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ICL76XX

ICL76XX Series Low Power CMOS Operational Amplifiers

GENERAL DESCRIPTION

The ICL761X/762X/763X/764X series is a family of monolithic CMOS operational amplifiers. These devices provide the designer with high performance operation at low supply voltages and selectable quiescent currents, and are an ideal design tool when ultra low input current and low power dissipation are desired.

The basic amplifier will operate at supply voltages ranging from ±1V to ±8V, and may be operated from a single Lithium cell.

A unique quiescent current programming pin allows setting of standby current to 1mA, 100μA, or 10μA, with no external components. This results in power consumption as low as 20μW. Output swings range to within a few millivolts of the supply voltages.

Of particular significance is the extremely low (1pA) input current, input noise current of .01pA/$\sqrt{Hz}$, and $10^{12}\Omega$ input impedance. These features optimize performance in very high source impedance applications.

The inputs are internally protected. Outputs are fully protected against short circuits to ground or to either supply.

AC performance is excellent, with a slew rate of 1.6V/μs, and unity gain bandwidth of 1MHz at I_Q = 1mA.

Because of the low power dissipation, operating temperatures and drift are quite low. Applications utilizing these features may include stable instruments, extended life designs, or high density packages.

FEATURES

- **Wide Operating Voltage Range ±1V to ±8V**
- **High Input Impedance — $10^{12}\Omega$**
- **Programmable Power Consumption — Low As 20μW**
- **Input Current Lower Than BIFETs — Typ 1pA**
- **Available As Singles, Duals, Triples, and Quads**
- **Output Voltage Swings to Within Millivolts Of V^- and V^+**
- **Low Power Replacement for Many Standard Op Amps**
- **Compensated and Uncompensated Versions**
- **Input Common Mode Voltage Range Greater Than Supply Rails (ICL7612)**

APPLICATIONS

- **Portable Instruments**
- **Telephone Headsets**
- **Hearing Aid/Microphone Amplifiers**
- **Meter Amplifiers**
- **Medical Instruments**
- **High Impedance Buffers**

SELECTION GUIDE

DEVICE NOMENCLATURE

ICL76XX X X XX

- XX — Package Code
  - TV — TO-99, 8 pin
  - PA — Plastic 8 pin Minidip
  - PD — 14 pin Plastic Dip
  - PE — 16 pin Plastic Dip
  - BA — 8 pin SOIC
- X (second) — Temperature Range
  - C = 0°C to 70°C
  - M = - 55°C to + 125°C
- X (first) — V_{OS} Selection
  - A = 2mV
  - B = 5mV
  - C = 10mV
  - D = 15mV
  - E = 20mV

SPECIAL FEATURE CODES

C	=	INTERNALLY COMPENSATED
H	=	HIGH QUIESCENT CURRENT (1mA)
L	=	LOW QUIESCENT CURRENT (10μA)
M	=	MEDIUM QUIESCENT CURRENT (100μA)
O	=	OFFSET NULL CAPABILITY
P	=	PROGRAMMABLE QUIESCENT CURRENT
V	=	EXTENDED CMVR

302060-003

NOTE: All typical values have been characterized but are not tested.

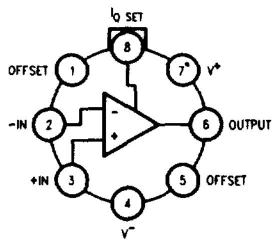
ORDERING INFORMATION

Basic Part Number	Number of OP-AMPS in Package, and Special Features (SEE CODES)	Package Type and Suffix				
		8-Lead TO-99		8-Pin MINIDIP	8-Pin SOIC	Plastic DIP (1)
		0°C to +70°C	−55°C to +125°C	0°C to +70°C	0°C to +70°C	0°C to +70°C
	SINGLE OP-AMP:					
ICL7611	C, O, P	ACTV	AMTV	ACPA	DCBA-T	
ICL7612	C, O, P, V	BCTV	BMTV	BCPA	DCBA	
		DCTV	DMTV	DCPA		
	DUAL OP-AMP:	ACTV	AMTV	ACPA		
ICL7621	C, M	BCTV	BMTV	BCPA	DCBA	
		DCTV	DMTV	DCPA	DCBA-T	
	TRIPLE OP-AMP:					
ICL7631	C, P					CCPE
						ECPE
	QUAD OP-AMP:					
ICL7641	C, H					
ICL7642	C, L					CCPD
						ECPD

NOTES: 1. Duals and quads are available in 14 pin DIP package, triples in 16 pin only.
2. Ordering code must consist of basic part number and package suffix, e.g., ICL7611BCPA.

Device	Description	Pin Assignments
ICL7611XCPA ICL7611XCTV ICL7611XMTV ICL7611XCBA ICL7612XCPA ICL7612XCTV ICL7612XMTV ICL7612XCBA	Internal compensation, plus offset null capability and external I_Q control	see below

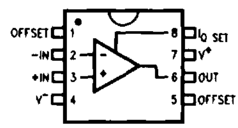
TO-99 (TOP VIEW)
(outline dwg TV)



0307-1

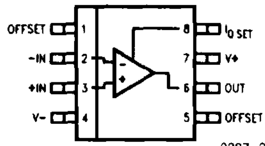
*Pin 7 connected to case.

8 PIN DIP (TOP VIEW)
(outline dwg PA)



0307-2

8 PIN DIP (TOP VIEW)
(outline dwg BA)



0307-3

Figure 1: Pin Configurations

NOTE: All typical values have been characterized but are not tested

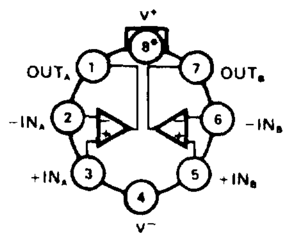
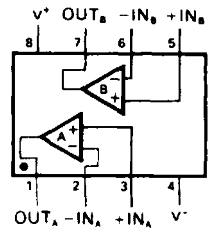
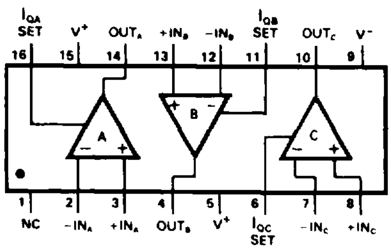
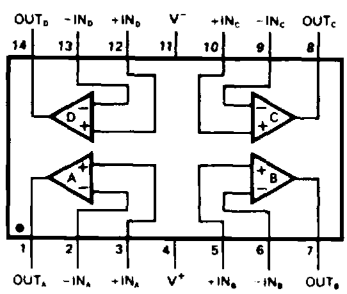
Device	Description	Pin Assignments
ICL7621XCPA ICL7621XCTV ICL7621XMTV ICL7621XCBA	Dual op amps with internal compensation; I_Q fixed at 100μA Pin compatible with Texas Inst. TL082 Motorola MC1458 Raytheon RC4558	TO-99 (TOP VIEW) (outline dwg TV)  0307-6 * PIN DIP (TOP VIEW) (outline dwg PA)  0307-7 *Pin 8 connected to case.
ICL7631XCPE	Triple op amps with internal compensation. Adjustable I_Q Same pin configuration as ICL8023.	16 PIN DIP (TOP VIEW) (outline dwg PE)  0307-9 Note: pins 5 and 15 are internally connected.
ICL7641XCPD ICL7642XCPD	Quad op amps with internal compensation. I_Q fixed at 1mA (ICL7641) I_Q fixed at 10μA (ICL7642) Pin compatible with Texas Instr. TL084 National LM324 Harris HA4741	14 PIN DIP (TOP VIEW) (outline dwg PD)  0307-10

Figure 1: Pin Configurations (Cont.)

NOTE All typical values have been characterized but are not tested

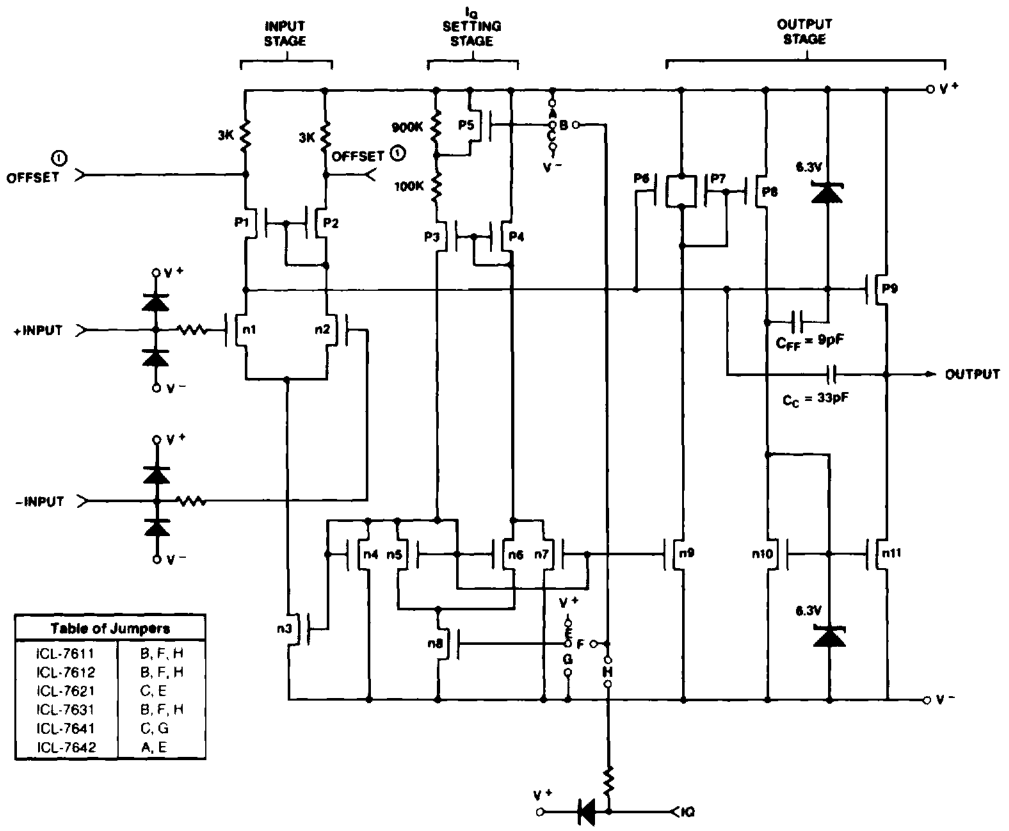


Table of Jumpers

ICL-7611	B, F, H
ICL-7612	B, F, H
ICL-7621	C, E
ICL-7631	B, F, H
ICL-7641	C, G
ICL-7642	A, E

NOTE 1: Offset nulling pins are not available on the dual (ICL-7621), triple (ICL-7631), and quad (ICL-764X) versions.

Figure 2: Functional Diagram

NOTE: All typical values have been characterized but are not tested

ABSOLUTE MAXIMUM RATINGS

Total Supply Voltage V^+ to V^- 18V
Input Voltage .... V^- −0.3 to V^+ +0.3V
Differential Input Voltage[1] . ±[(V^+ +0.3)−(V^- −0.3)]V
Duration of Output Short Circuit[2] .... Unlimited

Continuous Power Dissipation

	@25°C	Above 25°C derate as below:
TO-99	250mW	2mW/°C
8 Lead Minidip	250mW	2mW/°C
14 Lead Plastic	375mW	3mW/°C
14 Lead Cerdip	500mW	4mW/°C
16 Lead Plastic	375mW	3mW/°C
16 Lead Cerdip	500mW	4mW/°C

Storage Temperature Range .... −65°C to +150°C
Operating Temperature Range
ICL76XXM .... −55°C to +125°C
ICL76XXC .... 0°C to +70°C
Lead Temperature (Soldering, 10sec) .... 300°C

NOTE: *Stresses above 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 above 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.
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.

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OPERATIONAL AMPLIFIERS

ELECTRICAL CHARACTERISTICS (7611/12 and 7621 ONLY)

(V_{SUPPLY} = ±5.0V, T_A = 25°C, unless otherwise specified.)

Symbol	Parameter	Test Conditions	76XXA			76XXB			76XXD			Units
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input Offset Voltage	$R_S \leq 100k\Omega$, T_A = 25°C $T_{MIN} \leq T_A \leq T_{MAX}$			2 3			5 7			15 20	mV
$\Delta V_{OS}/\Delta T$	Temperature Coefficient of V_{OS}	$R_S \leq 100k\Omega$		10			15			25		µV/°C
I_{OS}	Input Offset Current	T_A = 25°C $\Delta T_A = C_{(2)}$ $\Delta T_A = M_{(2)}$		0.5	30 300 800		0.5	30 300 800		0.5	30 300 800	pA
I_{BIAS}	Input Bias Current	T_A = 25°C ΔT_A = C ΔT_A = M		1.0	50 400 4000		1.0	50 400 4000		1.0	50 400 4000	pA
V_{CMR}	Common Mode Voltage Range (Except ICL7612)	$I_Q = 10\mu A^{(1)}$ $I_Q = 100\mu A$ $I_Q = 1mA^{(1)}$	±4.4 ±4.2 ±3.7			±4.4 ±4.2 ±3.7			±4.4 ±4.2 ±3.7			V
V_{CMR}	Extended Common Mode Voltage Range (ICL7612 Only)	$I_Q = 10\mu A$	±5.3			±5.3			±5.3			V
		$I_Q = 100\mu A$	+5.3 −5.1			+5.3 −5.1			+5.3 −5.1			
		I_Q = 1mA	+5.3 −4.5			+5.3 −4.5			+5.3 −4.5			
V_{OUT}	Output Voltage Swing	(1) $I_Q = 10\mu A$, $R_L = 1M\Omega$ T_A = 25°C ΔT_A = C ΔT_A = M	±4.9 ±4.8 ±4.7			±4.9 ±4.8 ±4.7			±4.9 ±4.8 ±4.7			V
		$I_Q = 100\mu A$, $R_L = 100k\Omega$ T_A = 25°C ΔT_A = C ΔT_A = M	±4.9 ±4.8 ±4.5			±4.9 ±4.8 ±4.5			±4.9 ±4.8 ±4.5			
		(1) I_Q = 1mA, $R_L = 10k\Omega$ T_A = 25°C ΔT_A = C ΔT_A = M	±4.5 ±4.3 ±4.0			±4.5 ±4.3 ±4.0			±4.5 ±4.3 ±4.0			

NOTE: All typical values have been characterized but are not tested.

ELECTRICAL CHARACTERISTICS (7611/12 and 7621 ONLY) (Continued)

(V_{SUPPLY} = ±5.0V, T_A = 25°C, unless otherwise specified.)

Symbol	Parameter	Test Conditions	76XXA Min	76XXA Typ	76XXA Max	76XXB Min	76XXB Typ	76XXB Max	76XXD Min	76XXD Typ	76XXD Max	Units
A_{VOL}	Large Signal Voltage Gain	V_O = ±4.0V, R_L = 1MΩ I_Q = 10μA(1), T_A = 25°C ΔT_A = C ΔT_A = M	 86 80 74	 104		 80 75 68	 104		 80 75 68	 104		dB
		V_O = ±4.0V, R_L = 100kΩ I_Q = 100μA, T_A = 25°C ΔT_A = C ΔT_A = M	 86 80 74	 102		 80 75 68	 102		 80 75 68	 102		
		V_O = ±4.0V, R_L = 10kΩ I_Q = 1mA(1), T_A = 25°C ΔT_A = C ΔT_A = M	 80 76 72	 83		 76 72 68	 83		 76 72 68	 83		
GBW	Unity Gain Bandwidth	I_Q = 10μA(1) I_Q = 100μA I_Q = 1mA(1)		0.044 0.48 1.4			0.044 0.48 1.4			0.044 0.48 1.4		MHz
R_{IN}	Input Resistance			10^{12}			10^{12}			10^{12}		Ω
CMRR	Common Mode Rejection Ratio	R_S ≤ 100kΩ, I_Q = 10μA(1) R_S ≤ 100kΩ, I_Q = 100μA R_S ≤ 100kΩ, I_Q = 1mA(1)	76 76 66	96 91 87		70 70 60	96 91 87		70 70 60	96 91 87		dB
PSRR	Power Supply Rejection Ratio V_{SUPPLY} = ±8V to ±2V	R_S ≤ 100kΩ, I_Q = 10μA(1) R_S ≤ 100kΩ, I_Q = 100μA R_S ≤ 100kΩ, I_Q = 1mA(1)	80 80 70	94 86 77		80 80 70	94 86 77		80 80 70	94 86 77		dB
e_n	Input Referred Noise Voltage	R_S = 100Ω, f = 1kHz		100			100			100		nV/√Hz
i_n	Input Referred Noise Current	R_S = 100Ω, f = 1kHz		0.01			0.01			0.01		pA/√Hz
I_{SUPPLY}	Supply Current (Per Amplifier)	No Signal, No Load I_Q SET = +5V(1) Low Bias I_Q SET = 0V Medium Bias I_Q SET = −5V(1) High Bias		 0.01 0.1 1.0	 0.02 0.25 2.5		 0.01 0.1 1.0	 0.02 0.25 2.5		 0.01 0.1 1.0	 0.02 0.25 2.5	mA
V_{O1}/V_{O2}	Channel Separation	A_V = 100		120			120			120		dB
SR	Slew Rate(3)	A_V = 1, C_L = 100pF V_{IN} = 8Vp-p I_Q = 10μA(1), R_L = 1MΩ I_Q = 100μA, R_L = 100kΩ I_Q = 1mA(1), R_L = 10kΩ		 0.016 0.16 1.6			 0.016 0.16 1.6			 0.016 0.16 1.6		V/μs
t_r	Rise Time(3)	V_{IN} = 50mV, C_L = 100pF I_Q = 10μA(1), R_L = 1MΩ I_Q = 100μA, R_L = 100kΩ I_Q = 1mA(1), R_L = 10kΩ		 20 2 0.9			 20 2 0.9			 20 2 0.9		μs
	Overshoot Factor(3)	V_{IN} = 50mV, C_L = 100pF I_Q = 10μA1, R_L = 1MΩ I_Q = 100μA, R_L = 100kΩ I_Q = 1mA1, R_L = 10kΩ		 5 10 40			 5 10 40			 5 10 40		%

NOTES: 1. ICL7611, 7612 only.

2. C = Commercial Temperature Range: 0°C to +70°C
M = Military Temperature Range: −55°C to +125°C

NOTE: All typical values have been characterized but are not tested.

ELECTRICAL CHARACTERISTICS (7611/12 A AND B GRADES ONLY)

(V_{SUPPLY} = ±1.0V, I_Q = 10μA, T_A = 25°C, unless otherwise specified.)

Symbol	Parameter	Test Conditions	76XXA Min	76XXA Typ	76XXA Max	76XXB Min	76XXB Typ	76XXB Max	Units
V_{OS}	Input Offset Voltage	$R_S \leq 100k\Omega$, $T_A = 25°C$ $T_{MIN} \leq T_A \leq T_{MAX}$			2 3			5 7	mV
$\Delta V_{OS}/\Delta T$	Temperature Coefficient of V_{OS}	$R_S \leq 100k\Omega$		10			15		μV/°C
I_{OS}	Input Offset Current	$T_A = 25°C$ $\Delta T_A = C$		0.5	30 300		0.5	30 300	pA
I_{BIAS}	Input Bias Current	$T_A = 25°C$ $\Delta T_A = C$		1.0	50 500		1.0	50 500	pA
V_{CMR}	Common Mode Voltage Range (Except ICL7612)		±0.6			±0.6			V
V_{CMR}	Extended Common Mode Voltage Range (ICL7612 Only)		+0.6 to −1.1			+0.6 to −1.1			V
V_{OUT}	Output Voltage Swing	$R_L = 1M\Omega$, $T_A = 25°C$ $\Delta T_A = C$		±0.98 ±0.96			±0.98 ±0.96		V
A_{VOL}	Large Signal Voltage Gain	$V_O = \pm 0.1V$, $R_L = 1M\Omega$ $T_A = 25°C$ $\Delta T_A = C$		90 80			90 80		dB
GBW	Unity Gain Bandwidth			0.044					MHz
R_{IN}	Input Resistance			10^{12}			10^{12}		
CMRR	Common Mode Rejection Ratio	$R_S \leq 100k\Omega$		80			80		
PSRR	Power Supply Rejection Ratio	$R_S \leq 100k\Omega$		80			80		dB
e_n	Input Referred Noise Voltage	$R_S = 100\Omega$, f = 1kHz		100			100		nV/$\sqrt{Hz}$
i_n	Input Referred Noise Current	$R_S = 100\Omega$, f = 1kHz		0.01			0.01		pA/$\sqrt{Hz}$
I_{SUPPLY}	Supply Current (Per Amplifier)	No Signal, No Load		6	15		6	15	μA
SR	Slew Rate	$A_V = 1$, $C_L = 100pF$ $V_{IN} = 0.2Vp\text{-}p$ $R_L = 1M\Omega$		0.016			0.016		V/μs
t_r	Rise Time	$V_{IN} = 50mV$, $C_L = 100pF$ $R_L = 1M\Omega$		20			20		μs
	Overshoot Factor	$V_{IN} = 50mV$, $C_L = 100pF$ $R_L = 1M\Omega$		5			5		%

NOTE: C = Commercial Temperature Range (0°C to +70°C) M = Military Temperature Range (−55°C to +125°C).

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OPERATIONAL AMPLIFIERS

NOTE: All typical values have been characterized but are not tested.

ELECTRICAL CHARACTERISTICS (7631, 7641/42 ONLY)

(V_{SUPPLY} = ±5.0V, T_A = 25°C, unless otherwise specified.)

Symbol	Parameter	Test Conditions	76XXC (6)			76XXE (6)			Units
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input Offset Voltage	$R_S \le 100k\Omega$, $T_A = 25°C$ $T_{MIN} \le T_A \le T_{MAX}$			10 15			20 25	mV
$\Delta V_{OS}/\Delta T$	Temperature Coefficient of V_{OS}	$R_S \le 100k\Omega$ (Note 5)		20			30		
I_{OS}	Input Offset Current	$T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$		0.5	30 300 800		0.5	30 300 800	pA
I_{BIAS}	Input Bias Current	$T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$		1.0	50 500 4000		1.0	50 500 4000	pA
V_{CMR}	Common Mode Voltage Range	$I_Q = 10\mu A$(1) $I_Q = 100\mu A$(3) $I_Q = 1mA$(2)	±4.4 ±4.2 ±3.7			±4.4 ±4.2 ±3.7			V
V_{OUT}	Output Voltage Swing	$I_Q = 10\mu A$(1), $R_L = 1M\Omega$ $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	 ±4.9 ±4.8 ±4.7			 ±4.9 ±4.8 ±4.7			
		$I_Q = 100\mu A$(3), $R_L = 100k\Omega$ $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	 ±4.9 ±4.8 ±4.5			 ±4.9 ±4.8 ±4.5			V
		$I_Q = 1mA$(2), $R_L = 10k\Omega$ $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	 ±4.5 ±4.3 ±4.0			 ±4.5 ±4.3 ±4.0			
A_{VOL}	Large Signal Voltage Gain	$V_O = \pm 4.0V$, $R_L = 1M\Omega$(1) $I_Q = 10\mu A$(1), $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	 80 75 68	 104		 80 75 68	 104		
		$V_O = \pm 4.0V$, $R_L = 100k\Omega$(3) $I_Q = 100\mu A$(3), $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	 80 75 68	 102		 80 75 68	 102		dB
		$V_O = \pm 4.0V$, $R_L = 10k\Omega$(2) $I_Q = 1mA$(2), $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	 76 72 68	 98		 76 72 68	 98		
GBW	Unity Gain Bandwidth	$I_Q = 10\mu A$(1) $I_Q = 100\mu A$(3) $I_Q = 1mA$(2)		0.044 0.48 1.4			0.044 0.48 1.4		MHz
R_{IN}	Input Resistance			10^{12}			10^{12}		Ω
CMRR	Common Mode Rejection Ratio	$R_S \le 100k\Omega$, $I_Q = 10\mu A$(1) $R_S \le 100k\Omega$, $I_Q = 100\mu A$ $R_S \le 100k\Omega$, $I_Q = 1mA$(2)	70 70 60	96 91 87		70 70 60	96 91 87		dB

NOTE: All typical values have been characterized but are not tested

ELECTRICAL CHARACTERISTICS (7631, 7641/42 ONLY) (Continued)

($V_{SUPPLY} = \pm 5.0V$, $T_A = 25°C$, unless otherwise specified.)

Symbol	Parameter	Test Conditions	76XXC (6) Min	76XXC (6) Typ	76XXC (6) Max	76XXE (6) Min	76XXE (6) Typ	76XXE (6) Max	Units
PSRR	Power Supply Rejection Ratio $V_{SUPPLY} = \pm 8V$ to $\pm 2V$	$R_S \leq 100k\Omega$, $I_Q = 10\mu A^{(1)}$ $R_S \leq 100k\Omega$, $I_Q = 100\mu A$ $R_S \leq 100k\Omega$, $I_Q = 1mA^{(2)}$	80 80 70	94 86 77		80 80 70	94 86 77		dB
e_n	Input Referred Noise Voltage	$R_S = 100\Omega$, $f = 1kHz$		100			100		$nV/\sqrt{Hz}$
I_n	Input Referred Noise Current	$R_S = 100\Omega$, $f = 1kHz$		0.01			0.01		$pA/\sqrt{Hz}$
I_{SUPPLY}	Supply Current (Per Amplifier)	No Signal, No Load 7642 ONLY $I_Q = 10\mu A^{(1)}$ Low Bias $I_Q = 100\mu A$ Medium Bias $I_Q = 1mA^{(2)}$ High Bias		0.01 0.01 0.1 1.0	0.03 0.022 0.25 2.5		0.01 0.01 0.1 1.0	0.03 0.022 0.25 2.5	mA
V_{O1}/V_{O2}	Channel Separation	$A_V = 100$		120			120		dB
SR	Slew Rate	$A_V = 1$, $C_L = 100pF$ $V_{IN} = 8Vp\text{-}p$ $I_Q = 10\mu A^{(1)}$, $R_L = 1M\Omega$ $I_Q = 100\mu A$, $R_L = 100k\Omega$ $I_Q = 1mA^{(2)}$, $R_L = 10k\Omega$		0.016 0.16 1.6			0.016 0.16 1.6		$V/\mu s$
t_r	Rise Time	$V_{IN} = 50mV$, $C_L = 100pF$ $I_Q = 10\mu A^{(1)}$, $R_L = 1M\Omega$ $I_Q = 100\mu A$, $R_L = 100k\Omega$ $I_Q = 1mA^{(2)}$, $R_L = 10k\Omega$		20 2 0.9			20 2 0.9		μs
	Overshoot Factor	$V_{IN} = 50mV$, $C_L = 100pF$ $I_Q = 10\mu A^{(1)}$, $R_L = 1M\Omega$ $I_Q = 100\mu A$, $R_L = 100k\Omega$ $I_Q = 1mA^{(2)}$, $R_L = 10k\Omega$		5 10 40			5 10 40		%

NOTES: 1. Does not apply to 7641.
2. Does not apply to 7642.
3. ICL7631 only.

For Test Conditions:
C = Commercial Temperature Range: 0°C to +70°C
M = Military Temperature Range: −55°C to +125°C

ELECTRICAL CHARACTERISTICS (7631 AND 7642 ONLY)

($V_{SUPPLY} = \pm 1.0V$, $I_Q = 10\mu A$, $T_A = 25°C$, unless otherwise specified.)

Symbol	Parameter	Test Conditions	76XXC Min	76XXC Typ	76XXC Max	Units
V_{OS}	Input Offset Voltage	$R_S \leq 100k\Omega$, $T_A = 25°C$ $T_{MIN} \leq T_A \leq T_{MAX}$			10 12	mV
$\Delta V_{OS}/\Delta T$	Temperature Coefficient of V_{OS}	$R_S \leq 100k\Omega$		20		$\mu V/°C$
I_{OS}	Input Offset Current	$T_A = 25°C$ $\Delta T_A = C$		0.5	30 300	pA
I_{BIAS}	Input Bias Current	$T_A = 25°C$ $\Delta T_A = C$		1.0	50 500	pA
V_{CMR}	Common Mode Voltage Range		±0.6			V

NOTE: All typical values have been characterized but are not tested.

ELECTRICAL CHARACTERISTICS (7631 AND 7642 ONLY) (Continued)

(V_{SUPPLY} = + 1.0V, I_Q = 10μA, T_A = 25°C, unless otherwise specified.)

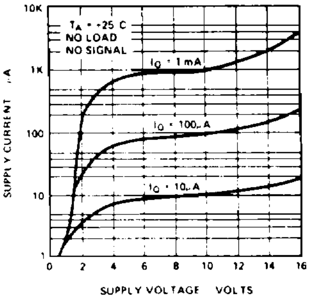
Symbol	Parameter	Test Conditions	76XXC			Units
			Min	Typ	Max	
V_{OUT}	Output Voltage Swing	$R_L = 1M\Omega$, $T_A = 25°C$ $\Delta T_A = C$		±0.98 ±0.96		V
A_{VOL}	Large Signal Voltage Gain	$V_O = \pm 0.1V$, $R_L = 1M\Omega$ $T_A = 25°C$ $\Delta T_A = C$		 90 80		dB
GBW	Unity Gain Bandwidth			0.044		MHz
R_{IN}	Input Resistance			10^{12}		Ω
CMRR	Common Mode Rejection Ratio	$R_S \leq 100k\Omega$		80		dB
PSRR	Power Supply Rejection Ratio			80		dB
e_n	Input Referred Noise Voltage	$R_S = 100\Omega$, f = 1kHz		100		$nV/\sqrt{Hz}$
i_n	Input Referred Noise Current	$R_S = 100\Omega$, f = 1kHz		0.01		$pA/\sqrt{Hz}$
I_{SUPPLY}	Supply Current (Per Amplifier)	No Signal, No Load		6	15	μA
$V_{O1/VO2}$	Channel Separation	$A_V = 100$		120		dB
SR	Slew Rate	$A_V = 1$, $C_L = 100pF$ $V_{IN} = 0.2Vp\text{-}p$ $R_L = 1M\Omega$		0.016		V/μs
t_r	Rise Time	$V_{IN} = 50mV$, $C_L = 100pF$ $R_L = 1M\Omega$		20		μs
	Overshoot Factor	$V_{IN} = 50mV$, $C_L = 100pF$ $R_L = 1M\Omega$		5		%

NOTE: C Commercial Temperature Range (0°C to + 70°C)

NOTE All typical values have been characterized but are not tested

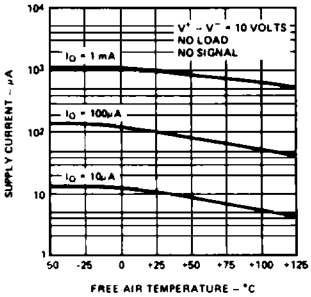
TYPICAL PERFORMANCE CHARACTERISTICS

SUPPLY CURRENT PER AMPLIFIER AS A FUNCTION OF SUPPLY VOLTAGE



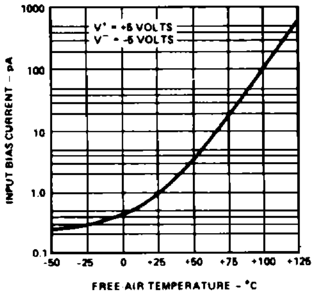
0307-12

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



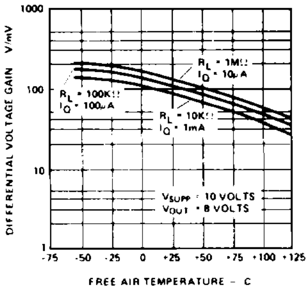
0307-13

INPUT BIAS CURRENT AS A FUNCTION OF TEMPERATURE



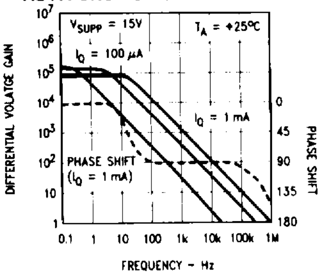
0307-14

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



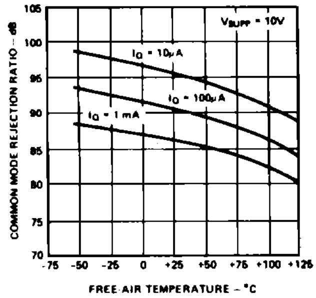
0307-15

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



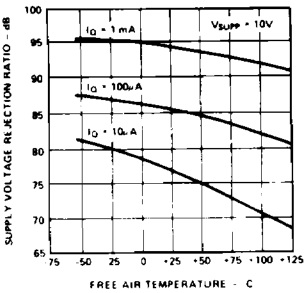
0307-16

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



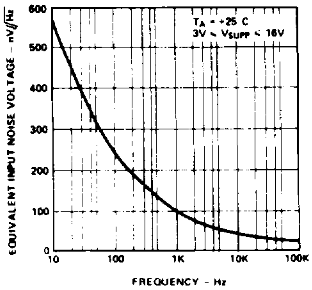
0307-17

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



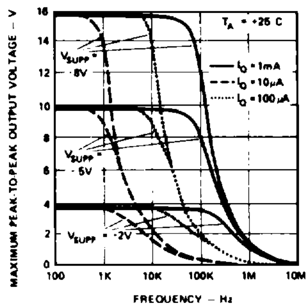
0307-18

EQUIVALENT INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



0307-19

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

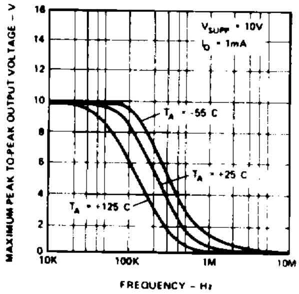


0307-20

NOTE: All typical values have been characterized but are not tested.

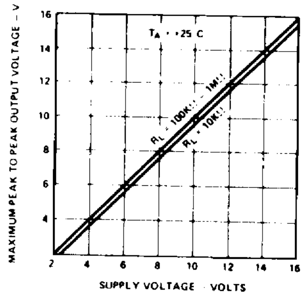
TYPICAL PERFORMANCE CHARACTERISTICS

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



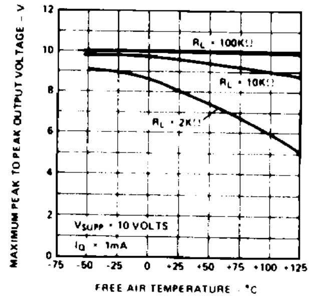
0307-21

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



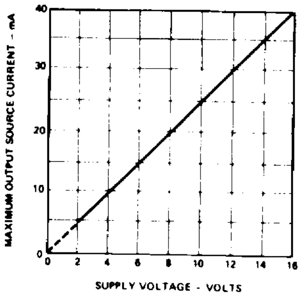
0307-22

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



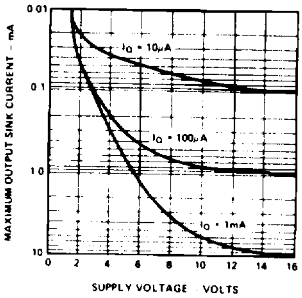
0307-23

MAXIMUM OUTPUT SOURCE CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



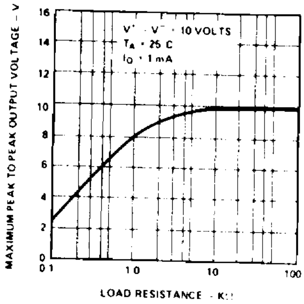
0307-24

MAXIMUM OUTPUT SINK CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



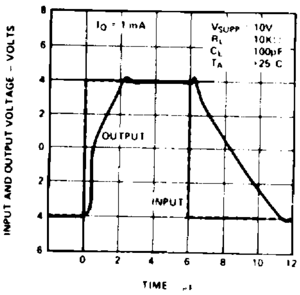
0307-25

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



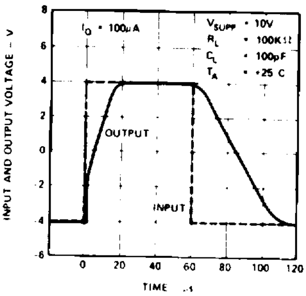
0307-26

VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



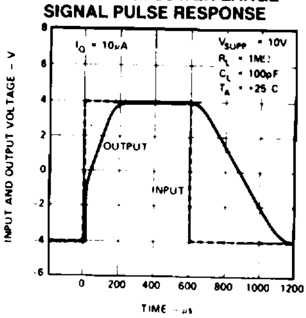
0307-27

VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



0307-28

VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



0307-29

NOTE: All typical values have been characterized but are not tested.

DETAILED DESCRIPTION

Static Protection

All devices are static protected by the use of input diodes. However, strong static fields should be avoided, as it is possible for the strong fields to cause degraded diode junction characteristics, which may result in increased input leakage currents.

Latchup Avoidance

Junction-isolated CMOS circuits employ configurations which produce a parasitic 4-layer (p-n-p-n) structure. The 4-layer structure has characteristics similar to an SCR, and under certain circumstances may be triggered into a low impedance state resulting in excessive supply current. To avoid this condition, no voltage greater than 0.3V beyond the supply rails may be applied to any pin. In general, the op-amp supplies must be established simultaneously with, or before any input signals are applied. If this is not possible, the drive circuits must limit input current flow to 2mA to prevent latchup.

Choosing the Proper I_Q

Each device in the ICL76XX family has a similar I_Q set-up scheme, which allows the amplifier to be set to nominal quiescent currents of 10μA, 100μA or 1mA. These current settings change only very slightly over the entire supply voltage range. The ICL7611/12 and ICL7631 have an external I_Q control terminal, permitting user selection of each amplifiers' quiescent current. (The 7621 and 7641/42 have fixed I_Q settings — refer to selector guide for details.) To set the I_Q of programmable versions, connect the I_Q terminal as follows:

I_Q = 10μA — I_Q pin to V^+

I_Q = 100μA — I_Q pin to ground. If this is not possible, any voltage from V^+ −0.8 to V^- +0.8 can be used.

I_Q = 1mA — I_Q pin to V^-

NOTE: The output current available is a function of the quiescent current setting. For maximum p-p output voltage swings into low impedance loads, I_Q of 1mA should be selected.

Output Stage and Load Driving Considerations

Each amplifiers' quiescent current flows primarily in the output stage. This is approximately 70% of the I_Q settings. This allows output swings to almost the supply rails for output loads of 1MΩ, 100kΩ, and 10kΩ, using the output stage in a highly linear class A mode. In this mode, crossover distortion is avoided and the voltage gain is maximized. However, the output stage can also be operated in Class AB for higher output currents. (See graphs under Typical Operating Characteristics). During the transition from Class A to Class B operation, the output transfer characteristic is non-linear and the voltage gain decreases.

Input Offset Nulling

For those models provided with OFFSET NULLING pins, nulling may be achieved by connecting a 25K 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 I_Q = 10μA, nulling may not be possible with higher values of V_{OS}.

Frequency Compensation

The ICL76XX are internally compensated, and are stable for closed loop gains as low as unity with capacitive loads up to 100pF

Extended Common Mode Input Range

The ICL7612 incorporates additional processing which allows the input CMVR to exceed each power supply rail by 0.1 volt for applications where $V_{SUPP} \geq \pm 1.5V$. For those applications where $V_{SUPP} \leq \pm 1.5V$, the input CMVR is limited in the positive direction, but may exceed the negative supply rail by 0.1 volt in the negative direction (eg. for $V_{SUPP} = \pm 1.0V$, the input CMVR would be +0.6 volts to −1.1 volts).

OPERATION AT $V_{SUPP} = \pm 1.0$ VOLTS

Operation at $V_{SUPP} = \pm 1.0V$ is guaranteed at I_Q = 10μA for A and B grades only. This applies to those devices with selectable I_Q, and devices that are set internally to I_Q = 10μA (i.e., ICL7611, 7612, 7631, 7642).

Output swings to within a few millivolts of the supply rails are achievable for $R_L \geq 1M\Omega$. Guaranteed input CMVR is ±0.6V minimum and typically +0.9V to −0.7V at $V_{SUPP} = \pm 1.0V$. For applications where greater common mode range is desirable, refer to the description of ICL7612 above.

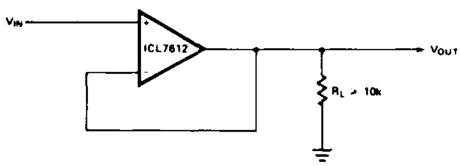
3 OPERATIONAL AMPLIFIERS

NOTE All typical values have been characterized but are not tested

The user is cautioned that, due to extremely high input impedances, care must be exercised in layout, construction, board cleanliness, and supply filtering to avoid hum and noise pickup.

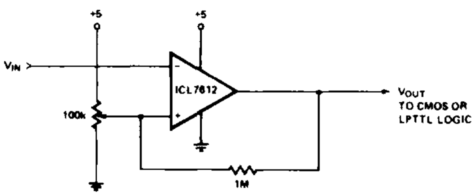
APPLICATIONS

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



0307-30

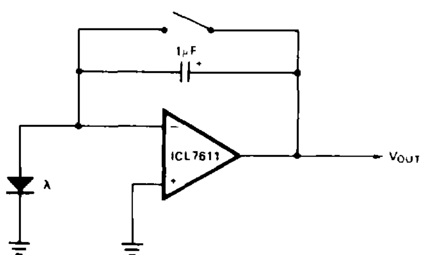
Figure 3: Simple Follower*



0307-31

*By using the ICL7612 in these applications, the circuits will follow rail to rail inputs.

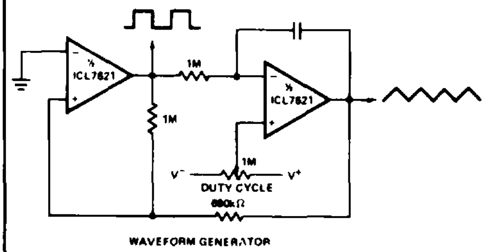
Figure 4: Level Detector*



0307-32

*Low leakage currents allow integration times up to several hours.

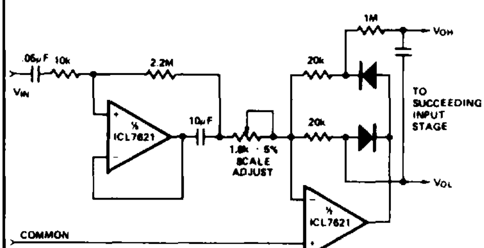
Figure 5: Photocurrent Integrator



0307-33

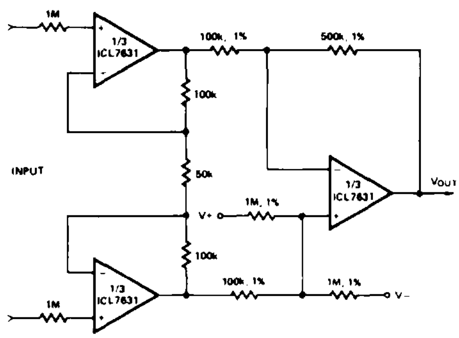
Since the output range swings exactly from rail to rail, frequency and duty cycle are virtually independent of power supply variations.

Figure 6: Precise Triangle/Square Wave Generator



0307-34

Figure 7: Averaging AC to DC Converter for A/D Converters Such as ICL7106, 7107, 7109, 7116, 7117

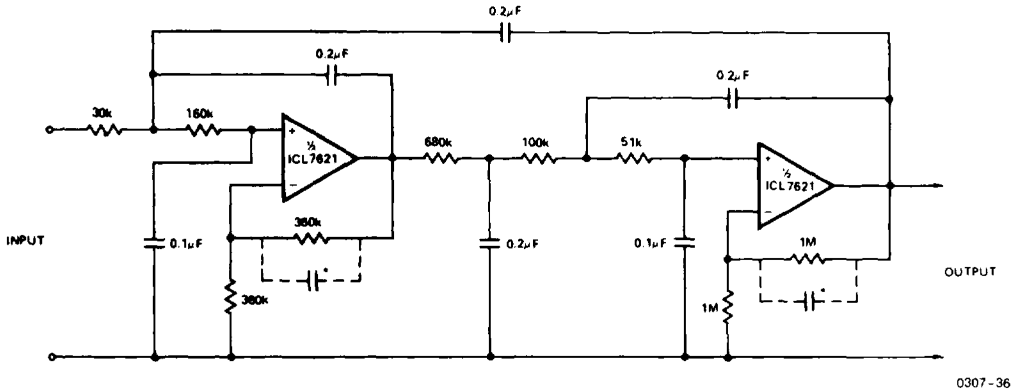


0307-35

Note that A_{VOL} 25; single Ni-cad battery operation. Input current (from sensors connected to patient) limited to < 5μA under fault conditions.

Figure 8: Medical Instrument Preamp

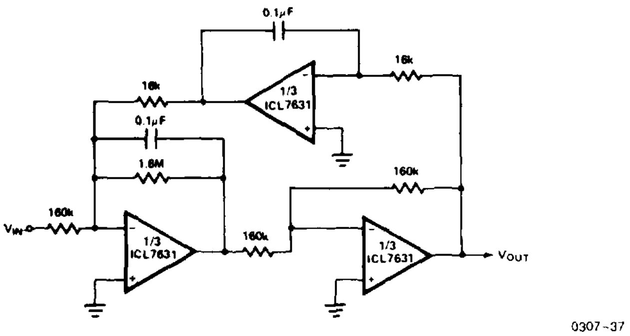
NOTE All typical values have been characterized but are not tested



The low bias currents permit high resistance and low capacitance values to be used to achieve low frequency cutoff. f_c = 10Hz, A_{VCL} = 4, Passband ripple = 0.1dB

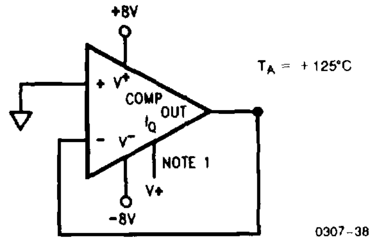
*Note that small capacitors (25 - 50pF) may be needed for stability in some cases.

Figure 9: Fifth Order Chebyshev Multiple Feedback Low Pass Filter



Note that I_Q on each amplifier may be different. A_{VCL} = 10, Q = 100, f_o = 100Hz.

Figure 10: Second Order Biquad Bandpass Filter



NOTE 1. For devices with programmable standby current, connect I_Q pin to V^+ (I_Q = 10μA mode).

Figure 11: Burn-In and Life Test Circuit

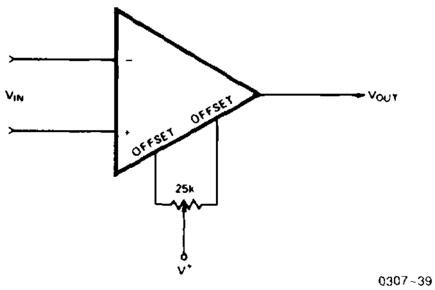


Figure 12: V_{OS} Null Circuit

NOTE: All typical values have been characterized but are not tested.