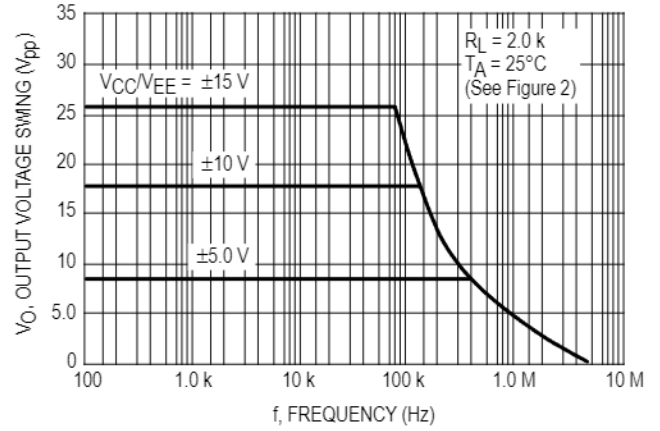


Figure 5. Output Voltage Swing versus Load Resistance

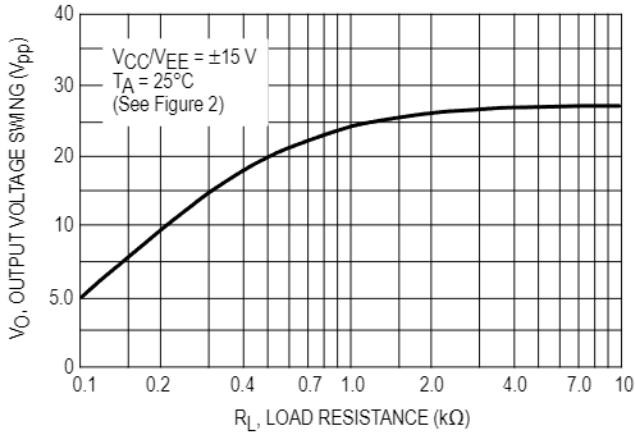


Figure 6. Output Voltage Swing versus Supply Voltage

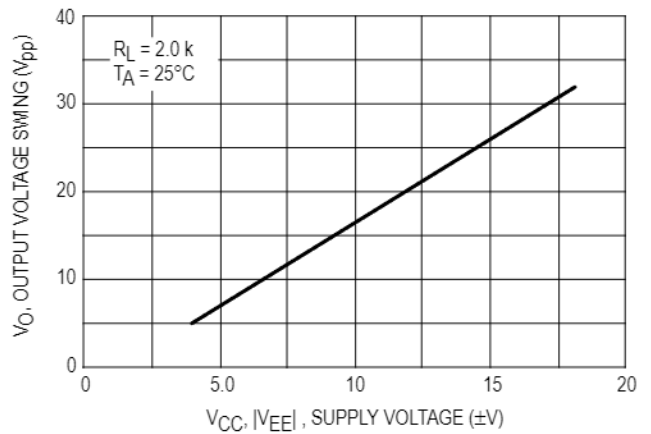


Figure 7. Output Voltage Swing versus Temperature

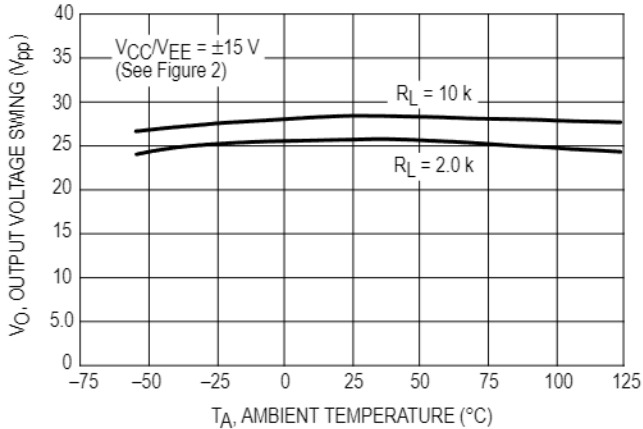


Figure 8. Supply Current per Amplifier versus Temperature

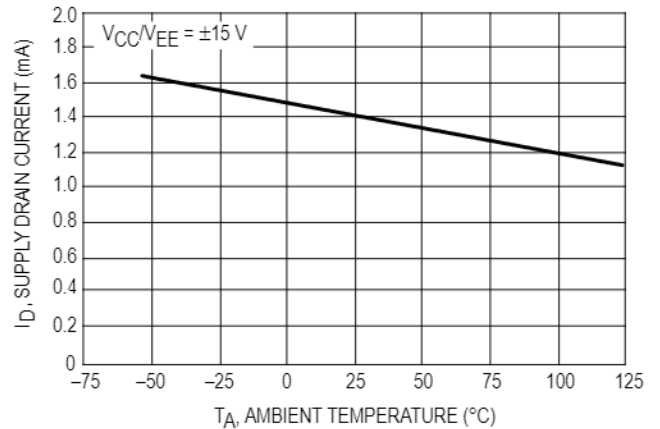


Figure 9. Large Signal Voltage Gain and Phase Shift versus Frequency

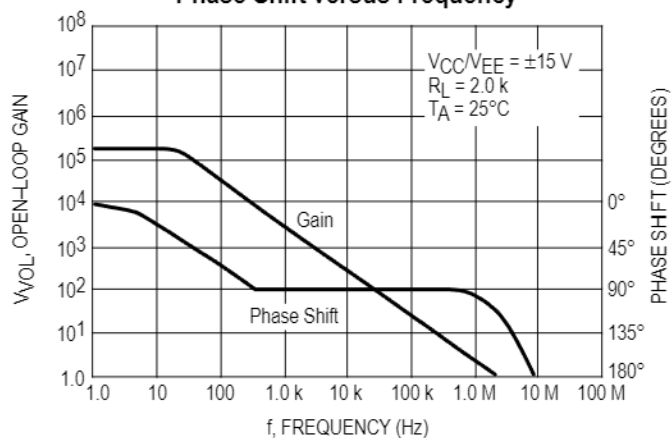


Figure 10. Large Signal Voltage Gain versus Temperature

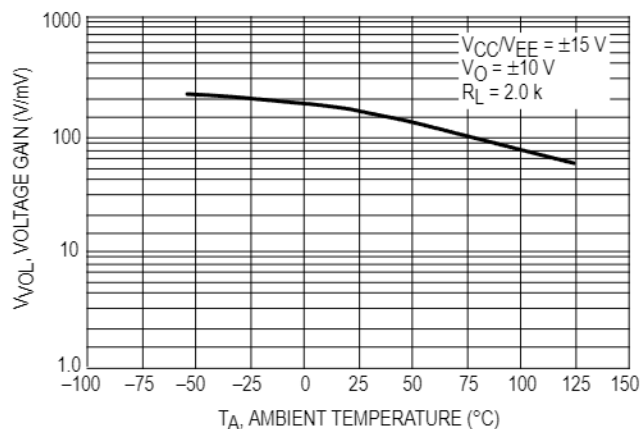


Figure 11. Normalized Slew Rate versus Temperature

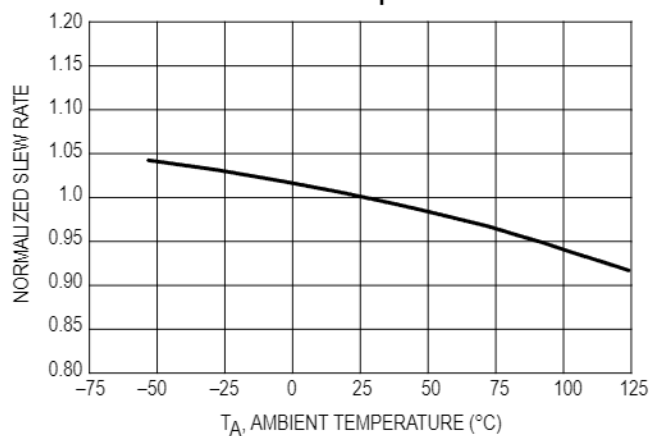


Figure 12. Equivalent Input Noise Voltage versus Frequency

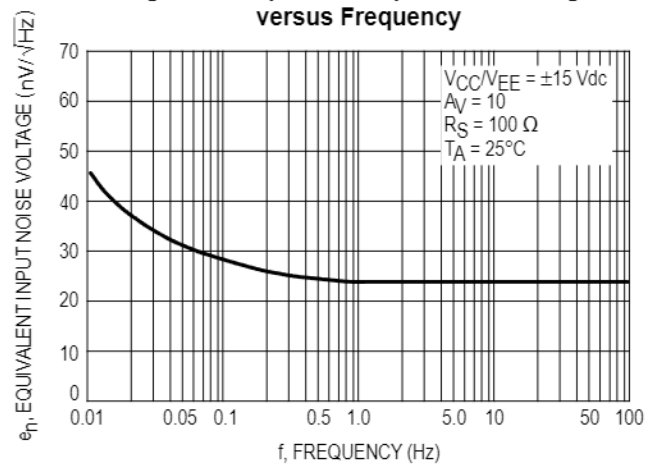
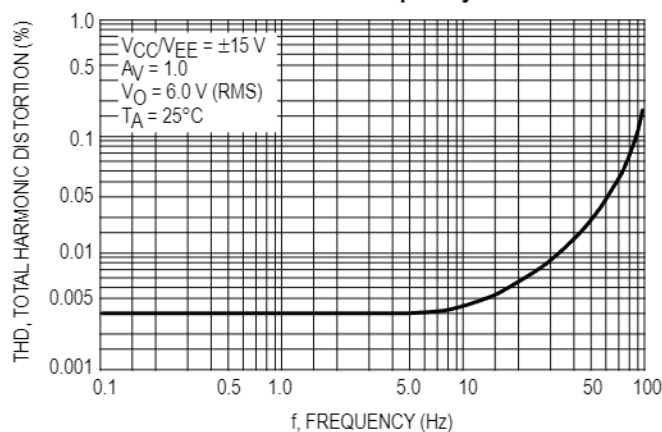
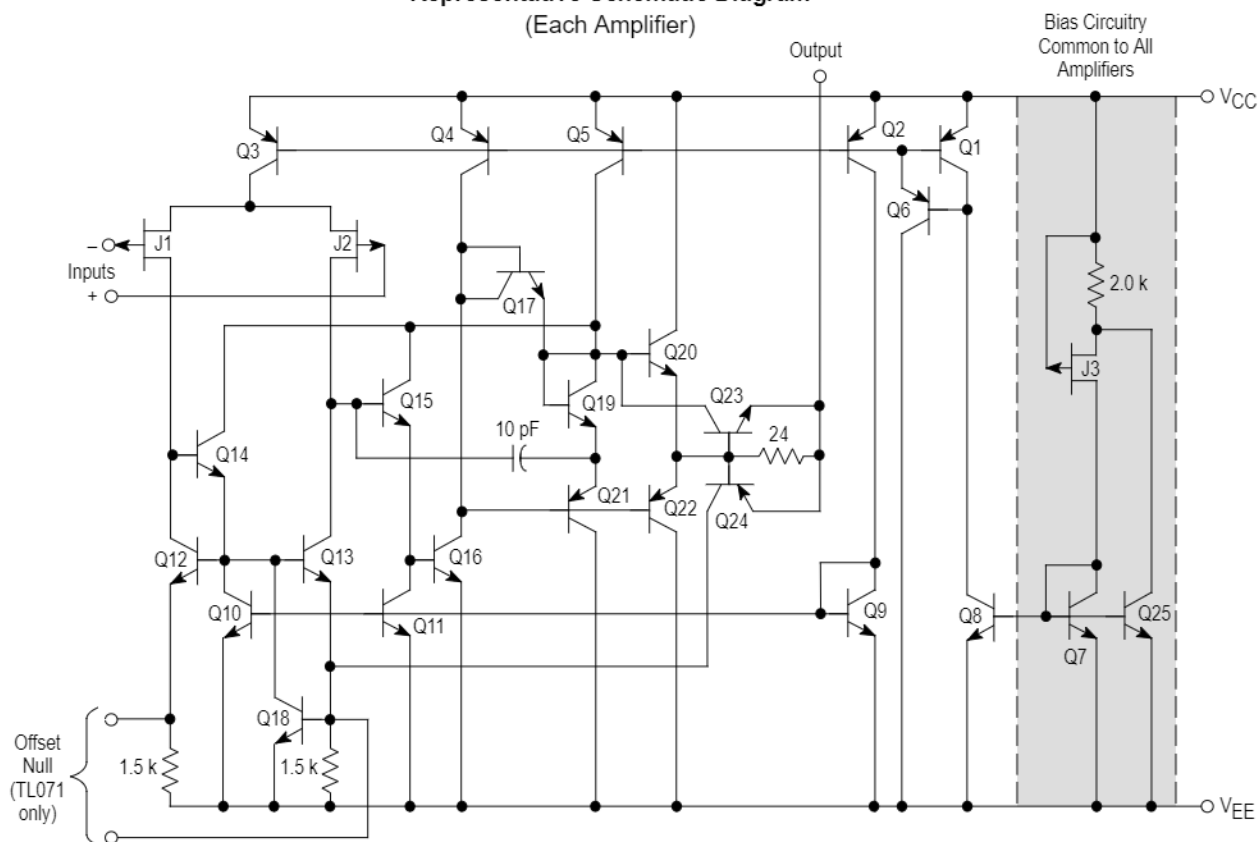


Figure 13. Total Harmonic Distortion versus Frequency

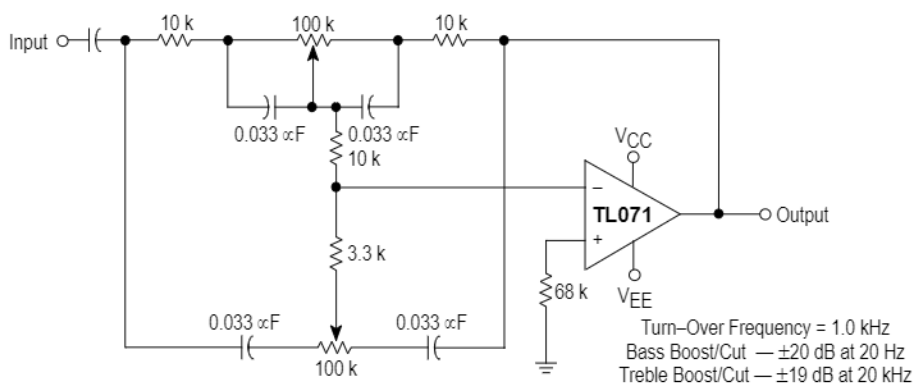


# TL071C,AC TL072C,AC TL074C,AC

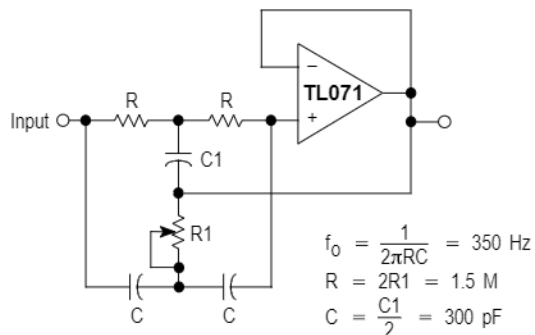
**Representative Schematic Diagram**  
(Each Amplifier)



**Figure 14. Audio Tone Control Amplifier**



**Figure 15. High Q Notch Filter**

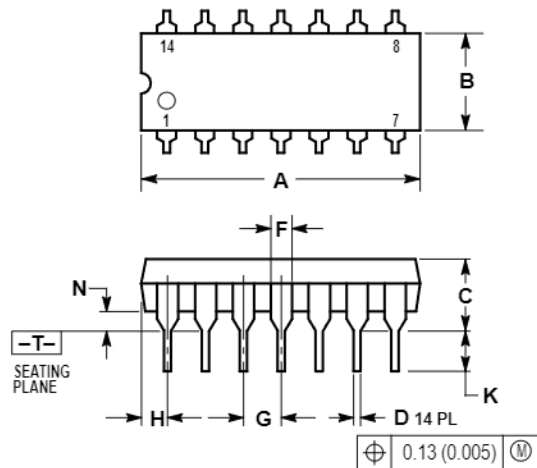




# TL071C,AC TL072C,AC TL074C,AC

## OUTLINE DIMENSIONS

**N SUFFIX**  
PLASTIC PACKAGE  
CASE 646-06  
ISSUE M



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	18.80
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	0.290	0.310	7.37	7.87
M	—	10°	—	10°
N	0.015	0.039	0.38	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.

Mfax is a trademark of Motorola, Inc.

### How to reach us:

**USA/EUROPE/Locations Not Listed:** Motorola Literature Distribution;  
P.O. Box 5405, Denver, Colorado 80217. 1-303-675-2140 or 1-800-441-2447

**JAPAN:** Nippon Motorola Ltd.: SPD, Strategic Planning Office, 4-32-1,  
Nishi-Gotanda, Shinagawa-ku, Tokyo 141, Japan. 81-3-5487-8488

**Customer Focus Center: 1-800-521-6274**

**Mfax™:** RMFAX0@email.sps.mot.com – TOUCHTONE 1-800-244-6609  
Motorola Fax Back System – US & Canada ONLY 1-800-774-1848  
– http://sps.motorola.com/mfax/

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

**HOME PAGE:** <http://motorola.com/sps/>



TL071C/D