19-0942; Rev 0; 4/85

MAXIM

Single/Dual/Triple/Quad Operational Amplifiers

ICL761X/2X/3X/4X

General Description

The ICL761X/762X/763X/764X 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 10, 100, or 1000 μA 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 1 pA 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 0.01 pA/$\sqrt{Hz}$ and an input impedance of 10^{12} ohms ensure optimum performance with very high source impedances in such applications as pH meters and photodiode amplifiers.

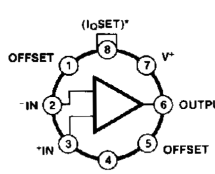
Applications

- 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

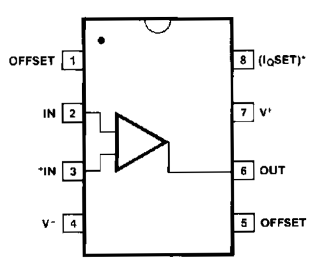
Top View

SINGLES—ICL7611/12/14/16
TO—99



*PIN 7 CONNECTED TO CASE

8 PIN DIP



*EXTERNAL COMPENSATION (ICL7614)

Features

Pin-for Pin 2nd Source!

- ♦ 1 pA Typical Bias Current—4 nA Maximum @ 125°C
- ♦ Wide Supply Voltage Range ±1V to ±8V
- ♦ Industry Standard Pinouts
- ♦ Programmable Quiescent Currents of 10, 100 and 1000 μA
- ♦ Monolithic, Low Power CMOS Design

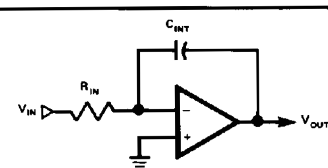
Ordering Information

ICL76XX M N OP

V_{OS} SELECTION	TEMP. RANGE	PACKAGE CODE
A=2mV	C=0°C to 70°C	TV - 8 PIN TO-99
B=5mV	M=-55°C to +125°C	PA - 8 PIN PLASTIC DIP
C=10mV		SA - 8 PIN SMALL S.O.
D=15mV		JD - 14 PIN CERDIP
E=20mV		PD - 14 PIN PLASTIC DIP
		SD - 14 PIN SMALL S.O.
		JE - 16 PIN CERDIP
		PE - 16 PIN PLASTIC DIP
		SE - 16 PIN SMALL S.O.
		WE - 16 PIN WIDE S.O.

	Singles ICL7611	Singles ICL7612	Singles ICL7614	Singles ICL7616	Duals ICL7621	Duals ICL7622	Triples ICL7631	Triples ICL7632	Quads ICL7641	Quads 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	

Typical Operating Circuit



Long Time Constant Integrator
(Detailed Circuit Diagram — Figure 10)

Single/Dual/Triple/Quad Operational Amplifiers

Ordering Information

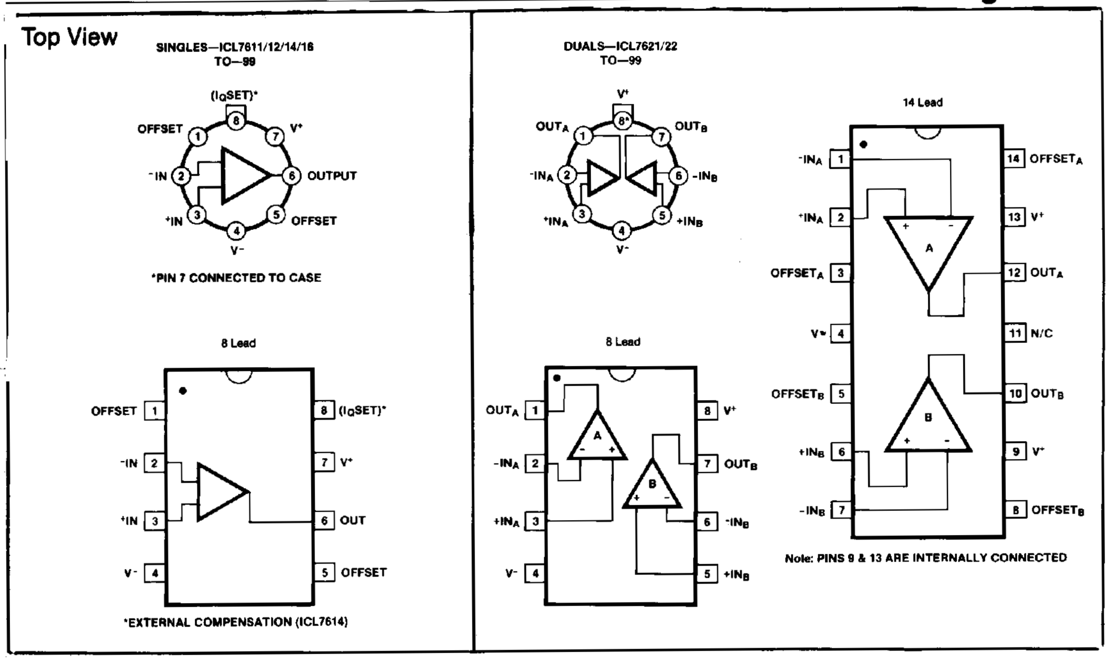
Single & Dual

PART	TEMP. RANGE	PACKAGE
ICL761XACPA	0°C to +70°C	8 Lead Plastic DIP
ICL761XACSA	0°C to +70°C	8 Lead Slim S.O.
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 Lead Plastic DIP
ICL761XBCSA	0°C to +70°C	8 Lead Slim S.O.
ICL761XBCTV	0°C to +70°C	TO-99 Metal Can
ICL761XBMTV	-55°C to +125°C	TO-99 Metal Can
ICL761XDCPA	0°C to +70°C	8 Lead Plastic DIP
ICL761XDCSA	0°C to +70°C	8 Lead Slim S.O.
ICL761XDCTV	0°C to +70°C	TO-99 Metal Can
ICL761XDC/D	0°C to +70°C	Dice
ICL7621ACPA	0°C to +70°C	8 Lead Plastic DIP
ICL7621ACSA	0°C to +70°C	8 Lead Slim S.O.
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 Lead Plastic DIP
ICL7621BCSA	0°C to +70°C	8 Lead Slim S.O.

PART	TEMP. RANGE	PACKAGE
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 Lead Plastic DIP
ICL7621DCSA	0°C to +70°C	8 Lead Slim S.O.
ICL7621DCTV	0°C to +70°C	TO-99 Metal Can
ICL7621DC/D	0°C to +70°C	Dice
ICL7622ACPD	0°C to +70°C	14 Lead Plastic DIP
ICL7622ACSD	0°C to +70°C	14 Lead Slim S.O.
ICL7622ACJD	0°C to +70°C	14 Lead CERDIP
ICL7622AMJD	-55°C to +125°C	14 Lead CERDIP
ICL7622BCPD	0°C to +70°C	14 Lead Plastic DIP
ICL7622BCSA	0°C to +70°C	14 Lead Slim S.O.
ICL7622BCJD	0°C to +70°C	14 Lead CERDIP
ICL7622BMJD	-55°C to +125°C	14 Lead CERDIP
ICL7622DCPD	0°C to +70°C	14 Lead Plastic DIP
ICL7622DCSD	0°C to +70°C	14 Lead Slim S.O.
ICL7622DCJD	0°C to +70°C	14 Lead CERDIP
ICL7622DC/D	0°C to +70°C	Dice

(X above is replaced by: 1, 2, 4, 6)

Pin Configuration



ABSOLUTE MAXIMUM RATINGS[1] — Single & Dual

Total Supply Voltage V^+ to V^- 18V
Input Voltage .... $V^+ + 0.3$ to $V^- - 0.3V$
Differential Input Voltage[2] ..... $\pm|(V^+ + 0.3) - (V^- - 0.3)|V$
Duration of Output Short Circuit[3] .... Unlimited
Continuous Power Dissipation @ 25°C Above 25°C derate as follows:

	@ 25°C	Above 25°C derate as follows
TO-99 Metal Can	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 .... −55°C to +150°C
Operating Temperature Range
M Series .... −55°C to +125°C
C Series .... 0°C to +70°C
Lead Temperature Soldering, 10 sec .... 300°C

Notes:

1. 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.
2. Long term offset voltage stability will be degraded if large input differential voltages are applied for long periods of time.
3. 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

($V_{SUPP} = \pm1.0V$, $I_Q = 10\mu A$, $T_A = 25°C$, unless noted)

PARAMETER	SYMBOL	CONDITIONS	76XXA MIN.	76XXA TYP.	76XXA MAX.	76XXB MIN.	76XXB TYP.	76XXB MAX.	UNITS
Input Offset Voltage	V_{OS}	$R_S \leq 100k\Omega$, $T_A = 25°C$ $T_{MIN} \leq T_A \leq T_{MAX}$			2 3			5 7	mV
Temperature Coefficient of V_{OS}	$\Delta V_{OS}/\Delta T$	$R_S \leq 100k\Omega$		10			15		µV/°C
Input Offset Current	I_{OS}	$T_A = 25°C$ $0°C \leq T_A \leq +70°C$		0.5	30 300		0.5	30 300	pA
Input Bias Current	I_{BIAS}	$T_A = 25°C$ $0°C \leq T_A \leq +70°C$		1.0	50 500		1.0	50 500	pA
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}	$I_Q = 10\mu A$	−1.3		-0.3	−1.3		-0.3	V
Output Voltage Swing	V_{OUT}	$R_L = 1M\Omega$, $T_A = 25°C$ $0°C \leq T_A \leq +70°C$		±0.98 ±0.96			±0.98 ±0.96		V
Large Signal Voltage Gain	A_{VOL}	$V_O = \pm0.1V$, $R_L = 1M\Omega$ $T_A = 25°C$ $0°C \leq T_A \leq +70°C$		90 80			90 80		dB
Unity Gain Bandwidth	G_{BW}			0.044			0.044		MHz
Input Resistance	R_{IN}			10^{12}			10^{12}		Ω
Common Mode Rejection Ratio	CMRR	$R_S \leq 100k\Omega$		80			80		dB
Power Supply Rejection Ratio	PSRR	$R_S \leq 100k\Omega$		80			80		dB
Input Referred Noise Voltage	e_n	$R_S = 100\Omega$, f = 1kHz		100			100		$nV/\sqrt{Hz}$
Input Referred Noise Current	i_n	$R_S = 100\Omega$, f = 1kHz		0.01			0.01		$pA/\sqrt{Hz}$
Supply Current (Per Amplifier)	I_{SUPP}	No Signal, No Load		6	15		6	15	µA
Slew Rate	SR	$A_{VOL} = 1$, $C_L = 100pF$, $V_{IN} = 0.2V_{p-p}$ $R_L = 1M\Omega$		0.016			0.016		V/µs
Rise Time	t_r	$V_{IN} = 50mV$, $C_L = 100pF$ $R_L = 1M\Omega$		20			20		µs
Overshoot Factor		$V_{IN} = 50mV$, $C_L = 100pF$ $R_L = 1M\Omega$		5			5		%

ELECTRICAL CHARACTERISTICS – Single & Dual
($V_{SUPP} = \pm5.0V$, $T_A = 25°C$, unless noted)

PARAMETER	SYMBOL	CONDITIONS	76XXA MIN.	76XXA TYP.	76XXA MAX.	76XXB MIN.	76XXB TYP.	76XXB MAX.	76XXD MIN.	76XXD TYP.	76XXD MAX.	UNITS
Input Offset Voltage	V_{OS}	$R_S \le 100k\Omega$, $T_A = 25°C$ $T_{MIN} \le T_A \le T_{MAX}$			2 3			5 7			15 20	mV mV
Temperature Coefficient of V_{OS}	$\Delta V_{OS}/\Delta T$	$R_S \le 100k\Omega$		10			15			25		$\mu V/°C$
Input Offset Current	I_{OS}	$T_A = 25°C$ $0°C \le T_A \le +70°C$ $-55°C \le T_A \le +125°C$		0.5	30 300 800		0.5	30 300 800		0.5	30 300 800	pA
Input Bias Current	I_{BIAS}	$T_A = 25°C$ $0°C \le T_A \le +70°C$ $-55°C \le T_A \le +125°C$		1.0	50 400 4000		1.0	50 400 4000		1.0	50 400 4000	pA
Common Mode Voltage Range (Except ICL7612, ICL7616)	V_{CMR}	$I_Q = 10\mu A$[1]	+4.4 −4.0			+4.4 −4.0			+4.4 −4.0			V
		$I_Q = 100\mu A$[1]	+4.2 −4.0			+4.2 −4.0			+4.2 −4.0			
		$I_Q = 1mA$[1]	+3.7 −3.7			+3.7 −3.7			+3.7 −3.7			
Extended Common Mode Voltage Range (ICL7612 Only)	V_{CMR}	$I_Q = 10\mu A$	±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			
Extended Common Mode Voltage Range (ICL7616 Only)	V_{CMR}	$I_Q = 10\mu A$	−5.3 +3.7			−5.3 +3.7			−5.3 +3.5			V
		$I_Q = 100\mu A$	−5.1 +3.0			−5.1 +3.0			−5.1 +2.7			
		$I_Q = 1mA$	−4.5 +2.0			+4.5 +2.0			−4.5 +1.7			
Output Voltage Swing	V_{OUT}	(1) $I_Q = 10\mu A$, $R_L = 1M\Omega$ $T_A = 25°C$ $0°C \le T_A \le +70°C$ $-55°C \le T_A \le +125°C$	±4.9 ±4.8 ±4.7			±4.9 ±4.8 ±4.7			±4.9 ±4.8 ±4.7			V
		$I_Q = 100\mu A$, $R_L = 100k\Omega$ $T_A = 25°C$ $0°C \le T_A \le +70°C$ $-55°C \le T_A \le +125°C$	±4.9 ±4.8 ±4.5			±4.9 ±4.8 ±4.5			±4.9 ±4.8 ±4.5			
		(1) $I_Q = 1mA$, $R_L = 10k\Omega$ $T_A = 25°C$ $0°C \le T_A \le +70°C$ $-55°C \le T_A \le +125°C$	±4.5 ±4.3 ±4.0			±4.5 ±4.3 ±4.0			±4.5 ±4.3 ±4.0			
Large Signal Voltage Gain	A_{VOL}	$V_O = \pm4.0V$, $R_L = 1M\Omega$ $I_Q = 10\mu A$, $T_A = 25°C$ $0°C \le T_A \le +70°C$ $-55°C \le T_A \le +125°C$	86 80 74	104		80 75 68	104		80 75 68	104		dB
		$V_O = \pm4.0V$, $R_L = 100k\Omega$ $I_Q = 100\mu A$, $T_A = 25°C$ $0°C \le T_A \le +70°C$ $-55°C \le T_A \le +125°C$	86 80 74	102		80 75 68	102		80 75 68	102		
		$V_O = \pm4.0V$, $R_L = 10k\Omega$ $I_Q = 1mA$[1] $T_A = 25°C$ $0°C \le T_A \le +70°C$ $-55°C \le T_A \le +125°C$	80 76 72	83		76 72 68	83		76 72 68	83		
Unity Gain Bandwidth	G_{BW}	$I_Q = 10\mu A$[1] $I_Q = 100\mu A$ $I_Q = 1mA$[1]		0.044 0.48 1.4			0.044 0.48 1.4			0.044 0.48 1.4		MHz

Note 1: ICL7611, 7612, 7616 only
Note 2: ICL7614; 39 pF from pin 6 to pin 8.

ELECTRICAL CHARACTERISTICS — Single & Dual (Continued)
(V_{SUPP} = ±5.0V, T_A = 25°C, unless noted)

			76XXA			76XXB			76XXD			
PARAMETER	**SYMBOL**	**CONDITIONS**	**MIN.**	**TYP.**	**MAX.**	**MIN.**	**TYP.**	**MAX.**	**MIN.**	**TYP.**	**MAX**	**UNITS**
Input Resistance	R_{IN}			10^{12}			10^{12}			10^{12}		Ω
Common Mode Rejection Ratio	CMRR	$R_S \leq$ 100kΩ, I_Q = 10μA[1] $R_S \leq$ 100kΩ, I_Q = 100μA $R_S \leq$ 100kΩ, I_Q = 1mA[1]	76 76 66	96 91 87		70 70 60	96 91 87		70 70 60	96 91 87		dB
Power Supply Rejection Ratio	PSRR	$R_S \leq$ 100kΩ, I_Q = 10μA[1] $R_S \leq$ 100kΩ, I_Q = 100μA $R_S \leq$ 100kΩ, I_Q = 1mA[1]	80 80 70	94 86 77		80 80 70	94 86 77		80 80 70	94 86 77		dB
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[1] I_Q = 100μA I_Q = 1mA[1]		 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
Channel Separation	V_{O1}/V_{O2}	A_{VOL} = 100		120			120			120		dB
Slew Rate[2]	SR	A_{VOL} = 1, C_L = 100pF V_{IN} = 8V_{p-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
Rise Time[2]	t_r	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[2]		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		 5 10 40			 5 10 40			 5 10 40		%

Note 1: ICL7611, 7612, 7616 only.
Note 2: ICL7614; 39 pF from pin 6 to pin 8.

Single/Dual/Triple/Quad Operational Amplifiers

Ordering Information

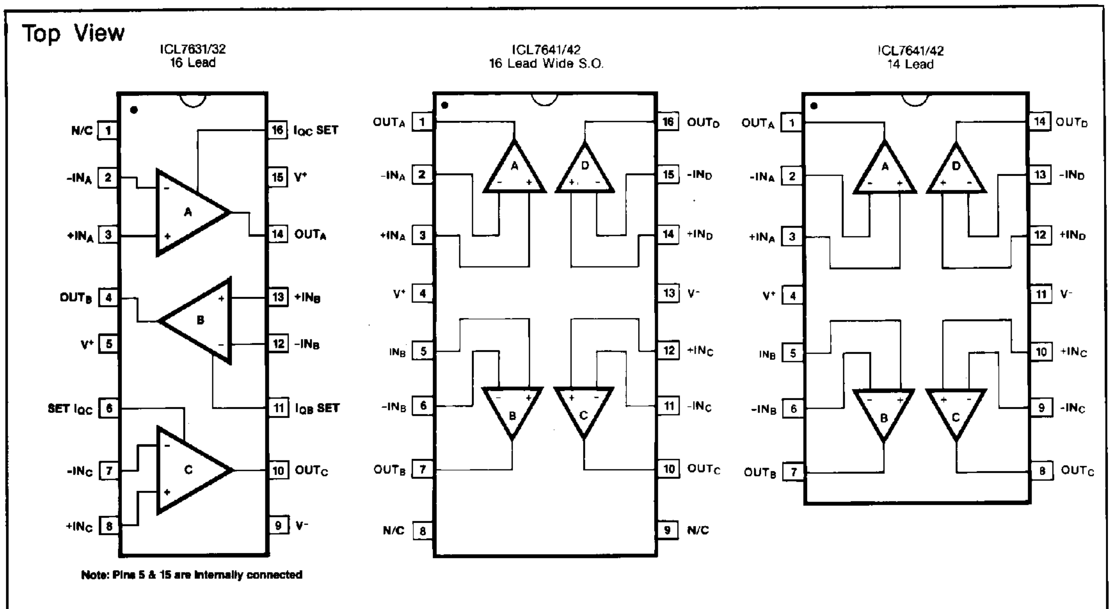
Triple & Quad

PART	TEMP. RANGE	PACKAGE
ICL763XBCPE	0°C to +70°C	16 Lead Plastic DIP
ICL763XBCSE	0°C to +70°C	16 Lead Slim S.O.
ICL763XCCPE	0°C to +70°C	16 Lead Plastic DIP
ICL763XCCSE	0°C to +70°C	16 Lead Slim S.O.
ICL763XECPE	0°C to +70°C	16 Lead Plastic DIP
ICL763XECSE	0°C to +70°C	16 Lead Slim S.O.
ICL763XBCJE	0°C to +70°C	16 Lead CERDIP
ICL763XCCJE	0°C to +70°C	16 Lead CERDIP
ICL763XECJE	0°C to +70°C	16 Lead CERDIP
ICL763XBMJE	-55°C to +125°C	16 Lead CERDIP
ICL763XCMJE	-55°C to +125°C	16 Lead CERDIP
ICL763XEC/D	0°C to +70°C	Dice

PART	TEMP. RANGE	PACKAGE
ICL764XBCPD	0°C to +70°C	14 Lead Plastic DIP
ICL764XBCWE	0°C to +70°C	16 Lead Wide S.O.
ICL764XCCPD	0°C to +70°C	14 Lead Plastic DIP
ICL764XCCWE	0°C to +70°C	16 Lead Wide S.O.
ICL764XECPD	0°C to +70°C	14 Lead Plastic DIP
ICL764XECWE	0°C to +70°C	16 Lead Wide S.O.
ICL764XBCJD	0°C to +70°C	14 Lead CERDIP
ICL764XCCJD	0°C to +70°C	14 Lead CERDIP
ICL764XECJD	0°C to +70°C	14 Lead CERDIP
ICL764XBMJD	-55°C to +125°C	14 Lead CERDIP
ICL764XCMJD	-55°C to +125°C	14 Lead CERDIP
ICL764XEC/D	0°C to +70°C	Dice

(X above is replaced by: 1, 2)

Pin Configuration



ABSOLUTE MAXIMUM RATINGS[1] – Triple & Quad

Total Supply Voltage V^+ to V^- 18V
Input Voltage .... $V^+ + 0.3$ to $V^- - 0.3V$
Differential Input Voltage[2] ..... $\pm|(V^+ + 0.3) - (V^- - 0.3)|V$
Duration of Output Short Circuit[3] .... Unlimited
Continuous Power Dissipation @ 25°C Above 25°C derate as follows:

	@ 25°C	Above 25°C derate as follows
TO-99 Metal Can	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 ...... −55°C to +150°C

Operating Temperature Range
M Series .... −55°C to +125°C
C Series .... 0°C to +70°C
Lead Temperature Soldering, 10 sec .... 300°C

Notes:
1. 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.
2. Long term offset voltage stability will be degraded if large input differential voltages are applied for long periods of time.
3. 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 – Triple & Quad

($V_{SUPP} = \pm 1.0V$, $I_Q = 10\mu A$, $T_A = 25°C$, unless noted)
Specs apply to ICL7631/7632/7642 only.

PARAMETER	SYMBOL	CONDITIONS	76XXB MIN.	76XXB TYP.	76XXB MAX.	76XXC MIN.	76XXC TYP.	76XXC MAX.	UNITS
Input Offset Voltage	V_{OS}	$R_S \leq 100k\Omega$, $T_A = 25°C$ $T_{MIN} \leq T_A \leq T_{MAX}$			5 7			10 12	mV
Temperature Coefficient of V_{OS}	$\Delta V_{OS}/\Delta T$	$R_S \leq 100k\Omega$		15			20		µV/°C
Input Offset Current	I_{OS}	$T_A = 25°C$ $0°C \leq T_A \leq +70°C$		0.5	30 300		0.5	30 300	pA
Input Bias Current	I_{BIAS}	$T_A = 25°C$ $0°C \leq T_A \leq +70°C$		1.0	50 500		1.0	50 500	pA
Common Mode Voltage Range	V_{CMR}		-0.4		+0.6	-0.4		+0.6	V
Output Voltage Swing	V_{OUT}	$R_L = 1M\Omega$, $T_A = 25°C$ $0°C \leq T_A \leq +70°C$		±0.98 ±0.96			±0.98 ±0.96		V
Large Signal Voltage Gain	A_{VOL}	$V_O = \pm 0.1V$, $R_L = 1M\Omega$ $T_A = 25°C$ $0°C \leq T_A \leq +70°C$		90 80			90 80		dB
Unity Gain Bandwidth	G_{BW}			0.044			0.044		MHz
Input Resistance	R_{IN}			10^{12}			10^{12}		Ω
Common Mode Rejection Ratio	CMRR	$R_S \leq 100k\Omega$		80			80		dB
Power Supply Rejection Ratio	PSRR			80			80		dB
Input Referred Noise Voltage	e_n	$R_S = 100\Omega$, f = 1kHz		100			100		$nV/\sqrt{Hz}$
Input Referred Noise Current	i_n	$R_S = 100\Omega$, f = 1kHz		0.01			0.01		$pA/\sqrt{Hz}$
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	$A_{VOL} = 1$, $C_L = 100pF$, $V_{IN} = 0.2V_{p-p}$ $R_L = 1M\Omega$		0.016			0.016		V/µs
Rise Time	t_r	$V_{IN} = 50mV$, $C_L = 100pF$ $R_L = 1M\Omega$		20			20		µs
Overshoot Factor		$V_{IN} = 50mV$, $C_L = 100pF$ $R_L = 1M\Omega$		5			5		%

Single/Dual/Triple/Quad Operational Amplifiers

ELECTRICAL CHARACTERISTICS — Triple & Quad
($V_{SUPP} = \pm5.0V$, $T_A = 25°C$, unless noted)

PARAMETER	SYMBOL	CONDITIONS	76XXB MIN.	76XXB TYP.	76XXB MAX.	76XXC MIN.	76XXC TYP.	76XXC MAX.	76XXE MIN.	76XXE TYP.	76XXE MAX.	UNITS
Input Offset Voltage	V_{OS}	$R_S \leq 100k\Omega$, $T_A = 25°C$ $T_{MIN} \leq T_A \leq T_{MAX}$			5 7			10 15			20 25	mV mV
Temperature Coefficient of V_{OS}	$\Delta V_{OS}/\Delta T$	$R_S \leq 100k\Omega$		15			20			30		µV/°C
Input Offset Current	I_{OS}	$T_A = 25°C$ $0°C \leq T_A \leq +70°C$ $-55°C \leq T_A \leq +125°C$		0.5	30 300 800		0.5	30 300 800		0.5	30 300 800	pA
Input Bias Current	I_{BIAS}	$T_A = 25°C$ $0°C \leq T_A \leq +70°C$ $-55°C \leq T_A \leq +125°C$		1.0	50 500 4000		1.0	50 500 4000		1.0	50 500 4000	pA
Common Mode Voltage Range	V_{CMR}	$I_Q = 10\mu A$[1]	+4.4 −4.0			+4.4 −4.0			+4.4 −4.0			V
		$I_Q = 100\mu A$[3]	+4.2 −4.0			+4.2 −4.0			+4.2 −4.0			V
		$I_Q = 1mA$[2]	+3.7 −3.7			+3.7 −3.7			+3.7 −3.7			V
Output Voltage Swing	V_{OUT}	(1) $I_Q = 10\mu A$, $R_L = 1M\Omega$ $T_A = 25°C$ $0°C \leq T_A \leq +70°C$ $-55°C \leq T_A \leq +125°C$	±4.9 ±4.8 ±4.7			±4.9 ±4.8 ±4.7			±4.9 ±4.8 ±4.7			V
		$I_Q = 100\mu A$, $R_L = 100k\Omega$ (3) $T_A = 25°C$ $0°C \leq T_A \leq +70°C$ $-55°C \leq T_A \leq +125°C$	±4.9 ±4.8 ±4.5			±4.9 ±4.8 ±4.5			±4.9 ±4.8 ±4.5			V
		(2) $I_Q = 1mA$, $R_L = 10k\Omega$ $T_A = 25°C$ $0°C \leq T_A \leq +70°C$ $-55°C \leq T_A \leq +125°C$	±4.5 ±4.3 ±4.0			±4.5 ±4.3 ±4.0			±4.5 ±4.3 ±4.0			V
Large Signal Voltage Gain	A_{VOL}	$V_O = \pm4.0V$, $R_L = 1M\Omega$[1] $I_Q = 10\mu A$[1] $T_A = 25°C$ $0°C \leq T_A \leq +70°C$ $-55°C \leq T_A \leq +125°C$	86 80 74	104		80 75 68	104		80 75 68	104		dB
		$V_O = \pm4.0V$, R_L $I_Q = 100\mu A$, $T_A = 25°C$ $0°C \leq T_A \leq +70°C$ $-55°C \leq T_A \leq +125°C$	86 80 74	102		80 75 68	102		80 75 68	102		dB
		$V_O = \pm4.0V$, $R_L = 10k\Omega$[2] $I_Q = 1mA$[1] $T_A = 25°C$ $0°C \leq T_A \leq +70°C$ $-55°C \leq T_A \leq +125°C$	86 80 74	98		80 75 68	98		80 75 68	98		dB
Unity Gain Bandwidth	G_{BW}	$I_Q = 10\mu A$[1] $I_Q = 100\mu A$[3] $I_Q = 1mA$[2]		0.044 0.48 1.4			0.044 0.48 1.4			0.044 0.48 1.4		MHz
Input Resistance	R_{IN}			10^{12}			10^{12}			10^{12}		Ω
Common Mode Rejection Ratio	CMRR	$R_S \leq 100k\Omega$, $I_Q = 10\mu A$[1] $R_S \leq 100k\Omega$, $I_Q = 100\mu A$ $R_S \leq 100k\Omega$, $I_Q = 1mA$[2]	76 76 66	96 91 87		70 70 60	96 91 87		70 70 60	96 91 87		dB
Power Supply Rejection Ratio	PSRR	$R_S \leq 100k\Omega$, $I_Q = 10\mu A$[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		80 80 70	94 86 77		dB

Note 1: Does not apply to 7641.
Note 2: Does not apply to 7642.
Note 3: ICL7631/32 only.
Note 4: Does not apply to 7632.

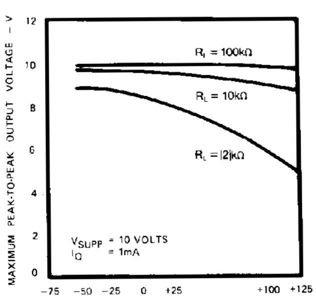
ELECTRICAL CHARACTERISTICS — Triple & Quad (Continued)
($V_{SUPP} = \pm 5.0V$, $T_A = 25°C$, unless noted)

PARAMETER	SYMBOL	CONDITIONS	76XXB MIN.	76XXB TYP.	76XXB MAX.	76XXC MIN.	76XXC TYP.	76XXC MAX.	76XXE MIN.	76XXE TYP.	76XXE MAX.	UNITS
Input Referred Noise Voltage	e_n	$R_S = 100\Omega$, f = 1kHz		100			100			100		$nV/\sqrt{Hz}$
Input Referred Noise Current	i_n	$R_S = 100\Omega$, f = 1kHz		0.01			0.01			0.01		$pA/\sqrt{Hz}$
Supply Current (Per Amplifier)	I_{SUPP}	No Signal, No Load $I_Q = 10\mu A$[1] $I_Q = 100\mu A$ $I_Q = 1mA$[2]		 0.01 0.1 1.0	 0.022 0.25 2.5		 0.01 0.1 1.0	 0.022 0.25 2.5		 0.01 0.1 1.0	 0.022 0.25 2.5	mA
Channel Separation	V_{O1}/V_{O2}	$A_{VOL} = 100$		120			120			120		dB
Slew Rate[4]	SR	$A_{VOL} = 1$, $C_L = 100pF$ $V_{IN} = 8V_{p-p}$ $I_Q = 10\mu A$,[1] $R_L = 1M\Omega$ $I_Q = 100\mu A$, $R_L = 100k\Omega$ $I_Q = 1mA$,[1] $R_L = 10k\Omega$[2]		 0.016 0.16 1.6			 0.016 0.16 1.6			 0.016 0.16 1.6		$V/\mu s$
Rise Time[4]	t_r	$V_{IN} = 50mV$, $C_L = 100pF$ $I_Q = 10\mu A$,[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			 20 2 0.9		μs
Overshoot Factor[4]		$V_{IN} = 50mV$, $C_L = 100pF$ $I_Q = 10\mu A$,[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			 5 10 40		%

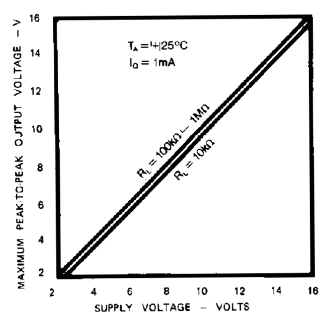
Note 1: Does not apply to 7641.
Note 2: Does not apply to 7642.
Note 3: ICL7631/32 only.
Note 4: Does not apply to 7632.

Typical Operating Characteristics

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



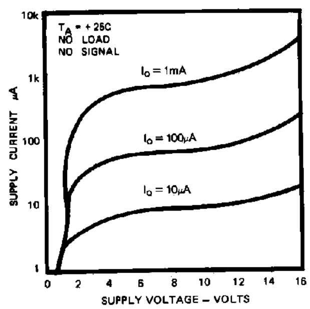
MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE AS A FUNCTION OF SUPPLY VOLTAGE



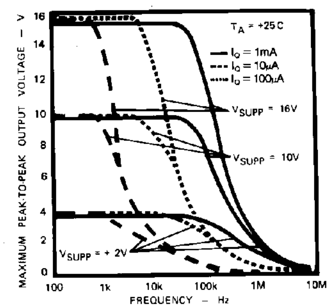
Single/Dual/Triple/Quad Operational Amplifiers

Typical Operating Characteristics

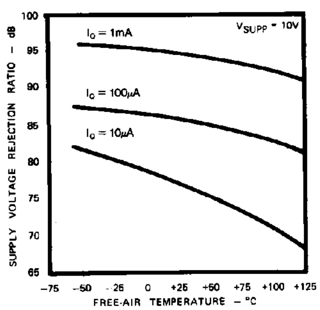
SUPPLY CURRENT PER AMPLIFIER AS A FUNCTION OF SUPPLY VOLTAGE



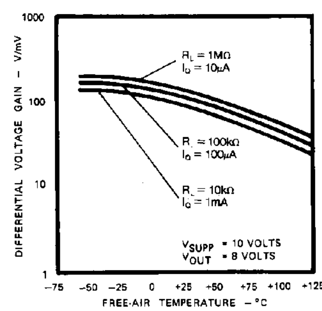
PEAK-TO-PEAK OUTPUT VOLTAGE AS A FUNCTION OF FREQUENCY



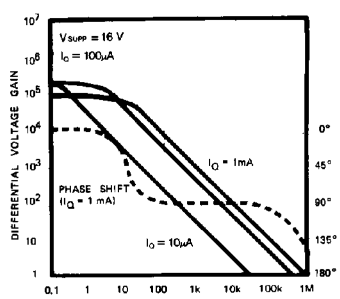
POWER SUPPLY REJECTION RATIO AS A FUNCTION OF FREE-AIR TEMPERATURE



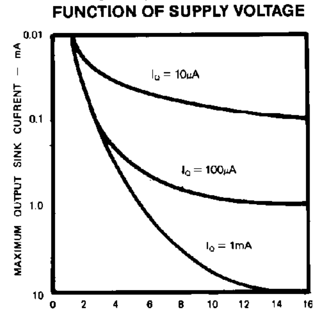
LARGE SIGNAL DIFFERENTIAL VOLTAGE GAIN AS A FUNCTION OF FREE-AIR TEMPERATURE



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

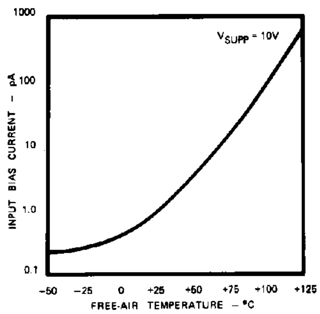


MAXIMUM OUTPUT SINK CURRENT AS A FUNCTION OF SUPPLY VOLTAGE

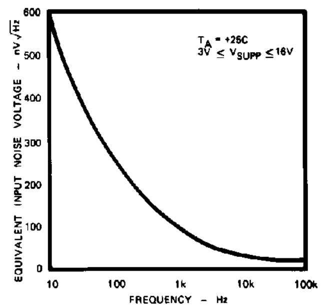


Typical Operating Characteristics

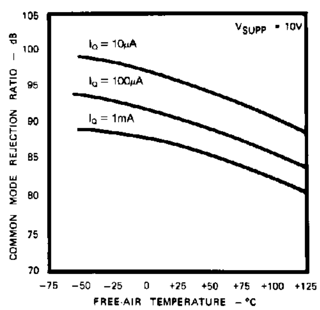
INPUT BIAS CURRENT AS A FUNCTION OF TEMPERATURE



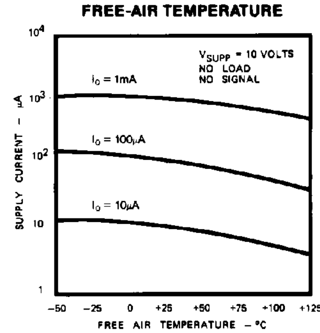
EQUIVALENT INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



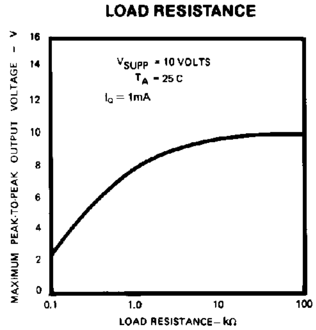
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREE-AIR TEMPERATURE



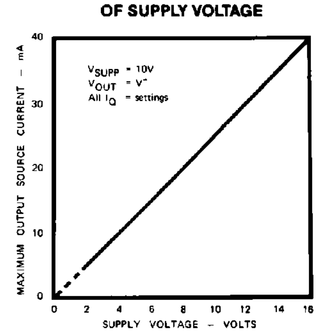
SUPPLY CURRENT PER AMPLIFIER AS A FUNCTION OF FREE-AIR TEMPERATURE



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



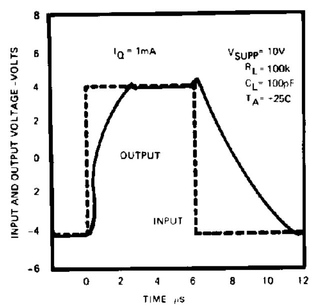
MAXIMUM OUTPUT/SOURCE CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



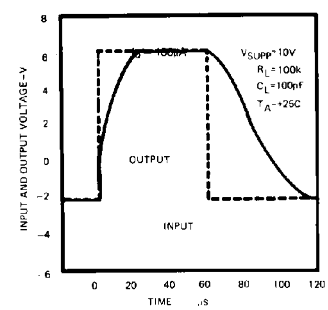
Single/Dual/Triple/Quad Operational Amplifiers

Typical Operating Characteristics

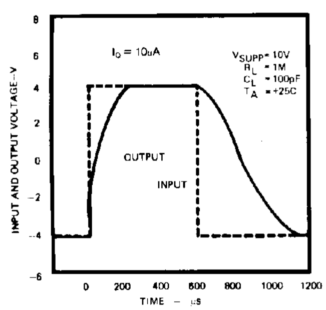
VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



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 10, 100 or 1000 μA. 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 = 10 μA. . . . . I_Q pin to V^+
I_Q = 100 μA. . . . . I_Q pin between V^- +0.8V and V^+ −0.8V
I_Q = 1 mA. . . . . I_Q pin to V^-

Input Offset Nulling

The input offset can be nulled by connecting a 25K pot between the OFFSET terminals with the wiper connected to V^+. At quiescent currents of 1 mA and 100 μA, the nulling range provided is adequate for all V_{OS} selections. However with higher values of V_{OS}, and an I_Q of 10 μA, 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 39 pF being sufficient compensation for a unity gain buffer. For gains 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 gains ≥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 1M, 100k and 10k, 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 graphs under Typical Operating Characteristics). The voltage gain decreases and the output transfer characteristic is non-linear 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 10k, 100k, and 1M 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 100 pF; and while on the 1mA I_Q setting, avoid loads less than 5 kΩ. Since the output stage is a transconductance output, very large (>10 μF) capacitive loads will create a dominant pole and the output will be stable, even with loads that are less than 5 kΩ.

Extended Common Mode Voltage Range, ICL7612 and ICL7616

A common mode voltage range that includes both V^+ and V^- is often desirable, especially in single supply operation. The ICL7612 and 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 of 10μA or 100μA.

Printed Circuit Board Layout

Careful PCB 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 ouput. 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 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 10 μA I_Q. At 100 μA I_Q the CMVR is 1.0V to (V^+ – 0.8V), and at 1 mA 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 = 10 μA. Output swings to within a few millivolts of the supply rails are achievable for R_L (> or =) 1 MΩ. 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, refer to description of ICL7612 and ICL7616 above.

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.

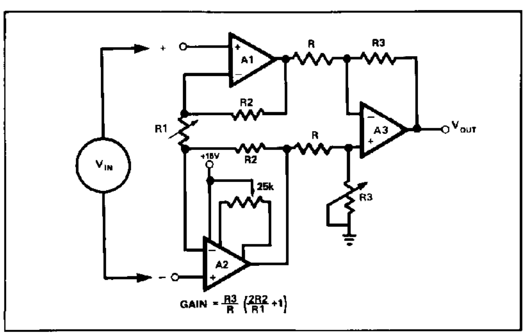


Figure 1. Instrumentation Amplifier—Adjust R3 to improve CMRR. The offset of all three amplifiers is nulled by the offset adjustment of A2.

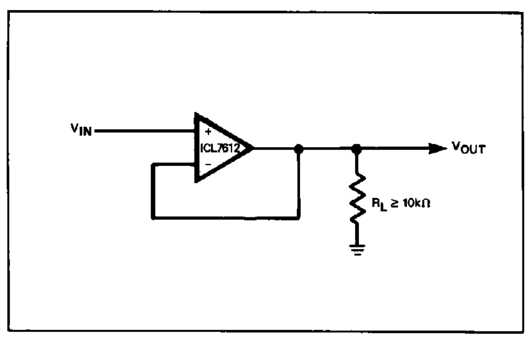


Figure 2. Simple Follower—By using the ICL7612 in these applications, the circuits will follow rail to rail inputs.

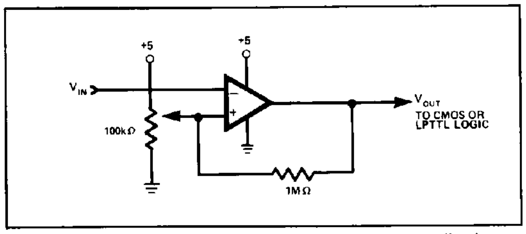


Figure 3. Level Detector – By using the ICL7612 in these applications, the circuits will follow rail to rail inputs.

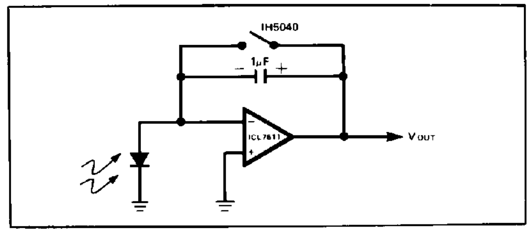


Figure 4. Photocurrent Integrator – Low leakage currents allow integration times up to several hours.

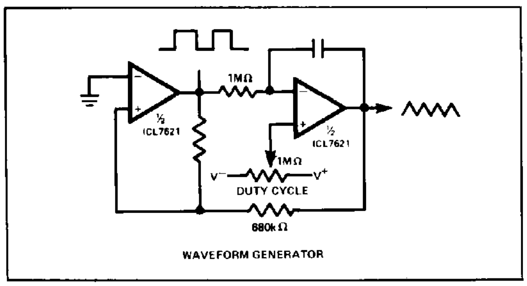


Figure 5. Precise Triangle/Square Wave Generator – The frequency and duty cycle are virtually independent of power supply.

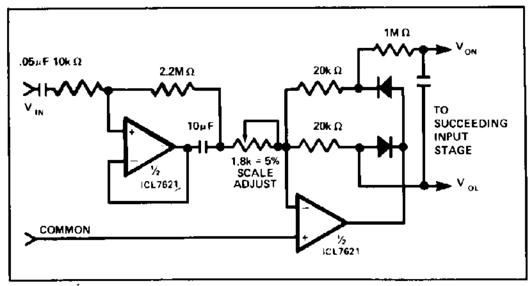


Figure 6. Averaging AC to DC Converter – Recommended for Maxim's ICL7106/07/09 A/D Converters.

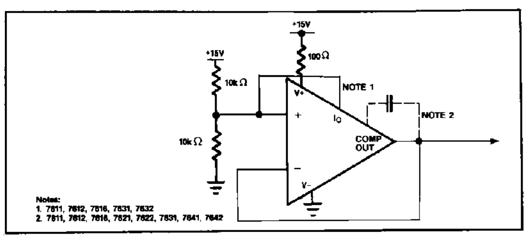


Figure 7. Burn-In and Life Test Circuit

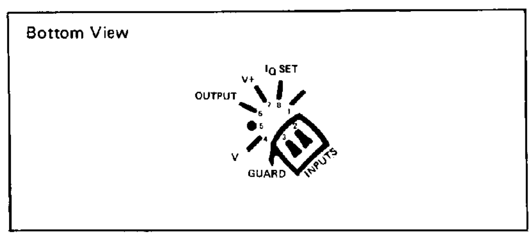


Figure 8. Input Guard for TO-99

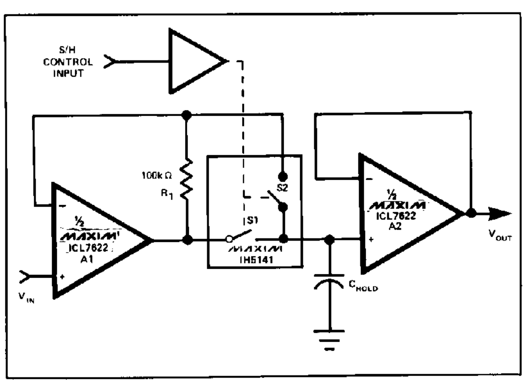


Figure 9. Low Droop Rate Sample & Hold – S2 improves accuracy and acquisition time by including the voltage drop across S1 inside the feedback loop. R1 closes the feedback loop of A1 during the hold phase. The droop rate is $[I_{BIAS(AZ)} + I_{LEAK(S1)} + I_{LEAK(S2)}]/C_{HOLD}$.

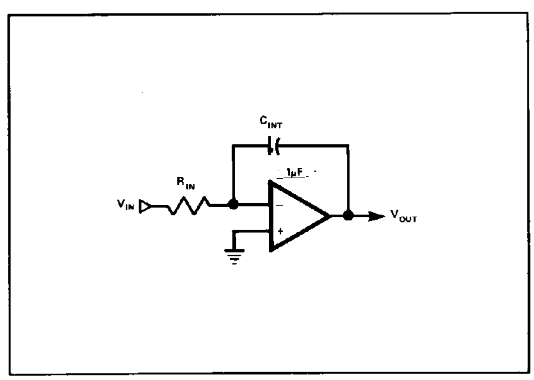


Figure 10. Long Time Constant Integrator – With R_{IN} = 10" ohm, the time constant of this integrator is 100,000 seconds. Since the input voltage is converted to a current by R_{IN}, the input voltage can far exceed the power supply voltage.

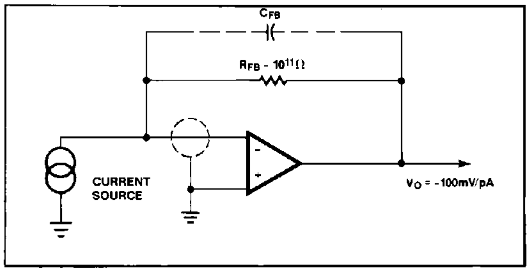


Figure 11. Pico Ammeter—The response time of this circuit is $R_{FB} \times C_{FB}$, where C_{FB} is the stray capacitance between the output and the inverting terminal of the amplifier.

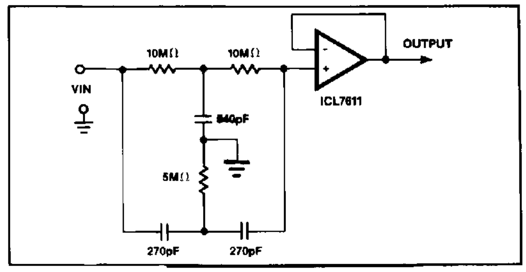


Figure 12. 60 Hz Twin "T" Notch Filter—The low, 1 pA bias current of the ICL7611 allows use of small 540 pF and 270 pF capacitors, even with a notch frequency of 60 Hz. The 60 Hz rejection is approximately 40 dB.

Chip Topographies