19-0942; Rev 3; 5/10

# Single/Dual/Triple/Quad Operational Amplifiers



## General Description

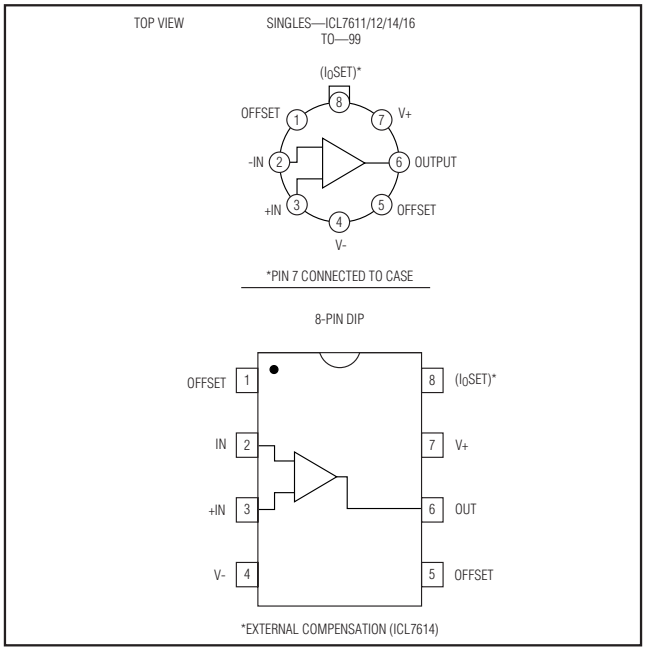
The ICL761X–ICL764X family of monolithic CMOS op amps combine ultra-low input current with low-power operation over a wide supply voltage range. With pin-selectable quiescent currents of 10µA, 100µA, or 1000µA per amplifier, these op amps will operate from ±1V to ±8V power supplies, or from single supplies from 2V to 16V. The CMOS outputs swing to within millivolts of the supply voltages.

The ultra-low bias current of 1pA makes this family of op amps ideal for long time constant integrators, picoammeters, low droop rate sample/hold amplifiers and other applications where input bias and offset currents are critical. A low noise current of 0.01pA$\sqrt{Hz}$ and an input impedance of $10^{12}\Omega$ ensure optimum performance with very high source impedances in such applications as pH meters and photodiode amplifiers.

## Applications

Battery-Powered Instruments
Low-Leakage Amplifiers
Long-Time Constant Integrators
Low-Frequency Active Filters
Hearing Aids and Microphone Amplifiers
Low Droop Rate Sample/Hold Amplifiers
Picoammeters

## Pin Configuration




## Features

- **Pin-for-Pin Second Source**
- **1pA Typical Bias Current—4nA (max) at +125°C**
- **±1V to ±8V Wide Supply Voltage Range**
- **Industry-Standard Pinouts**
- **Programmable Quiescent Currents of 10µA, 100µA, and 1000µA**
- **Monolithic, Low-Power CMOS Design**

## Ordering Information

| ICL76XX | M | N | OP |
|---|---|---|---|
| | VOS SELECTION | TEMP RANGE | PKG CODE |
| | A = 2mV | C = 0°C to 70°C | TV= 8-Pin TO-99 |
| | B = 5mV | E = -40°C to +85°C | PA = 8-Pin Plastic Dip |
| | C = 10mV | M = -55°C to +125°C | SA = 8-Pin Small SO |
| | D = 15mV | | JD = 14-Pin CERDIP |
| | E = 20mV | | PD = 14-Pin Plastic Dip |
| | | | SD = 14-Pin Small SO |
| | | | JE = 16-Pin CERDIP |
| | | | PE = 16-Pin Plastic Dip |
| | | | SE = 16-Pin Small SO |
| | | | WE – 16-Pin Wide SO |

***Typical Operating Circuit appears at end of data sheet.***

# Single/Dual/Triple/Quad Operational Amplifiers

## Ordering Information (continued)

| | ICL7611 | ICL7612 | ICL7614 | ICL7616 | ICL7621 | ICL7622 | ICL7631 | ICL7632 | ICL7641 | ICL7642 |
|---|---|---|---|---|---|---|---|---|---|---|
| Compensated | X | X | | X | X | X | X | | X | X |
| Externally Compensated | | | X | | | | | | | |
| Extended CMVR | | X | | X | | | | | | |
| Offset null capability | X | X | X | X | | X | | | | |
| Programmable $I_Q$ | X | X | | X | | | X | X | | |
| Fixed $I_Q$-10µA | | | | | | | | | | X |
| Fixed $I_Q$-100µA | | | X | | X | X | | | | |
| Fixed $I_Q$-1mA | | | | | | | | | X | |

## Ordering Information (Single/Dual)

| PART | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| **ICL761X**ACPA | 0°C to +70°C | 8 Plastic Dip |
| ICL761XACSA | 0°C to +70°C | 8 Slim SO |
| ICL761XACTV | 0°C to +70°C | TO-99 Metal Can |
| ICL761XAMTV | -55°C to +125°C | TO-99 Metal Can |
| ICL761XBCPA | 0°C to +70°C | 8 Plastic Dip |
| ICL761XBCSA | 0°C to +70°C | 8 Slim SO |
| ICL761XBCTV | 0°C to +70°C | TO-99 Metal Can |
| ICL761XBESA | -40°C to +85°C | 8 Slim SO |
| ICL761XBMTV | -55°C to +125°C | TO-99 Metal Can |
| ICL761XDCPA | 0°C to +70°C | 8 Plastic Dip |
| ICL761XDCSA | 0°C to +70°C | 8 Slim SO |
| ICL761XDCTV | 0°C to +70°C | TO-99 Metal Can |
| ICL761XDESA | -40°C to +85°C | 8 Slim SO |
| **ICL7621**ACPA | 0°C to +70°C | 8 Plastic Dip |
| ICL7621ACSA | 0°C to +70°C | 8 Slim SO |
| ICL7621ACTV | 0°C to +70°C | TO-99 Metal Can |
| ICL7621AMTV | -55°C to +125°C | TO-99 Metal Can |
| ICL7621BCPA | 0°C to +70°C | 8 Plastic Dip |

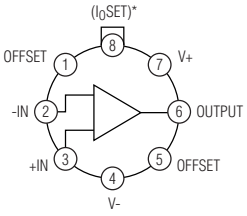
| PART | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| ICL7621BCSA | 0°C to +70°C | 8 Slim SO |
| ICL7621BCTV | 0°C to +70°C | TO-99 Metal Can |
| ICL7621BMTV | -55°C to +125°C | TO-99 Metal Can |
| ICL7621DCPA | 0°C to +70°C | 8 Plastic Dip |
| ICL7621DCSA | 0°C to +70°C | 8 Slim SO |
| ICL7621DCTV | 0°C to +70°C | TO-99 Metal Can |
| **ICL7622**ACPD | 0°C to +70°C | 14 Plastic Dip |
| ICL7622ACSD | 0°C to +70°C | 14 Slim SO |
| ICL7622ACJD | 0°C to +70°C | 14 CERDIP |
| ICL7622AMJD | -55°C to +125°C | 14 CERDIP |
| ICL7622BCPD | 0°C to +70°C | 14 Plastic Dip |
| ICL7622BCSA | 0°C to +70°C | 14 Slim SO |
| ICL7622BCJD | 0°C to +70°C | 14 CERDIP |
| ICL7622BMJD | -55°C to +125°C | 14 CERDIP |
| ICL7622DCPD | 0°C to +70°C | 14 Plastic Dip |
| ICL7622DCSD | 0°C to +70°C | 14 Slim SO |
| ICL7622DCJD | 0°C to +70°C | 14 CERDIP |

***Note:*** *X above is replaced by: 1, 2, 4, 8.*

## Pin Configurations

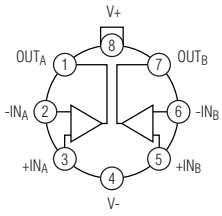
TOP VIEW

SINGLES—ICL7611/12/14/16
TO—99

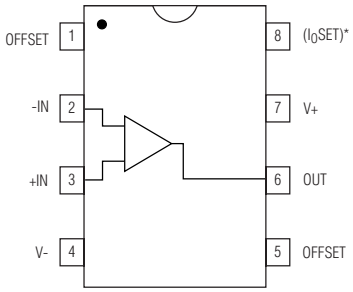



*PIN 7 CONNECTED TO CASE

DUALS—ICL7621/22
TO—99

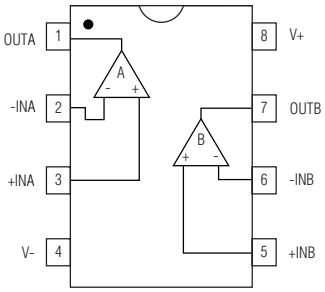



8 LEAD

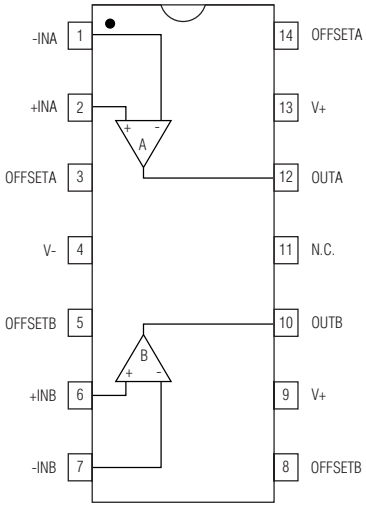



*EXTERNAL COMPENSATION (ICL7614)

8 LEAD




14 LEAD




NOTE: PINS 9 & 13 ARE INTERNALLY CONNECTED

# Single/Dual/Triple/Quad Operational Amplifiers

## ABSOLUTE MAXIMUM RATINGS (Single/Dual)

Total Supply Voltage (V+ to V-) .....+18V
Input Voltage .....(V+ + 0.3V) to (V- - 0.3V)
Differential Input Voltage (Note 1).....±(V+ + 0.3V) to (V- - 0.3V)
Duration of Output Short Circuit (Note 2).....Unlimited
Continuous Power Dissipation ($T_A$ = +25°C)
TO-99 Metal Can (derate 2mW/°C above +25°C) .....250mW
8-Pin Minidip (derate 2mW/°C above +25°C).....250mW
14-Pin Plastic (derate 3mW/°C above +25°C) .....375mW
14-Pin CERDIP (derate 4mW/°C above +25°C).....500mW
16-Pin Plastic (derate 3mW/°C above +25°C) .....375mW
16-Pin CERDIP (derate 4mW/°C above +25°C).....500mW

Operating Temperature Ranges:
M Series.....-55°C to +125°C
E Series.....-40°C to +85°C
C Series .....-0°C to +70°C
Storage Temperature Range .....-55°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C
Soldering Temperature (reflow)
Lead(Pb)-Free Packages.....+260°C
Packages Containing Lead.....+240°C

*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

**Note 1:** Long-term offset voltage stability will be degraded if large input differential voltages are applied for long periods of time.
**Note 2:** The outputs may be shorted to ground or to either supply for $V_{SUPP} \leq 10V$. Care must be taken to insure that the dissipation rating is not exceeded.

## ELECTRICAL CHARACTERISTICS (Single/Dual)

($V_{SUPP}$ = ±1.0V, $I_Q$ = 10µA, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | ICL76XXA | | | ICL76XXB | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Input Offset Voltage | $V_{OS}$ | $R_S \leq 100k\Omega$, $T_A$ = +25°C | | | 2 | | | 5 | mV |
| | | $R_S \leq 100k\Omega$, $T_{MIN} \leq T_A \leq T_{MAX}$ | | | 3 | | | 7 | |
| Temperature Coefficient of $V_{OS}$ | $\Delta V_{OS}/\Delta T$ | $R_S \leq 100k\Omega$ | | 10 | | | 15 | | µV/°C |
| Input Offset Current | $I_{OS}$ | $T_A$ = +25°C | | 0.5 | 30 | | 0.5 | 30 | pA |
| | | 0°C ≤ $T_A$ ≤ +70°C | | | 300 | | | 300 | |
| Input Bias Current | $I_{BIAS}$ | $T_A$ = +25°C | | 1.0 | 50 | | 1.0 | 50 | pA |
| | | 0°C ≤ $T_A$ ≤ +70°C | | | 500 | | | 500 | |
| Common-Mode Voltage Range (Except ICL7612/ ICL7616) | $V_{CMR}$ | | -0.4 | | +0.6 | -0.4 | | +0.6 | V |
| Extended Common-Mode Voltage Range (ICL7612 Only) | $V_{CMR}$ | | -1.1 | | +0.6 | -1.1 | | +0.6 | V |
| Extended Common-Mode Voltage Range (ICL7616 Only) | $V_{CMR}$ | $I_Q$ = 10µA | -1.3 | | -0.3 | -1.3 | | -0.3 | V |
| Output Voltage Swing | $V_{OUT}$ | $R_L$ = 1MΩ, $T_A$ = +25°C | | ±0.98 | | | ±0.98 | | V |
| | | $R_L$ = 1MΩ, 0°C ≤ $T_A$ ≤ +70°C | | ±0.96 | | | ±0.96 | | |

## ELECTRICAL CHARACTERISTICS (Single/Dual) (continued)

($V_{SUPP}$ = ±1.0V, $I_Q$ = 10µA, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | ICL76XXA | | | ICL76XXB | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Large-Signal Voltage Gain | $A_{VOL}$ | $V_O$ = ±0.1V, $R_L$ = 1MΩ, $T_A$ = +25°C | | 90 | | | 90 | | dB |
| | | $V_O$ = ±0.1V, $R_L$ = 1MΩ, 0°C ≤ $T_A$ ≤ +70°C | | 80 | | | 80 | | |
| Unity-Gain Bandwidth | GBW | | | 0.044 | | | 0.044 | | MHz |
| Input Resistance | $R_{IN}$ | | | $10^{12}$ | | | $10^{12}$ | | Ω |
| Common-Mode Rejection Ratio | CMRR | $R_S$ ≤ 100kΩ | | 80 | | | 80 | | dB |
| Power-Supply Rejection Ratio | PSRR | $R_S$ ≤ 100kΩ | | 80 | | | 80 | | dB |
| Input-Referred Noise Voltage | $e_n$ | $R_S$ = 100Ω, f = 1kHz | | 100 | | | 100 | | nV/√Hz |
| Input-Referred Noise Current | $i_n$ | $R_S$ = 100Ω, f = 1kHz | | 0.01 | | | 0.01 | | pA/√Hz |
| Supply Current (Per Amplifier) | $I_{SUPP}$ | No signal, no load | | 6 | 15 | | 6 | 15 | µA |
| Slew Rate | SR | $A_{VOL}$ = 1, $C_L$ = 100pF, $V_{IN}$ = 0.2$V_{P-P}$, $R_L$ = 1MΩ | | 0.016 | | | 0.016 | | V/µs |
| Rise Time | $t_r$ | $V_{IN}$ = 50mV, $C_L$ = 100pF, $R_L$ = 1MΩ | | 20 | | | 20 | | µs |
| Overshoot Factor | | $V_{IN}$ = 50mV, $C_L$ = 100pF, $R_L$ = 1MΩ | | 5 | | | 5 | | % |

## ELECTRICAL CHARACTERISTICS (Single/Dual)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | ICL76XXA | | | ICL76XXB | | | ICL76XXD | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Input Offset Voltage | $V_{OS}$ | $R_S$ ≤ 100kΩ, $T_A$ = +25°C | | | 2 | | | 5 | | | 15 | mV |
| | | $R_S$ ≤ 100kΩ, $T_{MIN}$ ≤ $T_A$ ≤ $T_{MAX}$ | | | 3 | | | 7 | | | 20 | |
| Temperature Coefficient of $V_{OS}$ | $\Delta V_{OS}/\Delta T$ | $R_S$ ≤ 100kΩ | | 10 | | | 15 | | | 25 | | µV/°C |
| Input Offset Current | $I_{OS}$ | $T_A$ = +25°C | | 0.5 | 30 | | 0.5 | 30 | | 0.5 | 30 | pA |
| | | C: 0°C ≤ $T_A$ ≤ +70°C | | | 300 | | | 300 | | | 300 | |
| | | E: -40°C ≤ $T_A$ ≤ +85°C | | | 800 | | | 800 | | | 800 | |
| | | M: -55°C≤ $T_A$ ≤ +125°C | | | 800 | | | 800 | | | 800 | |

## ELECTRICAL CHARACTERISTICS (Single/Dual) (continued)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | ICL76XXA | | | ICL76XXB | | | ICL76XXD | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Input Bias Current | $I_{BIAS}$ | $T_A$ = +25°C | | 1.0 | 50 | | 1.0 | 50 | | 1.0 | 50 | pA |
| | | C: 0°C ≤ $T_A$ ≤ +70°C | | | 400 | | | 400 | | | 400 | |
| | | E: -40°C ≤ $T_A$ ≤ +85°C | | | 4000 | | | 4000 | | | 4000 | |
| | | M: -55°C≤ $T_A$ ≤ +125°C | | | 4000 | | | 4000 | | | 4000 | |
| Common-Mode Voltage Range (Except ICL7612/ ICL7616) | $V_{CMR}$ | $I_Q$ = 10µA (Note 3) | +4.4 | | | +4.4 | | | +4.4 | | | V |
| | | | -4.0 | | | -4.0 | | | -4.0 | | | |
| | | $I_Q$ = 100µA (Note 3) | +4.2 | | | +4.2 | | | +4.2 | | | |
| | | | -4.0 | | | -4.0 | | | -4.0 | | | |
| | | $I_Q$ = 1mA (Note 3) | +3.7 | | | +3.7 | | | +3.7 | | | |
| | | | -3.7 | | | -3.7 | | | -3.7 | | | |
| Extended Common-Mode Voltage Range (ICL7612 Only) | $V_{CMR}$ | $I_Q$ = 10µA | ±5.3 | | | ±5.3 | | | ±5.3 | | | V |
| | | $I_Q$ = 100µA | +5.3 | | | +5.3 | | | +5.3 | | | |
| | | | -5.1 | | | -5.1 | | | -5.1 | | | |
| | | $I_Q$ = 1mA | +5.3 | | | +5.3 | | | +5.3 | | | |
| | | | -4.5 | | | -4.5 | | | -4.5 | | | |
| Extended Common-Mode Voltage Range (ICL7616 Only) | $V_{CMR}$ | $I_Q$ = 10µA | -5.3 | | | -5.3 | | | -5.3 | | | V |
| | | | +3.7 | | | +3.7 | | | +3.5 | | | |
| | | $I_Q$ = 100µA | -5.1 | | | -5.1 | | | -5.1 | | | |
| | | | +3.0 | | | +3.0 | | | +2.7 | | | |
| | | $I_Q$ = 1mA | -4.5 | | | -4.5 | | | -4.5 | | | |
| | | | +2.0 | | | +2.0 | | | +1.7 | | | |

## ELECTRICAL CHARACTERISTICS (Single/Dual) (continued)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | ICL76XXA | | | ICL76XXB | | | ICL76XXD | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Output Voltage Swing | $V_{OUT}$ | $I_Q$ = 10µA, $R_L$ = 1MΩ (Note 3) | $T_A$ = +25°C | ±4.9 | | | ±4.9 | | | ±4.9 | | | V |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | ±4.8 | | | ±4.8 | | | ±4.8 | | | |
| | | | E: -40°C ≤ $T_A$ ≤ +85°C | ±4.7 | | | ±4.7 | | | ±4.7 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | ±4.7 | | | ±4.7 | | | ±4.7 | | | |
| | | $I_Q$ = 100µA, $R_L$ = 100kΩ | $T_A$ = +25°C | ±4.9 | | | ±4.9 | | | ±4.9 | | | |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | ±4.8 | | | ±4.8 | | | ±4.8 | | | |
| | | | E: -40°C ≤ $T_A$ ≤ +85°C | ±4.5 | | | ±4.5 | | | ±4.5 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | ±4.5 | | | ±4.5 | | | ±4.5 | | | |
| | | $I_Q$ = 1mA, $R_L$ = 10kΩ (Note 3) | $T_A$ = +25°C | ±4.5 | | | ±4.5 | | | ±4.5 | | | |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | ±4.3 | | | ±4.3 | | | ±4.3 | | | |
| | | | E: -40°C ≤ $T_A$ ≤ +85°C | ±4.0 | | | ±4.0 | | | ±4.0 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | ±4.0 | | | ±4.0 | | | ±4.0 | | | |

## ELECTRICAL CHARACTERISTICS (Single/Dual) (continued)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | ICL76XXA | | | ICL76XXB | | | ICL76XXD | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Large-Signal Voltage Gain | $A_{VOL}$ | $V_O$ = ±4.0V $R_L$ = 1MΩ, $I_Q$ = 10µA | $T_A$ = +25°C | 86 | 104 | | 80 | 104 | | 80 | 104 | | dB |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | 80 | | | 75 | | | 75 | | | |
| | | | E: -40°C ≤ $T_A$ ≤ +85°C | 74 | | | 68 | | | 68 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | 74 | | | 68 | | | 68 | | | |
| | | $V_O$ = ±4.0V, $R_L$ = 100kΩ, $I_Q$ = 100µA | $T_A$ = +25°C | 86 | 102 | | 80 | 102 | | 80 | 102 | | |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | 80 | | | 75 | | | 75 | | | |
| | | | E: -40°C ≤ $T_A$ ≤ +85°C | 74 | | | 68 | | | 68 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | 74 | | | 68 | | | 68 | | | |
| | | $V_O$ = ±4.0V, $R_L$ = 10kΩ, $I_Q$ = 1mA (Note 3) | $T_A$ = +25°C | 80 | 83 | | 76 | 83 | | 76 | 83 | | |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | 76 | | | 72 | | | 72 | | | |
| | | | E: -40°C ≤ $T_A$ ≤ +85°C | 72 | | | 68 | | | 68 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | 72 | | | 68 | | | 68 | | | |

## ELECTRICAL CHARACTERISTICS (Single/Dual) (continued)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | ICL76XXA | | | ICL76XXB | | | ICL76XXD | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Unity-Gain Bandwidth | GBW | $I_Q$ = 10µA (Note 3) | | | 0.044 | | | 0.044 | | | 0.044 | | MHz |
| | | $I_Q$ = 100µA | | | 0.48 | | | 0.48 | | | 0.48 | | |
| | | $I_Q$ = 1mA (Note 3) | | | 1.4 | | | 1.4 | | | 1.4 | | |
| Input Resistance | $R_{IN}$ | | | | $10^{12}$ | | | $10^{12}$ | | | $10^{12}$ | | Ω |
| Common-Mode Rejection Ratio | CMRR | $R_S$ ≤ 100kΩ, $I_Q$ = 10µA (Note 3) | | 76 | 96 | | 70 | 96 | | 70 | 96 | | dB |
| | | $R_S$ ≤ 100kΩ, $I_Q$ = 100µA | | 76 | 91 | | 70 | 91 | | 70 | 91 | | |
| | | $R_S$ ≤ 100kΩ, $I_Q$ = 1mA (Note 3) | | 66 | 87 | | 60 | 87 | | 60 | 87 | | |
| Power-Supply Rejection Ratio | PSRR | $R_S$ ≤ 100kΩ, $I_Q$ = 10µA (Note 3) | | 80 | 94 | | 80 | 94 | | 80 | 94 | | dB |
| | | $R_S$ ≤ 100kΩ, $I_Q$ = 100µA | | 80 | 86 | | 80 | 86 | | 80 | 86 | | |
| | | $R_S$ ≤ 100kΩ, $I_Q$ = 1mA (Note 3) | | 70 | 77 | | 70 | 77 | | 70 | 77 | | |
| Input-Referred Noise Voltage | $e_n$ | $R_S$ = 100Ω, f = 1kHz | | | 100 | | | 100 | | | 100 | | nV/√Hz |
| Input-Referred Noise Current | $i_n$ | $R_S$ = 100Ω, f = 1kHz | | | 0.01 | | | 0.01 | | | 0.01 | | pA/√Hz |
| Supply Current (Per Amplifier) | $I_{SUPP}$ | No signal, no load | $I_Q$ = 10µA (Note 3) | | 0.01 | 0.02 | | 0.01 | 0.02 | | 0.01 | 0.02 | mA |
| | | | $I_Q$ = 100µA | | 0.1 | 0.25 | | 0.1 | 0.25 | | 0.1 | 0.25 | |
| | | | $I_Q$ = 1mA (Note 3) | | 1.0 | 2.5 | | 1.0 | 2.5 | | 1.0 | 2.5 | |
| Channel Separation | $V_{O1}$ / $V_{O2}$ | $A_{VOL}$ = 100 | | | 120 | | | 120 | | | 120 | | dB |

# Single/Dual/Triple/Quad Operational Amplifiers

## ELECTRICAL CHARACTERISTICS (Single/Dual) (continued)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | ICL76XXA | | | ICL76XXB | | | ICL76XXD | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Slew Rate (Note 4) | SR | $A_{VOL}$ = 1, $C_L$ = 100pF, $V_{IN}$ = $8V_{P-P}$ | $I_Q$ = 10µA (Note 3), $R_L$ = 1MΩ | | 0.016 | | | 0.016 | | | 0.016 | | V/µs |
| | | | $I_Q$ = 100µA, $R_L$ = 100kΩ | | 0.16 | | | 0.16 | | | 0.16 | | |
| | | | $I_Q$ = 1mA (Note 3), $R_L$ = 10kΩ | | 1.6 | | | 1.6 | | | 1.6 | | |
| Rise Time (Note 4) | $t_r$ | $V_{IN}$ = 50mV, $C_L$ = 100pF | $I_Q$ = 10µA (Note 3), $R_L$ = 1MΩ | | 20 | | | 20 | | | 20 | | µs |
| | | | $I_Q$ = 100µA, $R_L$ = 100kΩ | | 2 | | | 2 | | | 2 | | |
| | | | $I_Q$ = 1mA (Note 3), $R_L$ = 10kΩ | | 0.9 | | | 0.9 | | | 0.9 | | |
| Overshoot Factor (Note 4) | | $V_{IN}$ = 50mV, $C_L$ = 100pF | $I_Q$ = 10µA (Note 3), $R_L$ = 1MΩ | | 5 | | | 5 | | | 5 | | % |
| | | | $I_Q$ = 100µA, $R_L$ = 100kΩ | | 10 | | | 10 | | | 10 | | |
| | | | $I_Q$ = 1mA (Note 3), $R_L$ = 10kΩ | | 40 | | | 40 | | | 40 | | |

**Note 3:** ICL7611, ICL7612, ICL7616 only.
**Note 4:** ICL7814; 39pF from pin 6 to pin 8.

## Ordering Information (Triple/Quad)

| PART | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| **ICL763X**BCPE | 0°C to +70°C | 16 Plastic Dip |
| ICL763XBCSE | 0°C to +70°C | 16 Slim SO |
| ICL763XCCPE | 0°C to +70°C | 16 Plastic Dip |
| ICL763XCCSE | 0°C to +70°C | 16 Slim SO |
| ICL763XECPE | 0°C to +70°C | 16 Plastic Dip |
| ICL763XECSE | 0°C to +70°C | 16 Slim SO |
| ICL763XBCJE | 0°C to +70°C | 16 CERDIP |
| ICL763XCCJE | 0°C to +70°C | 16 CERDIP |
| ICL763XECJE | 0°C to +70°C | 16 CERDIP |
| ICL763XBMJE | -55°C to +125°C | 16 CERDIP |
| ICL763XCMJE | -55°C to +125°C | 16 CERDIP |

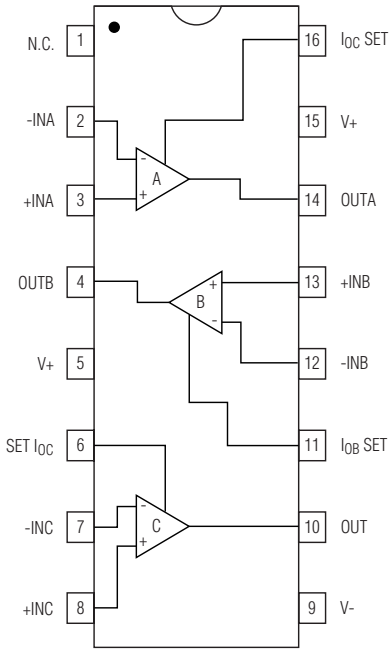
| PART | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| **ICL764X**BCPD | 0°C to +70°C | 14 Plastic Dip |
| ICL764XBCWE | 0°C to +70°C | 16 Wide SO |
| ICL764XCCPD | 0°C to +70°C | 14 Plastic Dip |
| ICL764XCCWE | 0°C to +70°C | 16 Wide SO |
| ICL764XECPD | 0°C to +70°C | 14 Plastic Dip |
| ICL764XECWE | 0°C to +70°C | 16 Wide SO |
| ICL764XBCJD | 0°C to +70°C | 14 CERDIP |
| ICL764XCCJD | 0°C to +70°C | 14 CERDIP |
| ICL764XECJD | 0°C to +70°C | 14 CERDIP |
| ICL764XBMJD | -55°C to +125°C | 14 CERDIP |
| ICL764XCMJD | -55°C to +125°C | 14 CERDIP |

*Note: X above is replaced by 1, 2.*

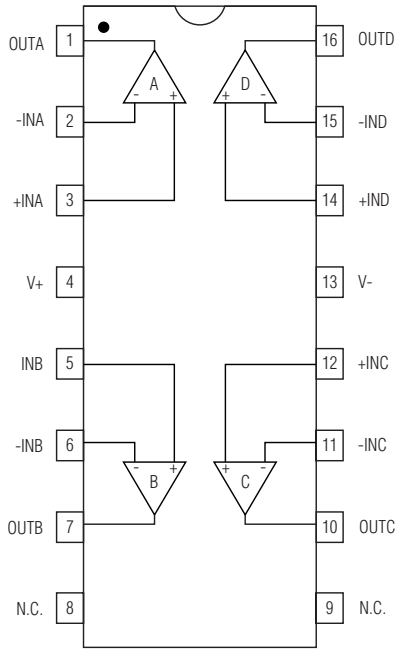
## Pin Configurations

TOP VIEW

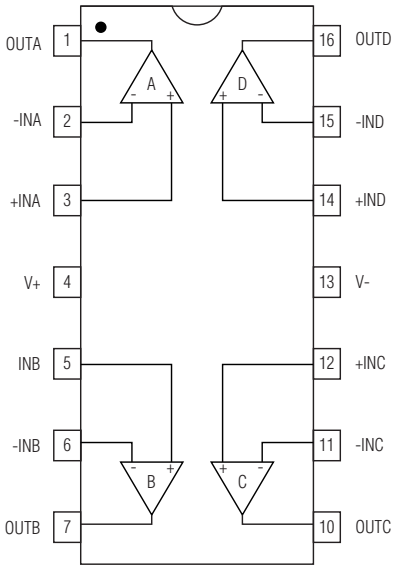
ICL7631/32
16 LEAD




ICL7641/42
16 LEAD WIDE S.O.




ICL7641/42
14 LEAD




NOTE: PINS 5 & 15 ARE INTERNALLY CONNECTED

# Single/Dual/Triple/Quad Operational Amplifiers

## ABSOLUTE MAXIMUM RATINGS (Triple/Quad)

Total Supply Voltage (V+ to V-) .....+18V
Input Voltage .....(V+ + 0.3V) to (V- - 0.3V)
Differential Input Voltage (Note 5).....±I(V+ + 0.3V) - (V- - 0.3V)
Duration of Output Short Circuit (Note 6).....Unlimited
Continuous Power Dissipation ($T_A$ = +25°C)
TO-99 Metal Can (derate 2mW/°C above +25°C) .....250mW
8-Pin Minidip (derate 2mW/°C above +25°C).....250mW
14-Pin Plastic (derate 3mW/°C above +25°C).....375mW
14-Pin CERDIP (derate 4mW/°C above +25°C).....500mW
16-Pin Plastic (derate 3mW/°C above +25°C).....375mW
16-Pin CERDIP (derate 4mW/°C above +25°C).....500mW
Operating Temperature Ranges:
M Series.....-55°C to +125°C
E Series.....-40°C to +85°C
C Series .....-0°C to +70°C
Storage Temperature Range .....-55°C to +150°C
Lead Temperature (soldering, 10s) .....+300°C

*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

**Note 5:** Long-term offset voltage stability will be degraded if large input differential voltages are applied for long periods of time.
**Note 6:** The outputs may be shorted to ground or to either supply for $V_{SUPP} \le 10V$. Care must be taken to insure that the dissipation rating is not exceeded.

## ELECTRICAL CHARACTERISTICS (Triple/Quad)

($V_{SUPP}$ = ±1.0V, $I_Q$ = 10µA, $T_A$ = +25°C, unless otherwise noted.) (Specifications apply to ICL7631/7632/7642 only.)

| PARAMETER | SYMBOL | CONDITIONS | ICL76XXB | | | ICL76XXC | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Input Offset Voltage | $V_{OS}$ | $R_S \le 100k\Omega$, $T_A$ = +25°C | | | 5 | | | 10 | mV |
| | | $R_S \le 100k\Omega$, $T_{MIN} \le T_A \le T_{MAX}$ | | | 7 | | | 12 | |
| Temperature Coefficient of $V_{OS}$ | $\Delta V_{OS}/\Delta T$ | $R_S \le 100k\Omega$ | | 15 | | | 20 | | µV/°C |
| Input Offset Current | $I_{OS}$ | $T_A$ = +25°C | | 0.5 | 30 | | 0.5 | 30 | pA |
| | | 0°C ≤ $T_A$ ≤ +70°C | | | 300 | | | 300 | |
| Input Bias Current | $I_{BIAS}$ | $T_A$ = +25°C | | 1.0 | 50 | | 1.0 | 50 | pA |
| | | 0°C ≤ $T_A$ ≤ +70°C | | | 500 | | | 500 | |
| Common-Mode Voltage Range | $V_{CMR}$ | | -0.4 | | +0.6 | -0.4 | | +0.6 | V |
| Output Voltage Swing | $V_{OUT}$ | $R_L$ = 1MΩ, $T_A$ = +25°C | | ±0.98 | | | ±0.98 | | V |
| | | $R_L$ = 1MΩ, 0°C ≤ $T_A$ ≤ +70°C | | ±0.96 | | | ±0.96 | | |
| Large-Signal Voltage Gain | $A_{VOL}$ | $V_O$ = ±0.1V, $R_L$ = 1MΩ, $T_A$ = +25°C | | 90 | | | 90 | | dB |
| | | $V_O$ = ±0.1V, $R_L$ = 1MΩ, 0°C ≤ $T_A$ ≤ +70°C | | 80 | | | 80 | | |
| Unity-Gain Bandwidth | GBW | | | 0.044 | | | 0.044 | | MHz |
| Input Resistance | $R_{IN}$ | | | $10^{12}$ | | | $10^{12}$ | | Ω |
| Common-Mode Rejection Ratio | CMRR | $R_S \le 100k\Omega$ | | 80 | | | 80 | | dB |

## ELECTRICAL CHARACTERISTICS (Triple/Quad) (continued)

($V_{SUPP}$ = ±1.0V, $I_Q$ = 10µA, $T_A$ = +25°C, unless otherwise noted.) (Specifications apply to ICL7631/7632/7642 only.)

| PARAMETER | SYMBOL | CONDITIONS | ICL76XXB | | | ICL76XXC | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Power-Supply Rejection Ratio | PSRR | | | 80 | | | 80 | | dB |
| Input-Referred Noise Voltage | $e_n$ | $R_S$ = 100Ω, f = 1kHz | | 100 | | | 100 | | nV/√Hz |
| Input-Referred Noise Current | $i_n$ | $R_S$ = 100Ω, f = 1kHz | | 0.01 | | | 0.01 | | pA/√Hz |
| Supply Current (Per Amplifier) | $I_{SUPP}$ | No signal, no load | | 6 | 15 | | 6 | 15 | µA |
| Channel Separation | $V_{O1}$ / $V_{O2}$ | $A_{VOL}$ = 100 | | 120 | | | 120 | | dB |
| Slew Rate | SR | $A_{VOL}$ = 1, $C_L$ = 100pF, $V_{IN}$ = 0.2$V_{P-P}$, $R_L$ = 1MΩ | | 0.016 | | | 0.016 | | V/µs |
| Rise Time | $t_r$ | $V_{IN}$ = 50mV, $C_L$ = 100pF, $R_L$ = 1MΩ | | 20 | | | 20 | | µs |
| Overshoot Factor | | $V_{IN}$ = 50mV, $C_L$ = 100pF, $R_L$ = 1MΩ | | 5 | | | 5 | | % |

## ELECTRICAL CHARACTERISTICS (Triple/Quad)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | ICL76XXB | | | ICL76XXC | | | ICL76XXE | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Input Offset Voltage | $V_{OS}$ | $R_S$ ≤ 100kΩ, $T_A$ = +25°C | | | 5 | | | 10 | | | 20 | mV |
| | | $R_S$ ≤ 100kΩ, $T_{MIN}$ ≤ $T_A$ ≤ $T_{MAX}$ | | | 7 | | | 15 | | | 25 | |
| Temperature Coefficient of $V_{OS}$ | $\Delta V_{OS}/\Delta T$ | $R_S$ ≤ 100kΩ | | 15 | | | 20 | | | 30 | | µV/°C |
| Input Offset Current | $I_{OS}$ | $T_A$ = +25°C | | 0.5 | 30 | | 0.5 | 30 | | 0.5 | 30 | pA |
| | | C: 0°C ≤ $T_A$ ≤ +70°C | | | 300 | | | 300 | | | 300 | |
| | | M: -55°C≤ $T_A$ ≤ +125°C | | | 800 | | | 800 | | | 800 | |
| Input Bias Current | $I_{BIAS}$ | $T_A$ = +25°C | | 1.0 | 50 | | 1.0 | 50 | | 1.0 | 50 | pA |
| | | C: 0°C ≤ $T_A$ ≤ +70°C | | | 500 | | | 500 | | | 500 | |
| | | M: -55°C≤ $T_A$ ≤ +125°C | | | 4000 | | | 4000 | | | 4000 | |

## ELECTRICAL CHARACTERISTICS (Triple/Quad) (continued)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | ICL76XXB | | | ICL76XXC | | | ICL76XXE | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Common-Mode Voltage Range | $V_{CMR}$ | $I_Q$ = 10µA (Note 7) | | +4.4 | | | +4.4 | | | +4.4 | | | V |
| | | | | -4.0 | | | -4.0 | | | -4.0 | | | |
| | | $I_Q$ = 100µA (Note 9) | | +4.2 | | | +4.2 | | | +4.2 | | | |
| | | | | -4.0 | | | -4.0 | | | -4.0 | | | |
| | | $I_Q$ = 1mA (Note 8) | | +3.7 | | | +3.7 | | | +3.7 | | | |
| | | | | -3.7 | | | -3.7 | | | -3.7 | | | |
| Output Voltage Swing | $V_{OUT}$ | $I_Q$ = 10µA, $R_L$ = 1MΩ (Note 7) | $T_A$ = +25°C | ±4.9 | | | ±4.9 | | | ±4.9 | | | V |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | ±4.8 | | | ±4.8 | | | ±4.8 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | ±4.7 | | | ±4.7 | | | ±4.7 | | | |
| | | $I_Q$ = 100µA, $R_L$ = 100kΩ (Note 9) | $T_A$ = +25°C | ±4.9 | | | ±4.9 | | | ±4.9 | | | |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | ±4.8 | | | ±4.8 | | | ±4.8 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | ±4.5 | | | ±4.5 | | | ±4.5 | | | |
| | | $I_Q$ = 1mA, $R_L$ = 10kΩ (Note 8) | $T_A$ = +25°C | ±4.5 | | | ±4.5 | | | ±4.5 | | | |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | ±4.3 | | | ±4.3 | | | ±4.3 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | ±4.0 | | | ±4.0 | | | ±4.0 | | | |

## ELECTRICAL CHARACTERISTICS (Triple/Quad) (continued)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | ICL76XXB | | | ICL76XXC | | | ICL76XXE | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Large-Signal Voltage Gain | $A_{VOL}$ | $V_O$ = ±4.0V, $R_L$ = 1MΩ, $I_Q$ = 10µA (Note 7) | $T_A$ = +25°C | 86 | 104 | | 80 | 104 | | 80 | 104 | | dB |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | 80 | | | 75 | | | 75 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | 74 | | | 68 | | | 68 | | | |
| | | $V_O$ = ±4.0V, $R_L$ = 100kΩ, $I_Q$ = 100µA | $T_A$ = +25°C | 86 | 102 | | 80 | 102 | | 80 | 102 | | |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | 80 | | | 75 | | | 75 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | 74 | | | 68 | | | 68 | | | |
| | | $V_O$ = ±4.0V, $R_L$ = 10kΩ (Note 8), $I_Q$ = 1mA (Note 7) | $T_A$ = +25°C | 86 | 98 | | 80 | 98 | | 80 | 98 | | |
| | | | C: 0°C ≤ $T_A$ ≤ +70°C | 80 | | | 75 | | | 75 | | | |
| | | | M: -55°C ≤ $T_A$ ≤ +125°C | 74 | | | 68 | | | 68 | | | |

## ELECTRICAL CHARACTERISTICS (Triple/Quad) (continued)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | ICL76XXB | | | ICL76XXC | | | ICL76XXE | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Unity-Gain Bandwidth | $G_{BW}$ | $I_Q$ = 10µA (Note 7) | | | 0.044 | | | 0.044 | | | 0.044 | | MHz |
| | | $I_Q$ = 100µA (Note 9) | | | 0.48 | | | 0.48 | | | 0.48 | | |
| | | $I_Q$ = 1mA (Note 8) | | | 1.4 | | | 1.4 | | | 1.4 | | |
| Input Resistance | $R_{IN}$ | | | | $10^{12}$ | | | $10^{12}$ | | | $10^{12}$ | | Ω |
| Common-Mode Rejection Ratio | CMRR | $R_S \le 100k\Omega$, $I_Q$ = 10µA (Note 7) | | 76 | 96 | | 70 | 96 | | 70 | 96 | | dB |
| | | $R_S \le 100k\Omega$, $I_Q$ = 100µA | | 76 | 91 | | 70 | 91 | | 70 | 91 | | |
| | | $R_S \le 100k\Omega$, $I_Q$ = 1mA (Note 8) | | 66 | 87 | | 60 | 87 | | 60 | 87 | | |
| Power-Supply Rejection Ratio | PSRR | $R_S \le 100k\Omega$, $I_Q$ = 10µA (Note 7) | | 80 | 94 | | 80 | 94 | | 80 | 94 | | dB |
| | | $R_S \le 100k\Omega$, $I_Q$ = 100µA | | 80 | 86 | | 80 | 86 | | 80 | 86 | | |
| | | $R_S \le 100k\Omega$, $I_Q$ = 1mA (Note 8) | | 70 | 77 | | 70 | 77 | | 70 | 77 | | |
| Input-Referred Noise Voltage | $e_n$ | $R_S$ = 100Ω, f = 1kHz | | | 100 | | | 100 | | | 100 | | $nV/\sqrt{Hz}$ |
| Input-Referred Noise Current | $i_n$ | $R_S$ = 100Ω, f = 1kHz | | | 0.01 | | | 0.01 | | | 0.01 | | $pA/\sqrt{Hz}$ |
| Supply Current (Per Amplifier) | $I_{SUPP}$ | No signal, no load | $I_Q$ = 10µA (Note 7) | | 0.01 | 0.022 | | 0.01 | 0.022 | | 0.01 | 0.022 | mA |
| | | | $I_Q$ = 100µA | | 0.1 | 0.25 | | 0.1 | 0.25 | | 0.1 | 0.25 | |
| | | | $I_Q$ = 1mA (Note 8) | | 1.0 | 2.5 | | 1.0 | 2.5 | | 1.0 | 2.5 | |
| Channel Separation | $V_{O1}$ / $V_{O2}$ | $A_{VOL}$ = 100 | | | 120 | | | 120 | | | 120 | | dB |
| Slew Rate (Note 10) | SR | $A_{VOL}$ = 1, $C_L$ = 100pF, $V_{IN}$ = $8V_{P-P}$ | $I_Q$ = 10µA (Note 7), $R_L$ = 1MΩ | | 0.016 | | | 0.016 | | | 0.016 | | V/µs |
| | | | $I_Q$ = 100µA, $R_L$ = 100kΩ | | 0.16 | | | 0.16 | | | 0.16 | | |
| | | | $I_Q$ = 1mA (Note 7), $R_L$ = 10kΩ | | 1.6 | | | 1.6 | | | 1.6 | | |

## ELECTRICAL CHARACTERISTICS (Triple/Quad) (continued)

($V_{SUPP}$ = ±5.0V, $T_A$ = +25°C, unless otherwise noted.)

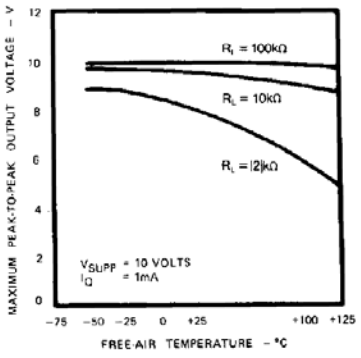
| PARAMETER | SYMBOL | CONDITIONS | | ICL76XXB | | | ICL76XXC | | | ICL76XXE | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| Rise Time (Note 10) | $t_r$ | $V_{IN}$ = 50mV, $C_L$ = 100pF | $I_Q$ = 10µA (Note 7), $R_L$ = 1MΩ | | 20 | | | 20 | | | 20 | | µs |
| | | | $I_Q$ = 100µA, $R_L$ = 100kΩ | | 2 | | | 2 | | | 2 | | |
| | | | $I_Q$ = 1mA (Note 8), $R_L$ = 10kΩ | | 0.9 | | | 0.9 | | | 0.9 | | |
| Overshoot Factor (Note 10) | | $V_{IN}$ = 50mV, $C_L$ = 100pF | $I_Q$ = 10µA (Note 7), $R_L$ = 1MΩ | | 5 | | | 5 | | | 5 | | % |
| | | | $I_Q$ = 100µA, $R_L$ = 100kΩ | | 10 | | | 10 | | | 10 | | |
| | | | $I_Q$ = 1mA (Note 8), $R_L$ = 10kΩ | | 40 | | | 40 | | | 40 | | |

**Note 7:** Does not apply to ICL7641.
**Note 8:** Does not apply to ICL7642.
**Note 9:** ICL7631/ICL7632 only.
**Note 10:** Does not apply to ICL7632.

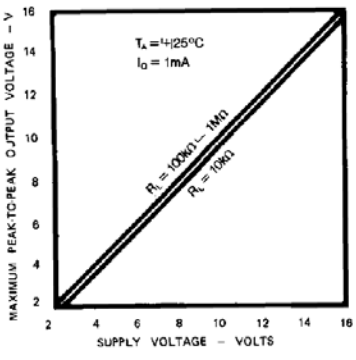
## Typical Operating Characteristics

($T_A$ = +25°C, unless otherwise noted.)

**MAXIMUM PEAK-TO-PEAK VOLTAGE AS A FUNCTION OF FREE-AIR TEMPERATURE**




**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE AS A FUNCTION OF SUPPLY VOLTAGE**

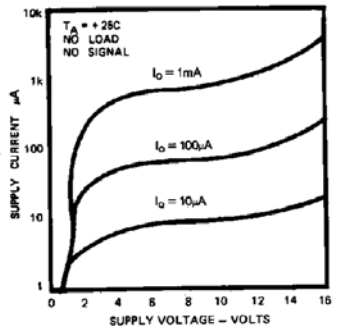


# Single/Dual/Triple/Quad Operational Amplifiers

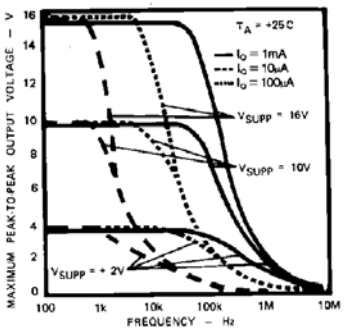
## Typical Operating Characteristics (continued)

($T_A$ = +25°C, unless otherwise noted.)

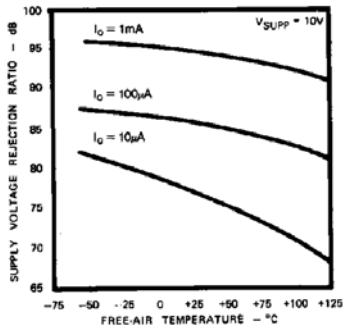
**SUPPLY CURRENT PER AMPLIFIER AS A FUNCTION OF SUPPLY VOLTAGE**



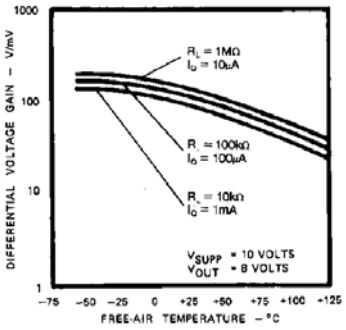

**PEAK-TO-PEAK OUTPUT VOLTAGE AS A FUNCTION OF FREQUENCY**



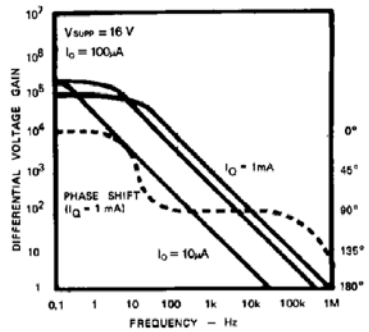

**POWER SUPPLY REJECTION RATIO AS A FUNCTION OF FREE-AIR TEMPERATURE**



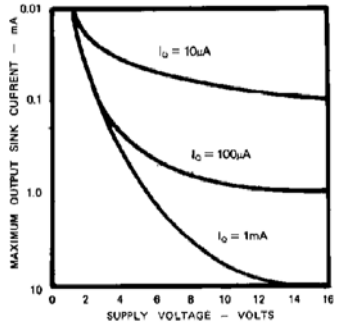

**LARGE SIGNAL DIFFERENTIAL VOLTAGE GAIN AS A FUNCTION OF FREE-AIR TEMPERATURE**




**LARGE SIGNAL DIFFERENTIAL VOLTAGE GAIN AND PHASE SHIFT AS A FUNCTION OF FREQUENCY**



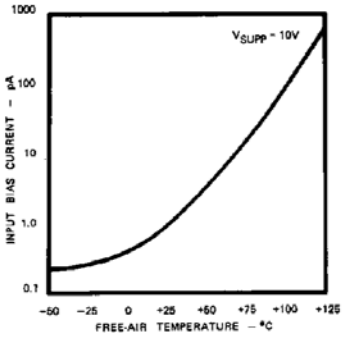

**MAXIMUM OUTPUT SINK CURRENT AS A FUNCTION OF SUPPLY VOLTAGE**



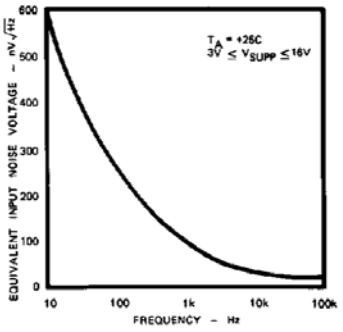
## Typical Operating Characteristics (continued)

($T_A$ = +25°C, unless otherwise noted.)

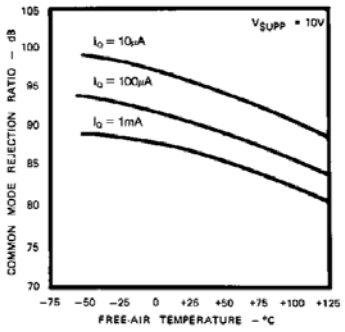
**INPUT BIAS CURRENT AS A FUNCTION OF TEMPERATURE**



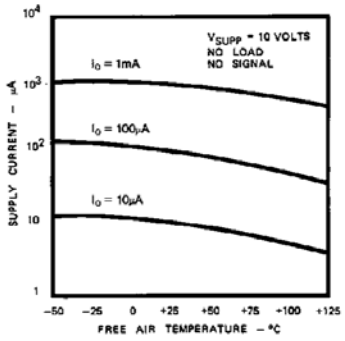

**EQUIVALENT INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY**



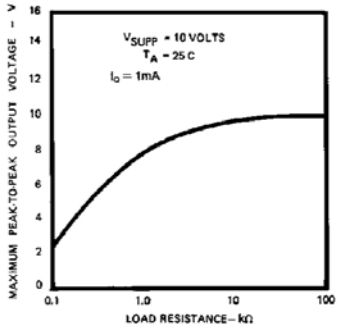

**COMMON MODE REJECTION RATIO AS A FUNCTION OF FREE-AIR TEMPERATURE**



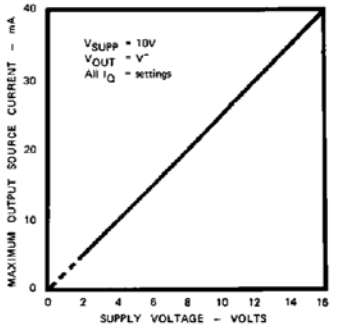

**SUPPLY CURRENT PER AMPLIFIER AS A FUNCTION OF FREE-AIR TEMPERATURE**




**MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE AS A FUNCTION OF LOAD RESISTANCE**




**MAXIMUM OUTPUT/SOURCE CURRENT AS A FUNCTION OF SUPPLY VOLTAGE**

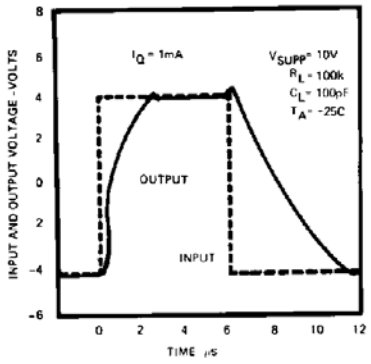


# Single/Dual/Triple/Quad Operational Amplifiers

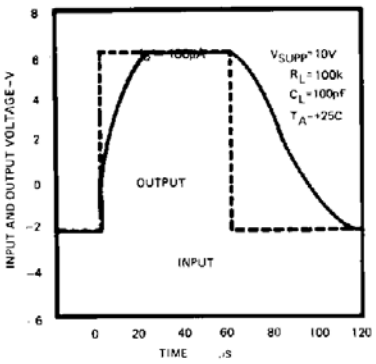
## Typical Operating Characteristics (continued)

($T_A$ = +25°C, unless otherwise noted.)

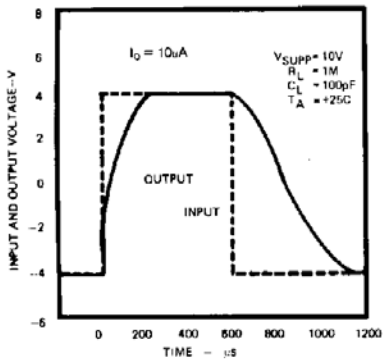
VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE




VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE




VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



## Detailed Description

### Quiescent Current Selection

The voltage input to the $I_Q$ pin of the single and triple amplifiers selects a quiescent current ($I_Q$) of 10µA, 100µA, or 1000µA. The dual and quad amplifiers have fixed quiescent current ($I_Q$) settings. Unity-gain bandwidth and slew-rate increase with increasing quiescent current, as does output sink current capability. The output source current capability is independent of quiescent current.

The lowest $I_Q$ setting that results in sufficient bandwidth and slew rate should be selected for each specific application.

The $I_Q$ pin of the single and triple amplifiers controls the quiescent current as follows:

| | |
|---|---|
| $I_Q$ = 10µA | $I_Q$ pin to V+ |
| $I_Q$ = 100µA | $I_Q$ pin between V- + 0.8V and V+ - 0.8V |
| $I_Q$ = 1mA | $I_Q$ pin to V- |

### Input Offset Nulling

The input offset can be nulled by connecting a 25kΩ pot between the OFFSET terminals with the wiper connected to V+. At quiescent currents of 1mA and 100µA, the nulling range provided is adequate for all $V_{OS}$ selections. However, with higher values of $V_{OS}$, and an $I_Q$ of 10µA, nulling may not be possible.

### Frequency Compensation

All of the ICL7611 and ICL7621 series except the ICL7614 are internally compensated for unity-gain operation. The ICL7614 is externally compensated by a capacitor connected between COMP and OUT pins, with 39pF being greater than unity. The compensation capacitor value may be reduced to increase the bandwidth and slew rate. The ICL7132 is not compensated and does not have frequency compensation pins. Use only at gains 20 at $I_Q$ of 1mA; at gains > 10 at $I_Q$ of 100µA; at gain > 5 at $I_Q$ of 10µA.

### Output Loading Considerations

Approximately 70% of the amplifier's quiescent current flows in the output stage. The output swing can approach the supply rails for output loads of 1MΩ, 100kΩ, and 10kΩ, using the output stage in a highly linear Class A mode. Crossover distortion is avoided and the voltage gain is maximized in this mode. The output stage, however, can also be operated in Class AB, which supplies higher output currents (see the *Typical Operating Characteristics*). The voltage gain decreases and the output transfer characteristic is nonlinear during the transition from Class A to Class B operation.

The output stage, with a gain that is directly proportional to load impedance, approximates a transconductance amplifier. Approximately the same open-loop gains are obtained at each of the $I_Q$ settings if corresponding loads of 10kΩ, 100kΩ, and 1MΩ are used.

The maximum output source current is higher than the maximum sink current, and is independent of $I_Q$.

Like most amplifiers, there are output loads for which the amplifier stability is not guaranteed. In particular, avoid capacitive loads greater than 100pF; and while on the 1mA $I_Q$ setting, avoid loads less than 5kΩ. Since the output stage is a transconductance output, very large (>10µF) capacitive loads will create a dominant pole and the output will be stable, even with loads that are less than 5kΩ.

### Extended Common-Mode Voltage Range (ICL7612/ICL7616)

A common-mode voltage range that includes both V+ and V- is often desirable, especially in single-supply operation. The ICL7612/ICL7616 extended common-mode range op amps are designed specifically to meet this need. The ICL7612 input common-mode voltage range (CMVR) extends beyond both power-supply rails when operated with at least 3V total supply and an $I_Q$ of 10µA or 100µA. The ICL7616 CMVR includes the negative supply voltage (or ground when operated with a single supply) at an $I_Q$ or 10µA or 100µA.

### PC Board Layout

Careful PC board layout techniques must be used to take full advantage of the very low bias current of the ICL7611 family. The inputs should be encircled with a low-impedance trace, or guard, that is at the same potential as the inputs. In an inverting amplifier, this is normally ground; in a unity-gain buffer connect the guard to the output. A convenient way of guarding the 8-pin TO-99 version of the ICL7611 is to use a 10-pin circle, with the two extra pads on either side of the input pins to provide space for a guard ring (see Figure 8). Assembled boards should be carefully cleaned, and if a high humidity environment is expected, conformally coated.

# Single/Dual/Triple/Quad Operational Amplifiers

### Single-Supply Operation

The ICL7611 family will operate from a single 2V to 16V power supply. The common-mode voltage range of the standard amplifier types when operated from a single supply is 1.0V to (V+ - 0.6V) at 10µA $I_Q$. At 100µA $I_Q$, the CMVR is 1.0V to (V+ - 0.8V), and at 1mA $I_Q$, the CMVR is 1.3V to (V+ - 1.3V). If this CMVR range is insufficient, use the ICL7612, whose CMVR includes both ground and V+, or the ICL7616, whose CMVR includes ground.

A convenient way to generate a psuedo-ground at V+/2 is to use one op amp of a quad to buffer a V+/2 voltage from a high-impedance resistive divider.

### Low-Voltage Operation

Operation at $V_{SUPP}$ = ±1.0V is only guaranteed at $I_Q$ = 10µA. Output swings to within a few millivolts of the supply rails are achievable for $R_L$ (> or =) 1MΩ. Guaranteed input CMVR is ±0.6V minimum and typically +0.9V to -0.7V at $V_{SUPP}$ = ±1.0V. For applications where greater common-mode range is desirable, see the description of ICL7612 and ICL7616 above.

## Applications Information

Note that in no case is IQ shown. The value of IQ must be chosen by the designer with regard to frequency response and power dissipation.

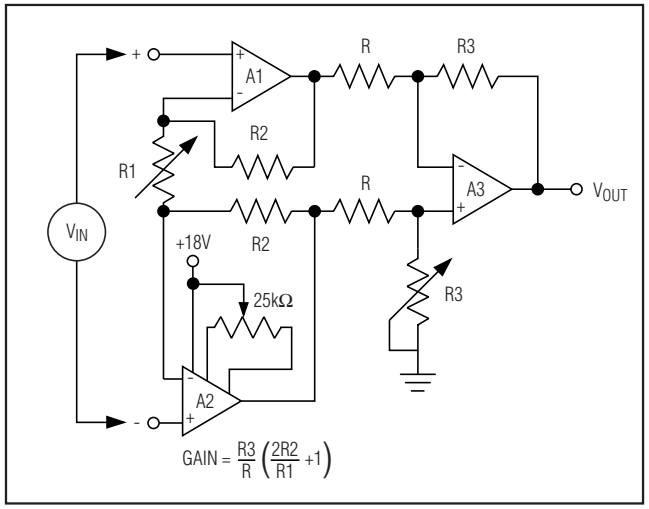



*Figure 1. Instrumentation Amplifier—Adjust R3 to improve CMRR. The offset of all three amplifiers is nulled by the offset adjustment of A2.*

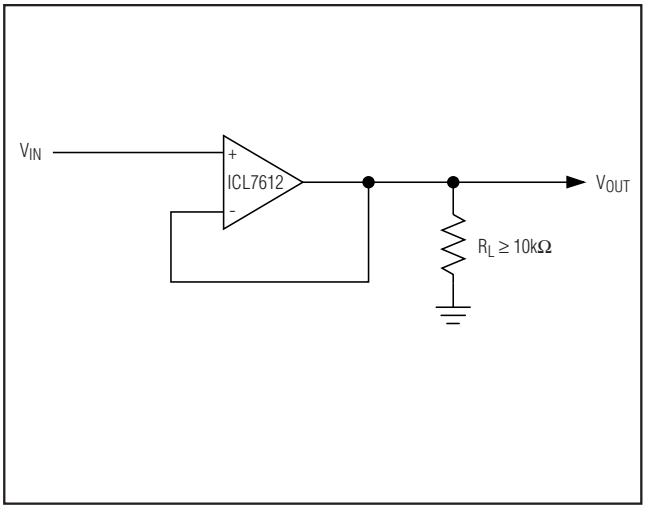



*Figure 2. Simple Follower—By using the ICL7612 in these applications, the circuits will follow rail-to-rail inputs*

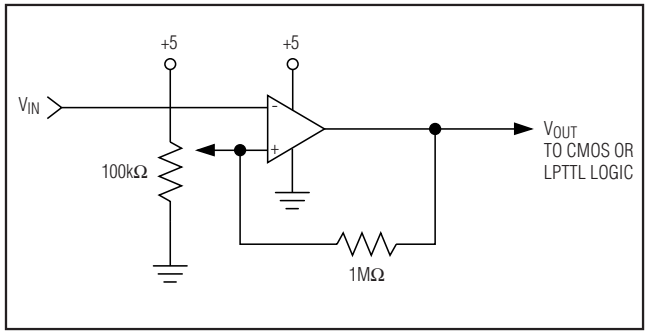



*Figure 3. Level Detector—By using the ICL7612 in these applications, the circuits will follow rail-to-rail inputs.*

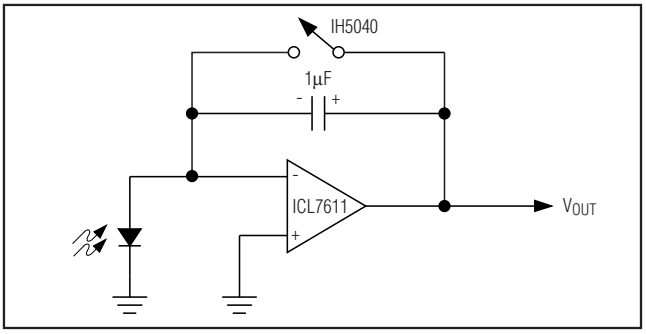



*Figure 4. Photocurrent Integrator—Low-leakage currents allow integration times up to several hours.*

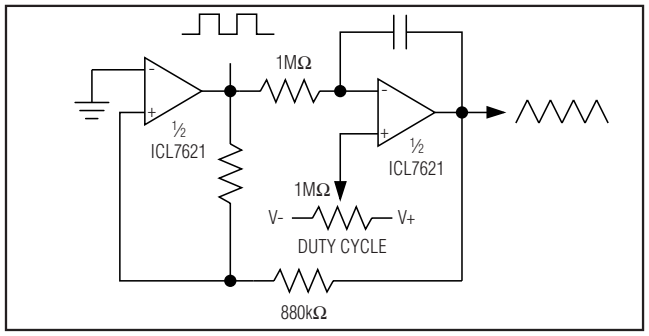



*Figure 5. Precise Triangle/Square Wave Generator—The frequency and duty cycle are virtually independent of power supply.*

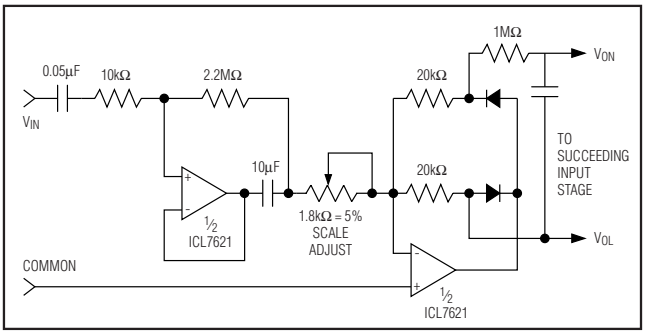



*Figure 6. Averaging AC to DC Converter—Recommended for Maxim's ICL7106/ICL7107/ICL7109 A/D Converters.*

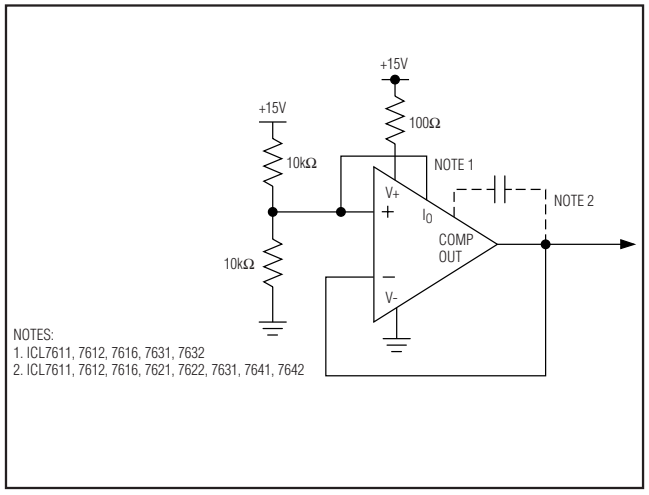



*Figure 7. Burn-In and Life Test Circuit*

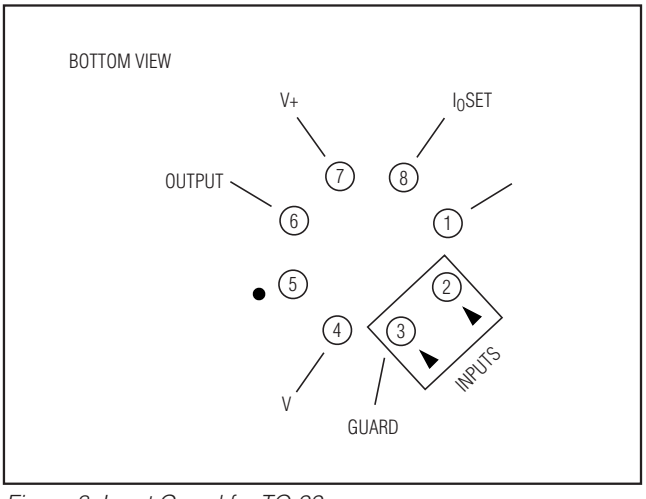



*Figure 8. Input Guard for TO-99*

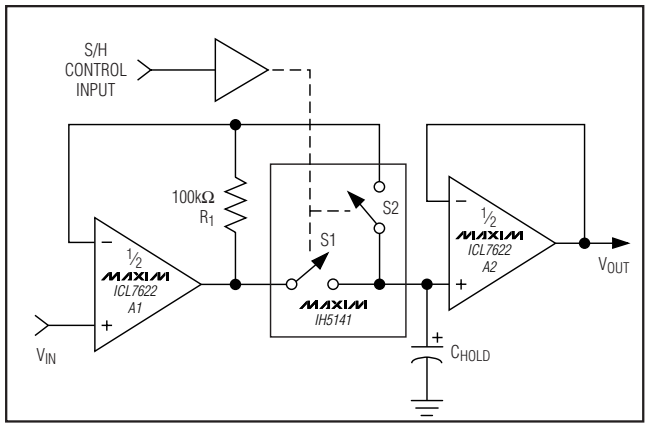



*Figure 9. Low Droop Rate Sample and Hold—S2 improves accuracy and acquisition time by including the voltage drop across S1 inside the feedback loop. R1 closes the feedback loop of A1 during the hold phase. The droop rate is [$I_{BIAS(AZ)}$ + $I_{LEAK(S1)}$ + $I_{LEAK(S2)}$]/$C_{HOLD}$.*

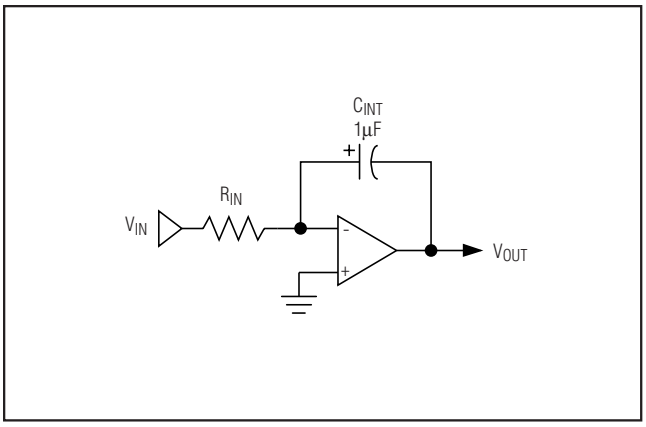



*Figure 10. Long-Time Constant Integrator—With $R_{IN}$ = 1011Ω, the time constant of this integrator is 100,000s. Since the input voltage is converted to a current by $R_{IN}$, the input voltage can far exceed the power-supply range.*

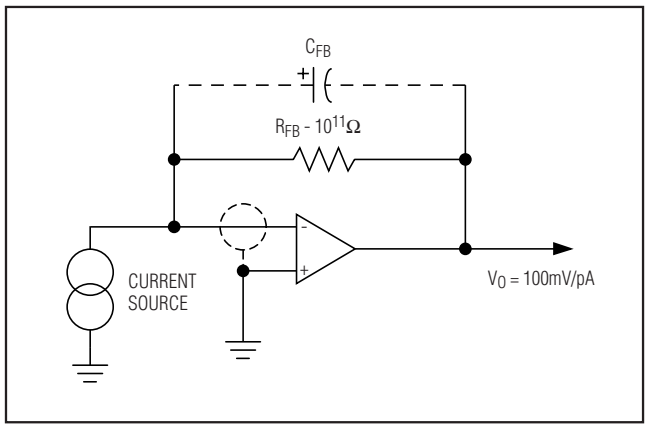



*Figure 11. Pico Ammeter—The response time of this curcuit is $R_{FB}$ x $C_{FB}$, where $C_{FB}$ is the stray capacitance between the output and the inverting terminal of the amplifier.*

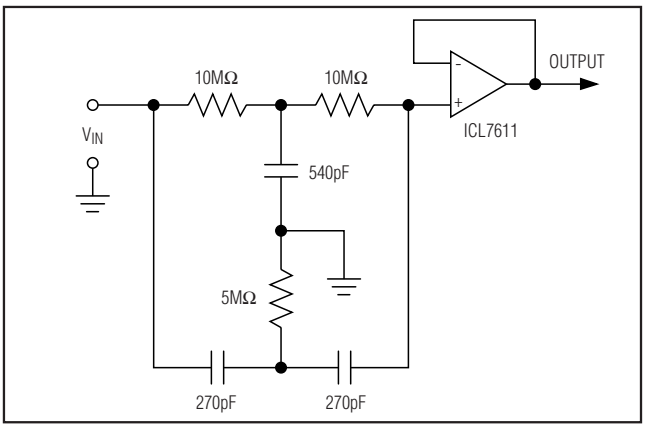
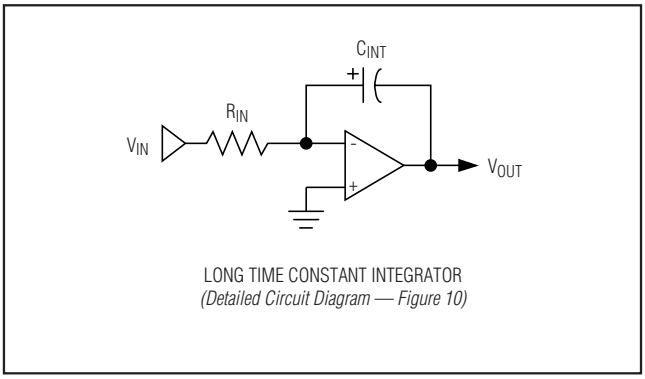
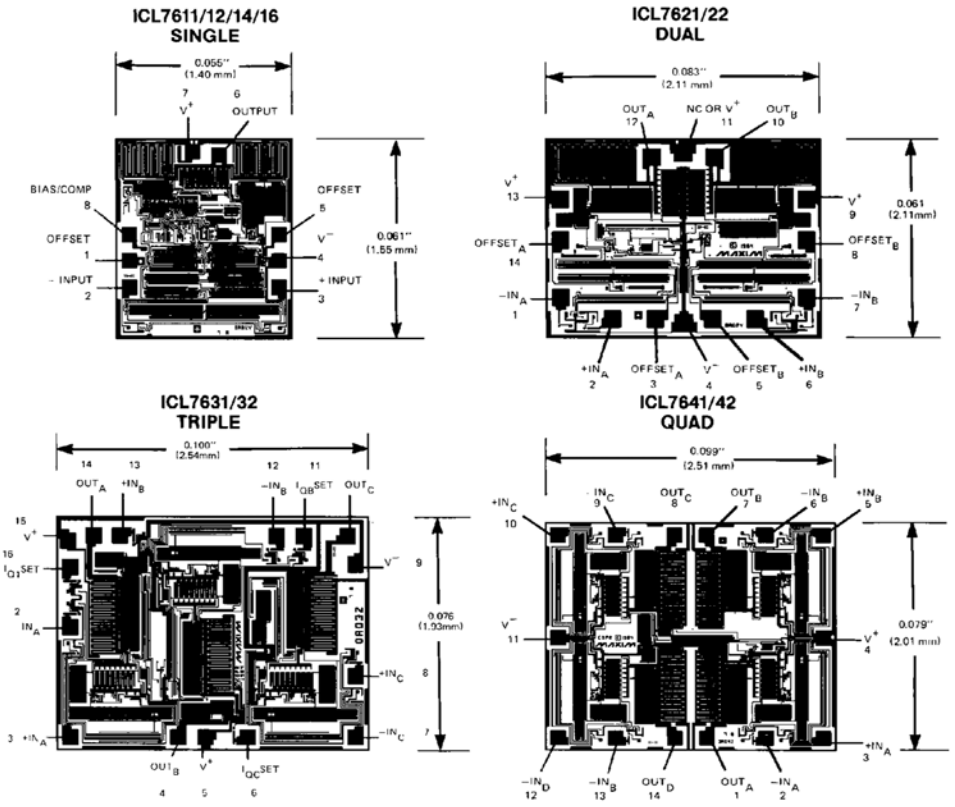



*Figure 12. 60Hz Twin "T" Notch Filter—The low 1pA bias current of the ICL7611 allows use of small 540pF and 270pF capacitors, even with a notch frequency of 60Hz. The 60Hz rejection is approximately 40dB.*

## Typical Operating Circuit



## Chip Topographies




## Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | DOCUMENT NO. |
|---|---|---|
| TO99 | T99-8 | 21-0022 |
| 8 PDIP | P8-1 | 21-0043 |
| 8 SO | S8-2 | 21-0041 |
| 8 CDIP | J16-3 | 21-0045 |
| 14 PDIP | P14-3 | 21-0043 |
| 14 CDIP | J14-3 | 21-0045 |
| 16 PDIP | P16-1 | 21-0043 |
| 16 SO | S16-1 | 21-0041 |
| 16 Wide SO | W16-2 | 21-0042 |

# Single/Dual/Triple/Quad Operational Amplifiers

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 2 | 4/08 | Removed all part numbers offered in die form from the Ordering Information | 2, 11 |
| 3 | 5/10 | Corrected letter grades in EC table headings | 13–17 |