

FEATURES

Very Low-Noise, $5 \text{ nV}/\sqrt{\text{Hz}}$ @ 1 kHz Max
Excellent Input Offset Voltage, 0.4 mV Max
Low Offset Voltage Drift, $2 \mu\text{V}/^\circ\text{C}$ Max
Very High Gain, 1000 V/mV Min
Outstanding CMR, 110 dB Min
Slew Rate, $2 \text{ V}/\mu\text{s}$ Typ
Gain-Bandwidth Product, 6 MHz Typ
Industry Standard Quad Pinouts
Available in Die Form

GENERAL DESCRIPTION

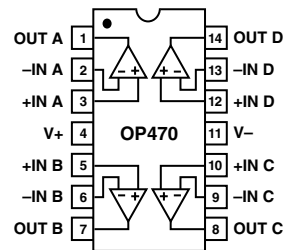
The OP470 is a high-performance monolithic quad operational amplifier with exceptionally low voltage noise, $5 \text{ nV}/\sqrt{\text{Hz}}$ at 1 kHz max, offering comparable performance to ADI's industry standard OP27.

The OP470 features an input offset voltage below 0.4 mV, excellent for a quad op amp, and an offset drift under $2 \mu\text{V}/^\circ\text{C}$, guaranteed over the full military temperature range. Open loop gain of the OP470 is over 1,000,000 into a 10 k Ω load ensuring excellent gain accuracy and linearity, even in high gain applications. Input bias current is under 25 nA, which reduces errors due to signal source resistance. The OP470's CMR of over 110 dB and PSRR of less than $1.8 \mu\text{V}/\text{V}$ significantly reduce errors due to ground noise and power supply fluctuations. Power consumption of the quad OP470 is half that of four OP27s, a significant advantage for power conscious applications. The OP470 is unity-gain stable with a gain bandwidth product of 6 MHz and a slew rate of 2 V/ μs .

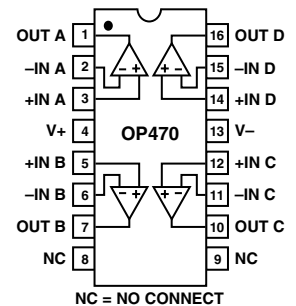
PIN CONNECTIONS

14-Lead Hermetic DIP
(Y-Suffix)

14-Lead Plastic DIP
(P-Suffix)



16-Lead SOIC Package
(S-Suffix)

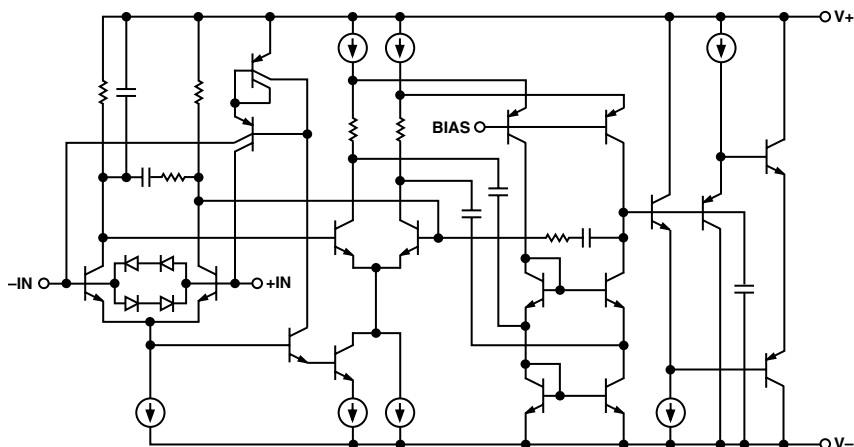


The OP470 offers excellent amplifier matching which is important for applications such as multiple gain blocks, low noise instrumentation amplifiers, quad buffers, and low noise active filters.

The OP470 conforms to the industry standard 14-lead DIP pinout. It is pin compatible with the LM148/149, HA4741, HA5104, and RM4156 quad op amps and can be used to upgrade systems using these devices.

For higher speed applications, the OP471, with a slew rate of 8 V/ μs , is recommended.

SIMPLIFIED SCHEMATIC



REV. B

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OP470—SPECIFICATIONS

ELECTRICAL CHARACTERISTICS (at $V_S = \pm 15\text{ V}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

Parameter	Symbol	Conditions	OP470A/E			OP470F			OP470G			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
INPUT OFFSET VOLTAGE	V_{OS}		0.1	0.4		0.2	0.8		0.4	1.0	mV	
INPUT OFFSET CURRENT	I_{OS}	$V_{CM} = 0\text{ V}$	3	10		6	20		12	30	nA	
INPUT BIAS CURRENT	I_B	$V_{CM} = 0\text{ V}$	6	25		15	50		25	60	nA	
INPUT NOISE VOLTAGE	e_{np-p}	0.1 Hz to 10 Hz (Note 1)	80	200		80	200		80	200	nV _{p-p}	
INPUT NOISE Voltage Density	e_n	$f_O = 10\text{ Hz}$ $f_O = 100\text{ Hz}$ $f_O = 1\text{ kHz}$ (Note 2)	3.8 3.3 3.2	6.5 5.5 5.0		3.8 3.3 3.2	6.5 5.5 5.0		3.8 3.3 3.2	6.5 5.5 5.0	nV $\sqrt{\text{Hz}}$	
INPUT NOISE Current Density	i_n	$f_O = 10\text{ Hz}$ $f_O = 100\text{ Hz}$ $f_O = 1\text{ kHz}$	1.7 0.7 0.4			1.7 0.7 0.4			1.7 0.7 0.4		pA $\sqrt{\text{Hz}}$	
LARGE-SIGNAL Voltage Gain	A_{VO}	$V = \pm 10\text{ V}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$	1000 500	2300 1200		800 400	1700 900		800 400	1700 900	V/mV	
INPUT VOLTAGE RANGE	IVR	(Note 3)	± 11	± 12		± 11	± 12		± 11	± 12	V	
OUTPUT VOLTAGE SWING	V_O	$R_L \geq 2\text{ k}\Omega$	± 12	± 13		± 12	± 13		± 12	± 13	V	
COMMON-MODE REJECTION	CMR	$V_{CM} = \pm 11\text{ V}$	110	125		100	120		100	120	dB	
POWER SUPPLY REJECTION RATIO	PSRR	$V_S = \pm 4.5\text{ V to } \pm 18\text{ V}$	0.56	1.8		1.0	5.6		1.0	5.6	$\mu\text{V/V}$	
SLEW RATE	SR		1.4	2		1.4	2		1.4	2	V/ μs	
SUPPLY CURRENT (All Amplifiers)	I_{SY}	No Load	9	11		9	11		9	11	mA	
GAIN BANDWIDTH PRODUCT	GBW	$A_V = 10$	6			6			6		MHz	
CHANNEL SEPARATION	CS	$V_O = 20\text{ V}_{p-p}$ $f_O = 10\text{ Hz}$ (Note 1)	125	155		125	155		125	155	dB	
INPUT CAPACITANCE	C_{IN}		2			2			2		pF	
INPUT RESISTANCE Differential-Mode	R_{IN}		0.4			0.4			0.4		M Ω	
INPUT RESISTANCE Common-Mode	R_{INCM}		11			11			11		G Ω	
SETTLING TIME	t_S	$A_V = 1$ to 0.1% to 0.01%	5.5 6.0			5.5 6.0			5.5 6.0		μs	

NOTES

¹Guaranteed but not 100% tested

²Sample tested

³Guaranteed by CMR test

ELECTRICAL CHARACTERISTICS (at $V_S = \pm 15\text{ V}$, $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$ for OP470A, unless otherwise noted.)

Parameter	Symbol	Conditions	OP470A			Unit
			Min	Typ	Max	
INPUT OFFSET VOLTAGE	V_{OS}			0.14	0.6	mV
AVERAGE INPUT Offset Voltage Drift	TCV_{OS}			0.4	2	$\mu\text{V}/^\circ\text{C}$
INPUT OFFSET CURRENT	I_{OS}	$V_{CM} = 0\text{ V}$		5	20	nA
INPUT BIAS CURRENT	I_B	$V_{CM} = 0\text{ V}$		15	20	nA
LARGE-SIGNAL Voltage Gain	A_{VO}	$V_O = \pm 10\text{ V}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$	750 400	1600 800		V/mV
INPUT VOLTAGE RANGE*	IVR		± 11	± 12		V
OUTPUT VOLTAGE SWING	V_O	$R_L \geq 2\text{ k}\Omega$	± 12	± 13		V
COMMON-MODE REJECTION	CMR	$V_{CM} = \pm 11\text{ V}$	100	120		dB
POWER SUPPLY REJECTION RATIO	PSRR	$V_S = \pm 4.5\text{ V to } \pm 18\text{ V}$		1.0	5.6	$\mu\text{V}/\text{V}$
SUPPLY CURRENT (All Amplifiers)	I_{SY}	No Load	—	9.2	11	mA

NOTE

*Guaranteed by CMR test

ELECTRICAL CHARACTERISTICS (at $V_S = \pm 15\text{ V}$, $-25^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$ for OP470E/OP470EF, $-40^\circ\text{C} \leq T_A \leq 85^\circ\text{C}$ for OP470G, unless otherwise noted.)

Parameter	Symbol	Conditions	OP470E			OP470F			OP470G			Unit
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
INPUT OFFSET VOLTAGE	V_{OS}		0.12	0.5		0.24	1.0		0.5	1.5	mV	
AVERAGE INPUT Offset Voltage Drift	TCV_{OS}		0.4	2		0.6	4		2		$\mu\text{V}/^\circ\text{C}$	
INPUT OFFSET CURRENT	I_{OS}	$V_{CM} = 0\text{ V}$	4	20		7	40		20	50	nA	
INPUT BIAS CURRENT	I_B	$V_{CM} = 0\text{ V}$	11	50		20	70		40	75	nA	
LARGE-SIGNAL Voltage Gain	A_{VO}	$V_O = \pm 10\text{ V}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$	800 400	1800 900		600 300	1400 700		600 300	1500 800	V/mV	
INPUT VOLTAGE RANGE*	IVR		± 11	± 12		± 11	± 12		± 11	± 12	V	
OUTPUT VOLTAGE SWING	V_O	$R_L \geq 2\text{ k}\Omega$	± 12	± 13		± 12	± 13		± 12	± 13	V	
COMMON-MODE REJECTION	CMR	$V_{CM} = \pm 11\text{ V}$	100	120		90	115		90	110	dB	
POWER SUPPLY REJECTION RATIO	PSRR	$V_S = \pm 4.5\text{ V to } \pm 18\text{ V}$		0.7	5.6		1.8	10		1.8	10	$\mu\text{V}/\text{V}$
SUPPLY CURRENT (All Amplifiers)	I_{SY}	No Load	—	9.2	11	—	9.2	11	—	9.3	11	mA

NOTE

*Guaranteed by CMR test

OP470—SPECIFICATIONS

WAFER TEST LIMITS (at $V_S = \pm 15\text{ V}$, 25°C , unless otherwise noted.)

Parameter	Symbol	Conditions	OP470GBC Limit	Unit
INPUT OFFSET VOLTAGE	V_{OS}		0.8	mV Max
INPUT OFFSET CURRENT	I_{OS}	$V_{CM} = 0\text{ V}$	20	nA Max
INPUT BIAS CURRENT	I_B	$V_{CM} = 0\text{ V}$	50	nA Min
LARGE-SIGNAL Voltage Gain	A_{VO}	$V_O = \pm 10\text{ V}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$	800 400	V/mV Min
INPUT VOLTAGE RANGE*	IVR		± 11	V Min
OUTPUT VOLTAGE SWING	V_O	$R_L \geq 2\text{ k}\Omega$	± 12	V Min
COMMON-MODE REJECTION	CMR	$V_{CM} = \pm 11\text{ V}$	100	dB
POWER SUPPLY REJECTION RATIO	PSRR	$V_S = \pm 4.5\text{ V to } \pm 18\text{ V}$	5.6	$\mu\text{V/V}$ Max
SUPPLY CURRENT (All Amplifiers)	I_{SY}	No Load	11	mA Max

NOTE

*Guaranteed by CMR test

Electrical tests are performed at wafer probe to the limits shown. Due to variations in assembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualification through sample lot assembly and testing.

ADV611/ADV612

Revision History

Location	Page
10/02—Data Sheet changed from REV. A to REV. B.	
Edits to 16-Lead SOIC	1
Edits to ELECTRICAL CHARACTERISTICS	3
Edits to ABSOLUTE MAXIMUM RATINGS	5
Updated OUTLINE DIMENSIONS	15
4/02—Data Sheet changed from REV. 0 to REV. A.	
28-Lead LCC (RC-Suffix) deleted	1
28-Lead LCC (TC-Suffix) deleted	1
Edits to ABSOLUTE MAXIMUM RATINGS	4
Edits to ORDERING GUIDE	4
Edits to PACKAGE TYPE	4

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