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 ±1.0V 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 and require no special handling procedures. 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 ±1.0V 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**
- **Inputs Protected to ±200V (ICL7613/15)**
- **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

Package Code
- TV — TO-99, 8 pin
- PA — Plastic 8 pin Minidip
- PD — 14 pin Plastic Dip
- PE — 16 pin Plastic Dip
- JD — 14 pin CERDIP
- JE — 16 pin CERDIP
- ID — Dice

Temperature Range
- C = 0°C to 70°C
- M = -55°C to +125°C

V_{OS} Selection
- A = 2mV
- B = 5mV
- C = 10mV
- D = 15mV
- E = 20mV

SPECIAL FEATURE CODES

C	=	INTERNALLY COMPENSATED
E	=	EXTERNALLY COMPENSATED
H	=	HIGH QUIESCENT CURRENT (1mA)
I	=	INPUT PROTECTED TO ±200V
L	=	LOW QUIESCENT CURRENT (10μA)
M	=	MEDIUM QUIESCENT CURRENT (100μA)
O	=	OFFSET NULL CAPABILITY
P	=	PROGRAMMABLE QUIESCENT CURRENT
V	=	EXTENDED CMVR

302060–002

Note: All typical values have been guaranteed by characterization and are not tested.

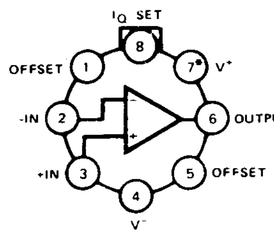
ORDERING INFORMATION

BASIC PART NUMBER	NUMBER OF OP-AMPS IN PACKAGE, AND SPECIAL FEATURES (SEE ABOVE)	PACKAGE TYPE AND SUFFIX							
		8-LEAD TO-99		8-PIN MINIDIP	8-PIN SOIC	PLASTIC DIP (1)	CERAMIC DIP (1)		DICE
		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	0°C to +70°C	−55°C to +125°C	
 ICL7611 ICL7612 ICL7613 ICL7614 ICL7615	SINGLE OP-AMP: C, O, P C, O, P, V C, I, O, P E, M, O E, I, M, O	ACTV BCTV DCTV	AMTV BMTV	ACPA BCPA DCPA	DCPA DCBA				D/D
ICL7621	DUAL OP-AMP: C, M	ACTV BCTV DCTV	AMTV BMTV	ACPA BCPA DCPA					D/D
ICL7622	DUAL OP-AMP: C, M, O					ACPD BCPD DCPD	ACJD BCJD DCJD	AMJD BMJD	D/D
 ICL7631 ICL7632	TRIPLE OP-AMP: C, P P(3)					CCPE ECPE	CCJE ECJE	CMJE	E/D
 ICL7641 ICL7642	QUAD OP-AMP: C, H C, L					CCPD ECPD	CCJD ECJD	CMJD	E/D

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.
3. ICL7632 is not compensatable. Recommended for use in high gain circuits only.
**Parameter Min/Max Limits guaranteed at 25°C only for DICE orders.

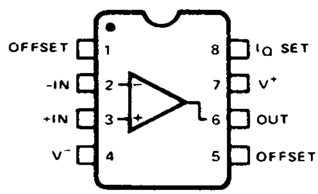
DEVICE	DESCRIPTION	PIN ASSIGNMENTS
ICL7611XCPA ICL7611XCTV ICL7611XMTV ICL7612XCPA ICL7612XCTV ICL7612XMTV ICL7613XCPA ICL7613XCTV ICL7613XMTV	Internal compensation, plus offset null capability and external I_Q control	see below

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



*Pin 7 connected to case.

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



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

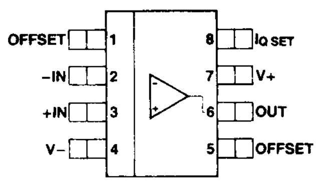


Figure 1: Pin Configurations

Note: All typical values have been guaranteed by characterization and are not tested.

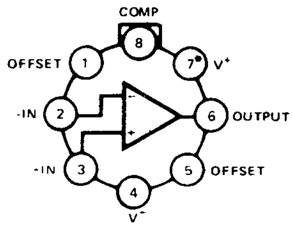
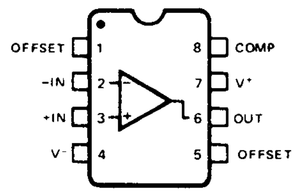
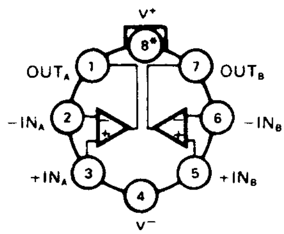
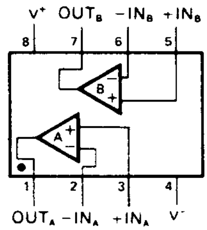
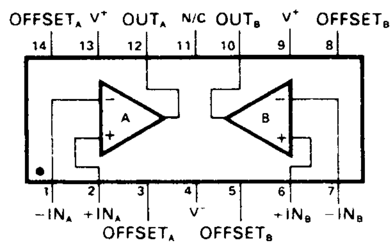
DEVICE	DESCRIPTION	PIN ASSIGNMENTS
ICL7614XCPA ICL7614XCTV ICL7614XMTV ICL7615XCPA ICL7615XCTV ICL7615XMTV	Fixed I_Q (100μA), external compensation, and offset null capability	TO-99 (TOP VIEW) (outline dwg TV) 8 PIN DIP (TOP VIEW) (outline dwg PA) SOIC-8  *Pin 7 connected to case. 
ICL7621XCPA ICL7621XCTV ICL7621XMTV	Dual op amps with internal compensation; I_Q fixed at 100μA Pin compaptible with Texas Inst. TL082 Motorola MC1458 Raytheon RC4558	TO-99 (TOP VIEW) (outline dwg TV) * PIN DIP (TOP VIEW) (outline dwg PA)  *Pin 8 connected to case. 
ICL7622XCPD	Dual op amps with external compensation and offset null capability; I_Q fixed at 100μA Pin compatible with Texas Inst. TL083 Fairchild μA747	14 PIN DIP (TOP VIEW) (outline dwgs JD, PD)  Note: Pins 9 and 13 are internally connected.

Figure 1: Pin Configurations (Cont.)

Note: All typical values have been guaranteed by characterization and are not tested.

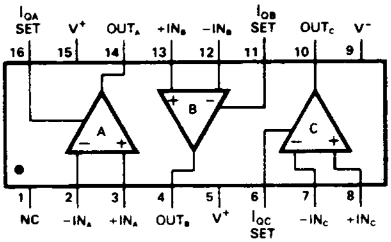
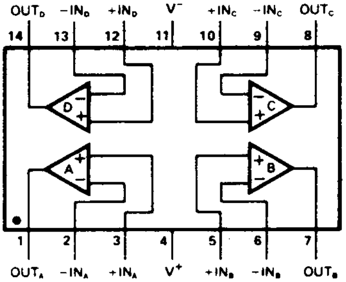
DEVICE	DESCRIPTION	PIN ASSIGNMENTS
ICL7631XCPE ICL7632XCPE	Triple op amps with internal compensation (ICL7631) and no compensation (ICL7632). Adjustable I_Q Same pin configuration as ICL8023.	16 PIN DIP (TOP VIEW) (outline dwgs JE, PE)  Note: pins 5 and 15 are internally connected.
ICL7641XCPD ICL7642XCPD	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 JD, PD) 

Figure 1: Pin Configurations (Cont.)

Note: All typical values have been guaranteed by characterization and are not tested.

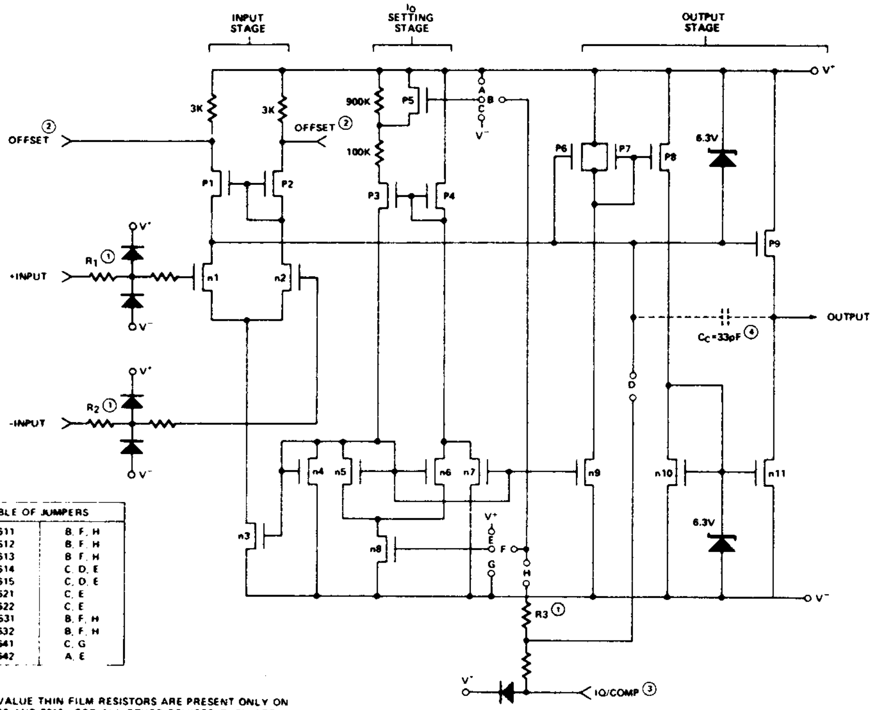


TABLE OF JUMPERS	
ICL 7611	B, F, H
ICL 7612	B, F, H
ICL 7613	B, F, H
ICL 7614	C, D, E
ICL 7615	C, D, E
ICL 7621	C, E
ICL 7622	C, E
ICL 7631	B, F, H
ICL 7632	B, F, H
ICL 7641	C, G
ICL 7642	A, E

NOTES
1. HIGH VALUE THIN FILM RESISTORS ARE PRESENT ONLY ON ICL 7613 AND 7615. FOR ALL OTHER DEVICES, THEY ARE REPLACED BY DIRECT CONNECTIONS.
2. OFFSET NULLING PINS ARE NOT AVAILABLE ON TRIPLE (ICL 763X) AND QUAD (ICL 764X) VERSIONS.
3. I_Q AND COMP TERMINALS ARE METAL MASK OPTIONS OF THE SAME BONDING PAD, ONLY ONE OF THESE FUNCTIONS IS AVAILABLE IN A GIVEN DEVICE.
4. FOR INTERNALLY COMPENSATED VERSIONS ONLY. THIS CAPACITOR IS ABSENT FOR ALL OTHER DEVICES.

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Figure 2: Functional Diagram

Note: All typical values have been guaranteed by characterization and are not tested.

ABSOLUTE MAXIMUM RATINGS

Total Supply Voltage V^+ to V^- 18V
Input Voltage .... V^- −0.3 to V^+ +0.3V
Input Voltage ICL7613/15 Only ....
V^- −200V to V^+ +200V
Differential Input Voltage[2] ... ±[(V^+ +0.3) − (V^- −0.3)]V
Differential Input Voltage[2] ICL7613/15 Only ....
±[(V^+ +200) − (V^- −200)]V
Duration of Output Short Circuit[3] .... 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
M Series .... −55°C to +125°C
C Series .... 0°C to +70°C
Lead Temperature (Soldering, 10sec) .... 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 $V_{SUPP} \le 10V$. Care must be taken to insure that the dissipation rating is not exceeded.

ELECTRICAL CHARACTERISTICS (761X and 762X ONLY)

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

SYMBOL	PARAMETER	TEST CONDITIONS	76XXA			76XXB			76XXD			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input Offset Voltage	$R_S \le 100k\Omega$, $T_A = 25°C$ $T_{MIN} \le T_A \le T_{MAX}$			2 3			5 7			15 20	mV
$\Delta V_{OS}/\Delta T$	Temperature Coefficient of V_{OS}	$R_S \le 100k\Omega$		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	$T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$		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) $I_Q = 10\mu A$, $R_L = 1M\Omega$ $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	±4.9 ±4.8 ±4.7			±4.9 ±4.8 ±4.7			±4.9 ±4.8 ±4.7			V
		$I_Q = 100\mu A$, $R_L = 100k\Omega$ $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	±4.9 ±4.8 ±4.5			±4.9 ±4.8 ±4.5			±4.9 ±4.8 ±4.5			
		(1) $I_Q = 1mA$, $R_L = 10k\Omega$ $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	±4.5 ±4.3 ±4.0			±4.5 ±4.3 ±4.0			±4.5 ±4.3 ±4.0			

Note: All typical values have been guaranteed by characterization and are not tested.

ICL76XX

ELECTRICAL CHARACTERISTICS (761X and 762X ONLY) (CONT.)

SYMBOL	PARAMETER	TEST CONDITIONS	76XXA			76XXB			76XXD			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
A_{VOL}	Large Signal Voltage Gain	$V_O = \pm4.0V$, $R_L = 1M\Omega$ $I_Q = 10\mu A^{(1)}$, $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	86 80 74	104		80 75 68	104		80 75 68	104		
		$V_O = \pm4.0V$, $R_L = 100k\Omega$ $I_Q = 100\mu A$, $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	86 80 74	102		80 75 68	102		80 75 68	102		dB
		$V_O = \pm4.0V$, $R_L = 10k\Omega$ $I_Q = 1mA^{(1)}$, $T_A = 25°C$ $\Delta T_A = C$ $\Delta T_A = M$	80 76 72	83		76 72 68	83		76 72 68	83		
GBW	Unity Gain Bandwidth	$I_Q = 10\mu A^{(1)}$ $I_Q = 100\mu A$ $I_Q = 1mA^{(1)}$		0.044 0.48 1.4			0.044 0.48 1.4			0.044 0.48 1.4		MHz
R_{IN}	Input Resistance			10^{12}			10^{12}			10^{12}		Ω
CMRR	Common Mode Rejection Ratio	$R_S \leq 100k\Omega$, $I_Q = 10\mu A^{(1)}$ $R_S \leq 100k\Omega$, $I_Q = 100\mu A$ $R_S \leq 100k\Omega$, $I_Q = 1mA^{(1)}$	76 76 66	96 91 87		70 70 60	96 91 87		70 70 60	96 91 87		dB
PSRR	Power Supply Rejection Ratio	$R_S \leq 100k\Omega$, $I_Q = 10\mu A^{(1)}$ $R_S \leq 100k\Omega$, $I_Q = 100\mu A$ $R_S \leq 100k\Omega$, $I_Q = 1mA^{(1)}$	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	$R_S = 100\Omega$, f = 1kHz		100			100			100		$nV/\sqrt{Hz}$
i_n	Input Referred Noise Current	$R_S = 100\Omega$, f = 1kHz		0.01			0.01			0.01		$pA/\sqrt{Hz}$
I_{SUPPLY}	Supply Current (Per Amplifier)	No Signal, No Load I_Q SET = $+5V^{(1)}$ I_Q SET = 0V I_Q SET = $-5V^{(1)}$		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
V_{O1}/V_{O2}	Channel Separation	$A_{VOL} = 100$		120			120			120		dB
SR	Slew Rate(3)	$A_{VOL} = 1$, $C_L = 100pF$ $V_{IN} = 8Vp\text{-}p$ $I_Q = 10\mu A^{(1)}$, $R_L = 1M\Omega$ $I_Q = 100\mu A$, $R_L = 100k\Omega$ $I_Q = 1mA^{(1)}$, $R_L = 10k\Omega$		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)	$V_{IN} = 50mV$, $C_L = 100pF$ $I_Q = 10\mu A^{(1)}$, $R_L = 1M\Omega$ $I_Q = 100\mu A$, $R_L = 100k\Omega$ $I_Q = 1mA^{(1)}$, $R_L = 10k\Omega$		20 2 0.9			20 2 0.9			20 2 0.9		μs
	Overshoot Factor(3)	$V_{IN} = 50mV$, $C_L = 100pF$ $I_Q = 10\mu A^1$, $R_L = 1M\Omega$ $I_Q = 100\mu A$, $R_L = 100k\Omega$ $I_Q = 1mA^1$, $R_L = 10k\Omega$		5 10 40			5 10 40			5 10 40		%

NOTES: 1. ICL7611, 7612, 7613 only. 2. C = Commercial Temperature Range: 0°C to +70°C M = Military Temperature Range: −55°C to +125°C 3. ICL7614/15; 39pF from pin 6 to pin.

ELECTRICAL CHARACTERISTICS (761X AND 762X ONLY)

($V_{SUPPLY} = \pm1.0V$, $I_Q = 10\mu A$, $T_A = 25°C$, unless otherwise specified. Specs apply to ICL7611/7612/7613 only.)

SYMBOL	PARAMETER	TEST CONDITIONS	76XXA			76XXB			UNIT
			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	mV
$\Delta V_{OS}/\Delta T$	Temperature Coefficient of V_{OS}	$R_S \leq 100k\Omega$		10			15		μV/°C

Note: All typical values have been guaranteed by characterization and are not tested.

ELECTRICAL CHARACTERISTICS (761X AND 762X ONLY) (CONT.)

SYMBOL	PARAMETER	TEST CONDITIONS	76XXA MIN	76XXA TYP	76XXA MAX	76XXB MIN	76XXB TYP	76XXB MAX	UNIT
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	$A_{VOL} = 1$, $C_L = 100pF$ $V_{IN} = 0.2Vp\text{-}p$ $R_L = 1M\Omega$		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).

ELECTRICAL CHARACTERISTICS (763X, 764X ONLY)

($V_{SUPPLY} = \pm 5.0V$, $T_A = 25°C$, 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	UNIT
V_{OS}	Input Offset Voltage	$R_S \leq 100k\Omega$, $T_A = 25°C$ $T_{MIN} \leq T_A \leq T_{MAX}$			10 15			20 25	mV
$\Delta V_{OS}/\Delta T$	Temperature Coefficient of V_{OS}	$R_S \leq 100k\Omega$ (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

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Note: All typical values have been guaranteed by characterization and are not tested.

ELECTRICAL CHARACTERISTICS (763X, 764X ONLY) (CONT.)

SYMBOL	PARAMETER	TEST CONDITIONS	76XXC (6)			76XXE (6)			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{OUT}	Output Voltage Swing	(1) $I_Q = 10\mu A$, $R_L = 1M\Omega$							
		$T_A = 25°C$	±4.9			±4.9			
		$\Delta T_A = C$	±4.8			±4.8			
		$\Delta T_A = M$	±4.7			±4.7			
		$I_Q = 100\mu A$, $R_L = 100k\Omega$							
		(3) $T_A = 25°C$	±4.9			±4.9			V
		$\Delta T_A = C$	±4.8			±4.8			
		$\Delta T_A = M$	±4.5			±4.5			
		(2) $I_Q = 1mA$, $R_L = 10k\Omega$							
		$T_A = 25°C$	±4.5			±4.5			
		$\Delta T_A = C$	±4.3			±4.3			
		$\Delta T_A = M$	±4.0			±4.0			
A_{VOL}	Large Signal Voltage Gain	$V_O = \pm 4.0V$, $R_L = 1M\Omega^{(1)}$							
		$I_Q = 10\mu A^{(1)}$, $T_A = 25°C$	80	104		80	104		
		$\Delta T_A = C$	75			75			
		$\Delta T_A = M$	68			68			
		$V_O = \pm 4.0V$, $R_L = 100k\Omega^{(3)}$							
		$I_Q = 100\mu A$, $T_A = 25°C$	80	102		80	102		
		$\Delta T_A = C$	75			75			
		$\Delta T_A = M$	68			68			dB
		$V_Q = \pm 4.0V$, $R_L = 10k\Omega^{(2)}$							
		$I_Q = 1mA^{(1)}$, $T_A = 25°C$	80	98		80	98		
		$\Delta T_A = C$	75			75			
		$\Delta T_A = M$	68			68			
GBW	Unity Gain Bandwidth	$I_Q = 10\mu A^{(1)}$		0.044			0.044		MHz
		$I_Q = 100\mu A^{(3)}$		0.48			0.48		
		$I_Q = 1mA^{(2)}$		1.4			1.4		
R_{IN}	Input Resistance		10^{12}			10^{12}		Ω	
CMRR	Common Mode Rejection Ratio	$R_S \leq 100k\Omega$, $I_Q = 10\mu A^{(1)}$	70	96		70	96		
		$R_S \leq 100k\Omega$, $I_Q = 100\mu A$	70	91		70	91		dB
		$R_S \leq 100k\Omega$, $I_Q = 1mA^{(2)}$	60	87		60	87		
PSRR	Power Supply Rejection Ratio	$R_S \leq 100k\Omega$, $I_Q = 10\mu A^{(1)}$	80	94		80	94		
		$R_S \leq 100k\Omega$, $I_Q = 100\mu A$	80	86		80	86		dB
		$R_S \leq 100k\Omega$, $I_Q = 1mA^{(2)}$	70	77		70	77		
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	No Signal, No Load		0.01	0.03		0.01	0.03	
	(Per Amplifier)	7642 ONLY							
		$I_Q = 10\mu A^{(1)}$		0.01	0.022		0.01	0.022	
		$I_Q = 100\mu A$		0.1	0.25		0.1	0.25	mA
		$I_Q = 1mA^{(2)}$		1.0	2.5		1.0	2.5	
V_{O1}/V_{O2}	Channel Separation	$A_{VOL} = 100$		120			120		dB
SR	Slew Rate(4)	$A_{VOL} = 1$, $C_L = 100pF$							
		$V_{IN} = 8Vp\text{-}p$							
		$I_Q = 10\mu A^{(1)}$, $R_L = 1M\Omega$		0.016			0.016		V/µs
		$I_Q = 100\mu A$, $R_L = 100k\Omega$		0.16			0.16		
		$I_Q = 1mA^{(1)}$, $R_L = 10k\Omega^{(2)}$		1.6			1.6		
t_r	Rise Time(4)	$V_{IN} = 50mV$, $C_L = 100pF$							
		$I_Q = 10\mu A^{(1)}$, $R_L = 1M\Omega$		20			20		µs
		$I_Q = 100\mu A$, $R_L = 100k\Omega$		2			2		
		$I_Q = 1mA^{(2)}$, $R_L = 10k\Omega$		0.9			0.9		

Note: All typical values have been guaranteed by characterization and are not tested.

ELECTRICAL CHARACTERISTICS (763X, 764X ONLY) (CONT.)

SYMBOL	PARAMETER	TEST CONDITIONS	76XXC (6)			76XXE (6)			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
	Overshoot Factor(4)	V_{IN} = 50mV, C_L = 100pF I_Q = 10μA(1), R_L = 1MΩ I_Q = 100μA, R_L = 100kΩ I_Q = 1mA(2), R_L = 10kΩ		5 10 40			5 10 40		%

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

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

ELECTRICAL CHARACTERISTICS (763X AND 764X ONLY)

(V_{SUPPLY} = ±1.0V, I_Q = 10μA, T_A = 25°C, unless otherwise specified. Specs apply to ICL7631/7632/7642 only.)

SYMBOL	PARAMETER	TEST CONDITIONS	76XXC			UNIT
			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 12	mV
$\Delta V_{OS}/\Delta T$	Temperature Coefficient of V_{OS}	$R_S \le 100k\Omega$		20		μV/°C
I_{OS}	Input Offset Current	T_A = 25°C ΔT_A = C		0.5	30 300	pA
I_{BIAS}	Input Bias Current	T_A = 25°C ΔT_A = C		1.0	50 500	pA
V_{CMR}	Common Mode Voltage Range		±0.6			V
V_{OUT}	Output Voltage Swing	R_L = 1MΩ, T_A = 25°C Δ T_A = C		±0.98 ±0.96		V
A_{VOL}	Large Signal Voltage Gain	V_O = ±0.1V, R_L = 1MΩ T_A = 25°C ΔT_A = C		90 80		dB
GBW	Unity Gain Bandwidth		0.044			MHz
R_{IN}	Input Resistance		10^{12}			Ω
CMRR	Common Mode Rejection Ratio	$R_S \le 100k\Omega$		80		dB
PSRR	Power Supply Rejection Ratio		80			dB
e_n	Input Referred Noise Voltage	R_S = 100Ω, f = 1kHz		100		nV/$\sqrt{Hz}$
i_n	Input Referred Noise Current	R_S = 100Ω, f = 1kHz		0.01		pA/$\sqrt{Hz}$
I_{SUPPLY}	Supply Current (Per Amplifier)	No Signal, No Load		6	15	μA
V_{O1}/V_{O2}	Channel Separation	A_{VOL} = 100		120		dB
SR	Slew Rate	A_{VOL} = 1, C_L = 100pF V_{IN} = 0.2Vp-p R_L = 1MΩ		0.016		V/μs
t_r	Rise Time	V_{IN} = 50mV, C_L = 100pF R_L = 1MΩ		20		μs
	Overshoot Factor	V_{IN} = 50mV, C_L = 100pF R_L = 1MΩ		5		%

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

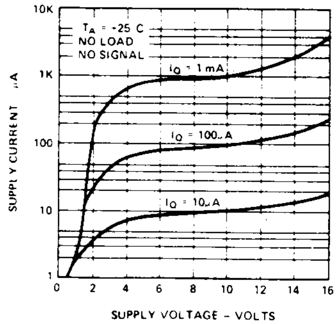
4

Note: All typical values have been guaranteed by characterization and are not tested.

INTERSIL

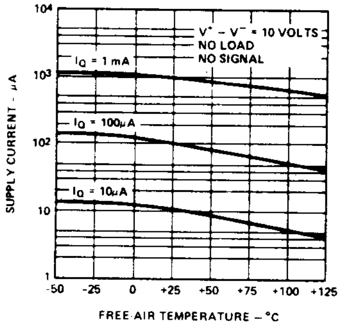
TYPICAL PERFORMANCE CHARACTERISTICS

SUPPLY CURRENT PER AMPLIFIER AS A FUNCTION OF SUPPLY VOLTAGE



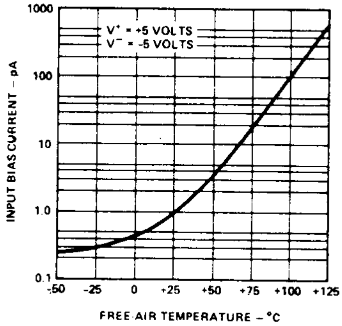
OP016301

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



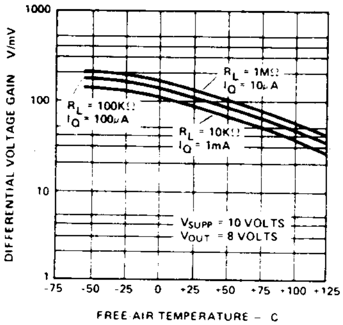
OP016401

INPUT BIAS CURRENT AS A FUNCTION OF TEMPERATURE



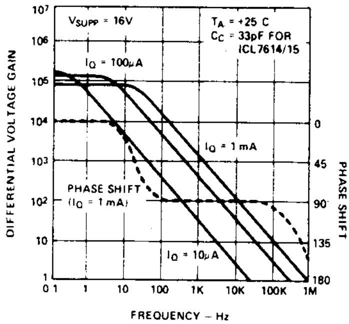
OP016501

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



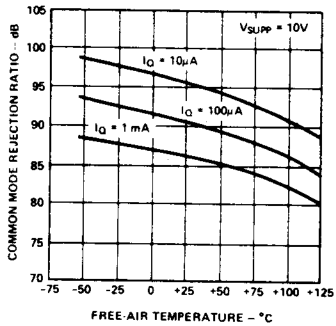
OP016601

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



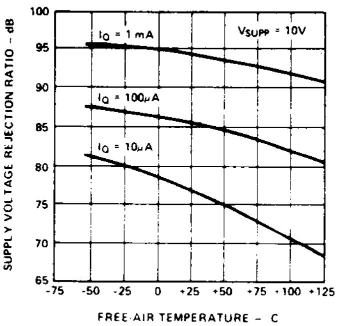
OP016701

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



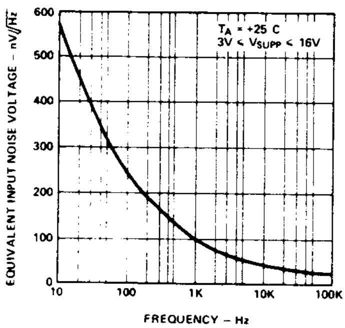
OP016801

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



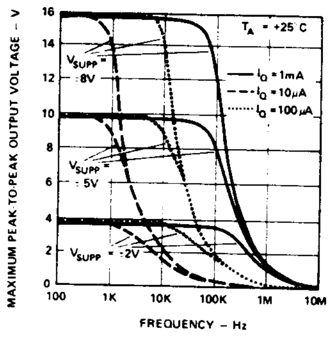
OP016901

EQUIVALENT INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



OP017001

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

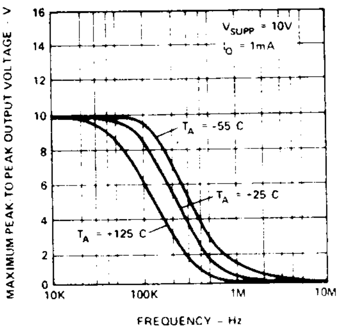


OP017101

Note: All typical values have been guaranteed by characterization and are not tested.

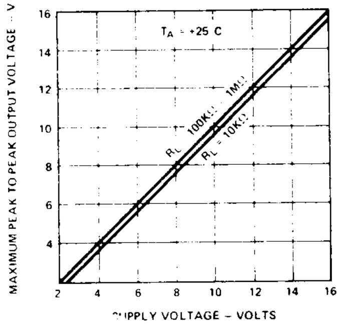
TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

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



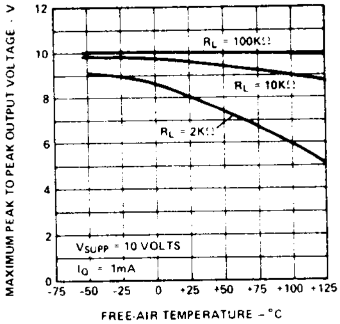
OP01720I

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



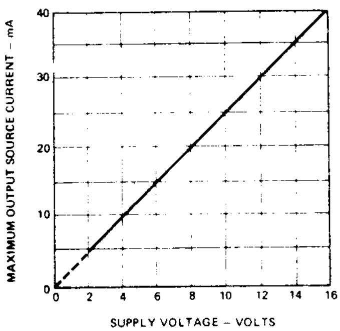
OP01730I

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



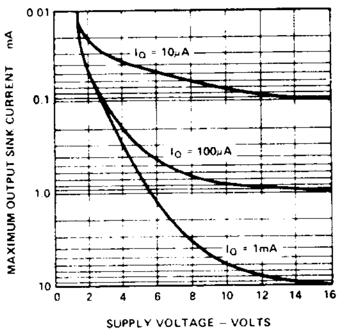
OP01740I

MAXIMUM OUTPUT/SOURCE CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



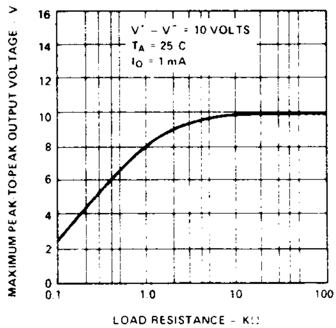
OP01750I

MAXIMUM OUTPUT SINK CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



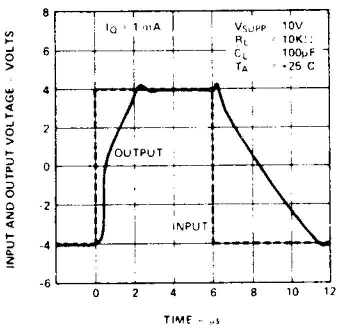
OP01760I

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



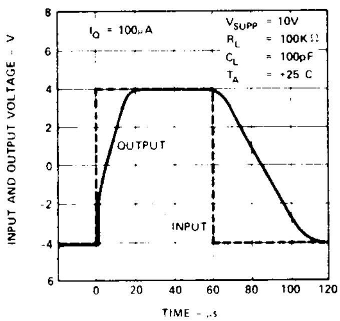
OP01770I

VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



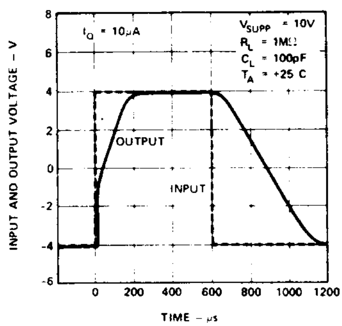
OP03580I

VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



OP01910I

VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



OP01920I

Note: All typical values have been guaranteed by characterization and 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. (An exception to this rule concerns the inputs of the ICL7613 and ICL7615, which are protected to ±200V.) 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 to 10μA, 100μA or 1mA. These current settings change only very slightly over the entire supply voltage range. The ICL7611/12/13 and ICL7631/32 have an external I_Q control terminal, permitting user selection of each amplifiers' quiescent current. (The ICL7614/15, 7621/22, 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 negative 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.

A special feature of the output stage is that it approximates a transconductance amplifier, and its gain is directly proportional to load impedance. 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.

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 ICL7611/12/13, 7621/22, 7631, 7641/42 are internally compensated, and are stable for closed loop gains as low as unity with capacitive loads up to 100pF

The ICL7614/15 are externally compensated by connecting a capacitor between the COMP and OUT pins. A 39pF capacitor is required for unity gain compensation; for greater than unity gain applications, increased bandwidth and slew rate can be obtained by reducing the value of the compensating capacitor. Since the g_m of the first stage is proportional to $\sqrt{I_Q}$, greatest compensation is required when I_Q=1mA.

The ICL7632 is not compensated internally, nor can it be compensated externally. The device is stable when used as follows:

I_Q of 1mA for gains ≥ 20

I_Q of 100μA for gains ≥ 10

I_Q of 10μA for gains ≥ 5

High Voltage Input Protection

The ICL7613 and 7615 include on-chip thin film resistors and clamping diodes which allow voltages of up to ±200V to be applied to either input for an indefinite time without device failure. These devices will be useful where high common mode voltages, differential mode voltages, or high transients may be experienced. Such conditions may be found when interfacing separate systems with separate supplies. Unity gain stability is somewhat degraded with capacitive loads because of the high value of input resistors.

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} ≥ ±1.5V. For those applications where V_{SUPP} ≤ ±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} = ±1.0V, the input CMVR would be +0.6 volts to −1.1 volts).

OPERATION AT V_{SUPP} = ±1.0 VOLTS

Operation at V_{SUPP} = ±1.0V is guaranteed at I_Q = 10μA only. This applies to those devices with selectable I_Q, and devices that are set internally to I_Q = 10μA (i.e., ICL7611, 7612, 7613, 7631, 7632, 7642).

Output swings to within a few millivolts of the supply rails are achievable for R_L ≥ 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, refer to the description of ICL7612 above.

The user is cautioned that, due to extremely high input impedances, care must be exercised in layout, construction,

Note: All typical values have been guaranteed by characterization and are not tested.

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.

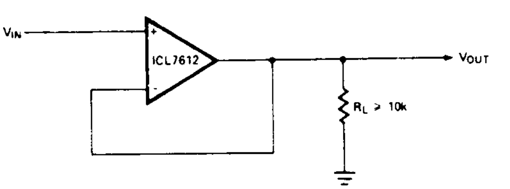
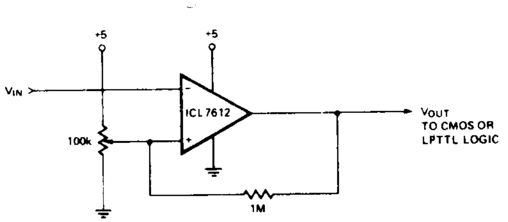
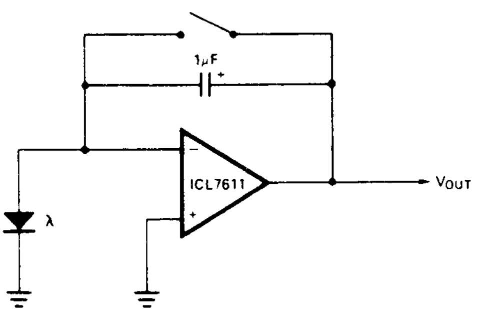


Figure 3: Simple Follower*



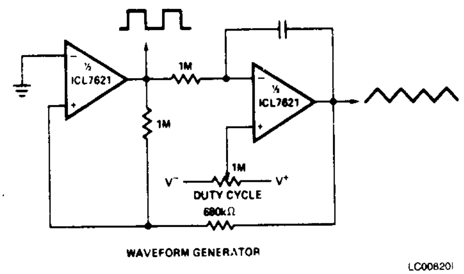
*By using the ICL7612 in these applications, the circuits will follow rail to rail inputs.

Figure 4: Level Detector*



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

Figure 5: Photocurrent Integrator



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

Figure 6: Precise Triangle/Square Wave Generator

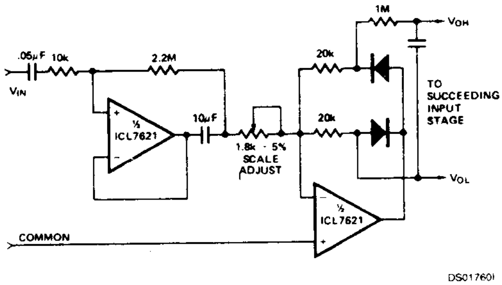
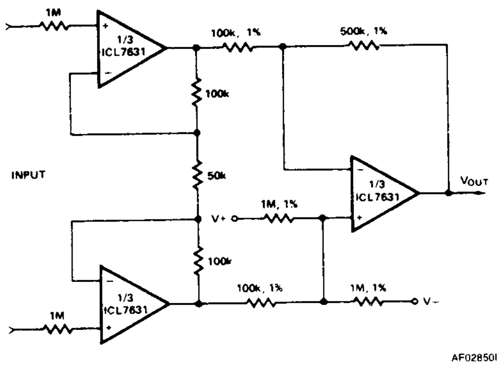


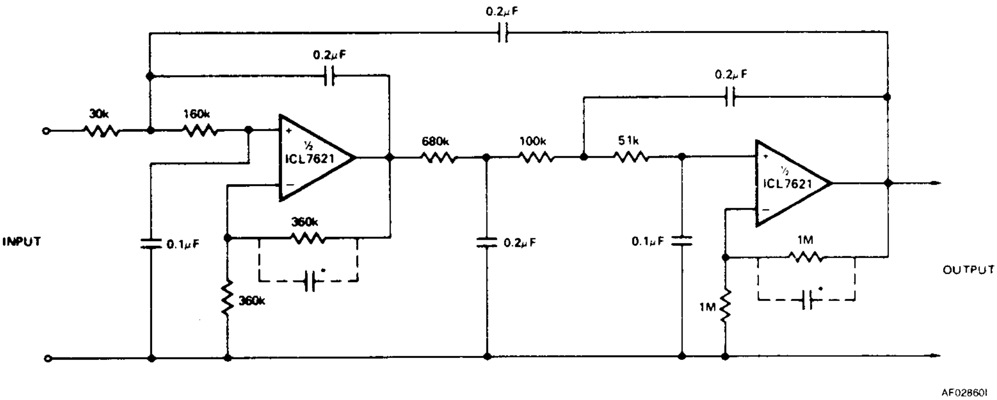
Figure 7: Averaging AC to DC Converter for A/D Converters Such as ICL7106, 7107, 7109, 7116, 7117



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

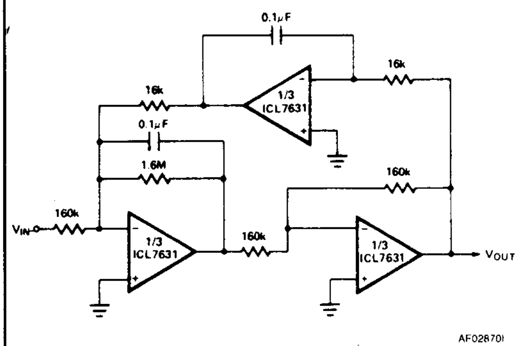
Note: All typical values have been guaranteed by characterization and are not tested.



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

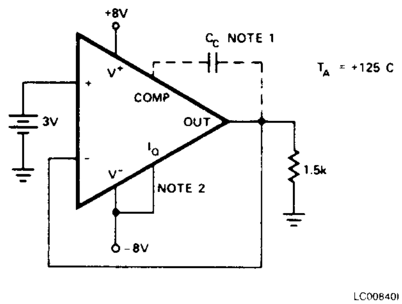
*Note that small capacitors (25-50pF) may be needed for stability in some cases.

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



NOTES:

1. For devices with external compensation, use 33pF.
2. For devices with programmable standby current, connect I_Q pin to V^- (I_Q = 1mA mode).

Figure 11: Burn-In and Life Test Circuit

Note: All typical values have been guaranteed by characterization and are not tested.

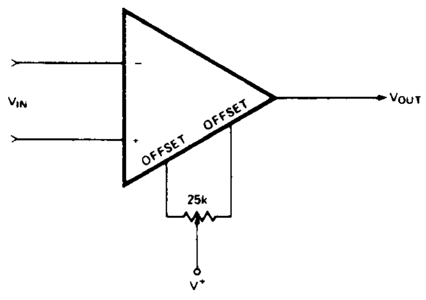


Figure 12: V_{OS} Null Circuit

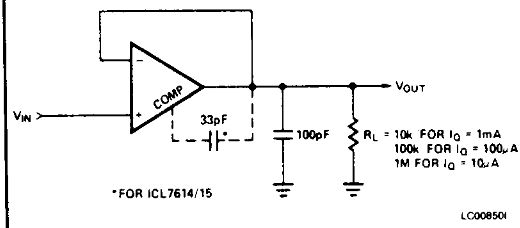


Figure 13: Unity Gain Frequency Compensation

Note: All typical values have been guaranteed by characterization and are not tested.