Quad Low Power, 3.6 MHz, Low Noise, Rail-to-Rail Output, Operational Amplifiers

Preliminary Technical Data

ADA4691-4

FEATURES

Low power: 180 µA typical
Low distortion: 0.003% THD + N
Low noise: 16 nV/√Hz typical
3.6 MHz bandwidth
Offset voltage: 500 µV typical
Low offset voltage drift: 4 µV/°C maximum
Very low input bias currents: 0.5 pA typical
2.7 V to 5 V single supply or ±1.35 V to ±2.5 V dual supply
Available in very small 2 mm × 2mm LFCSP packages

APPLICATIONS

Photodiode amplifier
Sensor amplifier
Portable instrumentation
Portable medical devices
Portable audio: MP3, PDA, smart phone, notebook
Headphone speaker driver
Communications
Low-side current sense
ADC driver
Active filter
Sample-and-hold
Automotive sensors

GENERAL DESCRIPTION

The ADA4691-4 is a quad rail-to-rail output, single-supply amplifier featuring low power, wide bandwidth, and low noise. The ADA4691-4 has two independent shutdown pins, allowing further reduction in supply current. These amplifiers are ideal for a wide variety of applications. Audio preamps, filters, IR/photodiode amplifiers, charge amps, and high impedance sensors all benefit from this combination of performance features. The ADA4692-4 is a quad version without shutdown in a 14-lead TSSOP package.

Applications for these amplifiers include consumer audio personal players with low noise and low distortion that provide enough gain and slew rate response over the audio band at low power. Industrial applications with high impedance sensors, such as pyroelectric sensors and other IR sensors, benefit from the high impedance input, low offset drift, and enough bandwidth and response for low gain applications.

The ADA4691-4 is specified over the extended industrial temperature range (−40°C to +125°C). The ADA4691-4 is available in a 16-lead LFCSP packages.

PIN CONFIGURATION

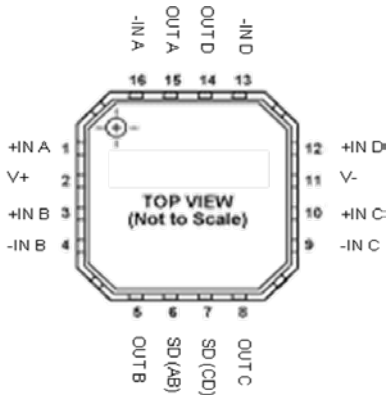

Figure 1. 16-Lead LFCSP

Rev. PrA

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SPECIFICATIONS

ELECTRICAL CHARACTERISTICS—2.7 V OPERATION

V_{SY} = 2.7 V, V_{CM} = V_{SY}/2, T_A = 25°C, unless otherwise specified.

Table 1.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	V_{CM} = −0.3 V to +1.6 V		0.5	2.5	mV
		V_{CM} = −0.1 V to +1.6 V; −40°C < T_A < +125°C			4.0	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		1	4	µV/°C
Input Bias Current	I_B			0.5	5	pA
		−40°C < T_A < +125°C			360	pA
Input Offset Current	I_{OS}			1	5	pA
		−40°C < T_A < +125°C			225	pA
Input Voltage Range		−40°C < T_A < +125°C	−0.3		+1.6	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = −0.3 V to +1.6 V	70	90		dB
		V_{CM} = −0.1 V to +1.6 V; −40°C < T_A < +125°C	62			dB
Large Signal Voltage Gain	A_{VO}	R_L = 2 kΩ, V_{OUT} = 0.5 V to 2.2 V	90	100		dB
		−40°C < T_A < +85°C	80			dB
		−40°C < T_A < +125°C	67			dB
		R_L = 600 Ω, V_{OUT} = 0.5 V to 2.2 V	85	95		dB
Input Capacitance	C_{IN}					
Differential Mode	C_{INDM}			2.5		pF
Common Mode	C_{INCM}			7		pF
Logic High Voltage (Enabled)	V_{IH}	−40°C < T_A < +125°C	+1.6			V
Logic Low Voltage (Power-Down)	V_{IL}	−40°C < T_A < +125°C			0.5	V
Logic Input Current (per Pin)	I_{IN}	−40°C < T_A < +125°C, 0 V ≤ V_{SD} ≤ 2.7 V			1	µA
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 2 kΩ to GND	2.65	2.67		V
		−40°C < T_A < +125°C	2.6			V
		R_L = 600 Ω to GND	2.55	2.59		V
		−40°C < T_A < +125°C	2.5			V
Output Voltage Low	V_{OL}	R_L = 2 kΩ to V_{SY}		24	30	mV
		−40°C < T_A < +125°C			40	mV
		R_L = 600 Ω to V_{SY}		78	95	mV
		−40°C < T_A < +125°C			125	mV
Short-Circuit Current	I_{SC}	V_{OUT} = V_{SY} or GND		±15		mA
Closed-Loop Output Impedance	Z_{OUT}	f = 1 MHz, A_V = −100		372		Ω
Output Pin Leakage Current		−40°C < TA < +125°C, shutdown active, V_{SD} = V_{SS}		1		nA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = 2.7 V to 5.5 V	80	90		dB
		−40°C < T_A < +125°C	75			dB
Supply Current Per Amplifier	I_{SY}	V_{OUT} = V_{SY}/2		165	200	µA
		−40°C < T_A < +125°C			240	µA
Supply Current Shutdown Mode	I_{SD}	All amplifiers shut down, V_{SD} = V_{SS}		10		nA
		−40°C < TA < +125°C			2	µA

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 600 Ω, C_L = 20 pF, A_V = +1		1.1		V/µs
		R_L = 2 kΩ, C_L = 20 pF, A_V = +1		1.4		V/µs
Settling Time to 0.1%	t_S	Step = 0.5 V, R_L = 2 kΩ, 600 Ω		1		µs
Gain Bandwidth Product	GBP	R_L = 1 MΩ, C_L = 35 pF, A_V = +1		3.6		MHz
Phase Margin	Φ_M	R_L = 1 MΩ, C_L = 35 pF, A_V = +1		49		Degrees
Turn-on, Turn-off Time		R_L = 600 Ω		1		µs
NOISE PERFORMANCE						
Distortion	THD + N	A_V = −1, R_L = 2 kΩ, f = 1 kHz, V_{IN} rms = 0.15 V rms		0.009		%
		A_V = −1, R_L = 600 Ω, f = 1 kHz, V_{IN} rms = 0.15 V rms		0.01		%
		A_V = +1, R_L = 2 kΩ, f = 1 kHz, V_{IN} rms = 0.15 V rms		0.006		%
		A_V = +1, R_L = 600 Ω, f = 1 kHz, V_{IN} rms = 0.15 V rms		0.007		%
Voltage Noise	e_n p-p	f = 0.1 Hz to 10 Hz		3.1		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		16		nV/√Hz
		f = 10 kHz		13		nV/√Hz

ELECTRICAL CHARACTERISTICS—5 V OPERATION

V_{SY} = 5 V, V_{CM} = V_{SY}/2, T_A = 25°C, unless otherwise specified.

Table 2.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	V_{CM} = −0.3 V to +3.9 V		0.5	2.5	mV
		V_{CM} = −0.1 V to +3.9 V; −40°C < T_A < +125°C			4.0	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +125°C		1	4	µV/°C
Input Bias Current	I_B			0.5	5	pA
		−40°C < T_A < +125°C			360	pA
Input Offset Current	I_{OS}			1	5	pA
		−40°C < T_A < +125°C			260	pA
Input Voltage Range		−40°C < T_A < +125°C	−0.3		+3.9	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = −0.3 V to +3.9 V	75	98		dB
		V_{CM} = −0.1 V to +3.9 V; −40°C < T_A < +125°C	68			dB
Large Signal Voltage Gain	A_{VO}	R_L = 2 kΩ, V_O = 0.5 V to 4.5 V, V_{CM} = 0 V	95	110		dB
		−40°C < T_A < +85°C	80			dB
		−40°C < T_A < +125°C	75			dB
		R_L = 600 Ω, V_O = 0.5 V to 4.5 V, V_{CM} = 0 V	90	100		dB
Input Capacitance						
Differential Mode	C_{INDM}			2.5		pF
Common Mode	C_{INCM}			7		pF
Logic High Voltage (Enabled)	V_{IH}	−40°C < T_A < +125°C	+2.0			V
Logic Low Voltage (Power-Down)	V_{IL}	−40°C < T_A < +125°C			0.8	V
Logic Input Current (per Pin)	I_{IN}	−40°C < T_A < +125°C, 0 V ≤ V_{SD} ≤ 2.7 V			1	µA
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 2 kΩ	4.95	4.97		V
		−40°C ≤ T_A ≤ +125°C	4.90			V
		R_L = 600 Ω to GND	4.85	4.88		V
		−40°C ≤ T_A ≤ +125°C	4.80			V

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
Output Voltage Low	V_{OL}	R_L = 2 kΩ		28	35	mV
		−40°C ≤ T_A ≤ +125°C			50	mV
		R_L = 600 Ω		90	110	mV
		−40°C ≤ T_A ≤ +125°C			145	mV
Short-Circuit Limit	I_{SC}	V_{OUT} = V_{SY} or GND		±55		mA
Closed-Loop Output Impedance	Z_{OUT}	ADA4691-2, f = 1 MHz, A_V = −100		364		Ω
		ADA4691-2, f = 1 MHz, A_V = −100		246		Ω
Output Pin Leakage Current		−40°C < TA < +125°C, shutdown active, V_{SD} = V_{SS}		1		nA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_{SY} = 2.7 V to 5.5 V	80	90		dB
		−40°C ≤ T_A ≤ +125°C	75			dB
Supply Current per Amplifier	I_{SY}	V_{OUT} = V_{SY}/2		180	225	µA
		−40°C ≤ T_A ≤ +125°C			275	µA
Supply Current Shutdown Mode	I_{SD}	All amplifiers shutdown, V_{SD} = V_{SS}		10		nA
		−40°C ≤ T_A ≤ +125°C			2	uA
DYNAMIC PERFORMANCE						
Slew Rate	SR	R_L = 2 kΩ, 600 Ω, C_L = 20 pF, A_V = +1		1.3		V/µs
Settling Time to 0.1%	t_S	V_{IN} = 2 V step, R_L = 2 kΩ or 600 Ω		1.5		µs
Gain Bandwidth Product	GBP	R_L = 1 MΩ, C_L = 35 pF, A_V = +1		3.6		MHz
Phase Margin	Φ_M	R_L = 1 MΩ, C_L = 35 pF, A_V = +1		52		Degrees
Turn-on, Turn-off Time		R_L = 600 Ω		1		µs
NOISE PERFORMANCE						
Distortion	THD + N	A_V = −1, R_L = 2 kΩ, f = 1 kHz, V_{IN} rms = 0.8 V rms		0.008		%
		A_V = −1, R_L = 600 Ω, f = 1 kHz, V_{IN} rms = 0.8 V rms		0.006		%
		A_V = +1, R_L = 2 kΩ, f = 1 kHz, V_{IN} rms = 0.8 V rms		0.003		%
		A_V = +1, R_L = 600 Ω, f = 1 kHz, V_{IN} rms = 0.8 V rms		0.001		%
Voltage Noise	e_n p-p	f = 0.1 Hz to 10 Hz		3.2		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		16		nV/√Hz
	e_n	f = 10 kHz		13		nV/√Hz

ABSOLUTE MAXIMUM RATINGS

Table 3.

Parameter	Rating
Supply Voltage	6 V
Input Voltage	V_{SS} − 0.3 V to V_{DD} + 0.3 V
Input Current[1]	±10 mA
Shutdown Pin Rise/Fall Times	50 μs maximum
Differential Input Voltage[2]	$\pm V_{SY}$
Output Short-Circuit Duration to GND	Indefinite
Temperature	
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−40°C to +125°C
Junction Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 sec)	300°C

[1] Input pins have clamp diodes to the supply pins. Limit the input current to 10 mA or less whenever the input signal exceeds the power supply rail by 0.3 V.

[2] Differential input voltage is limited to 5 V or the supply voltage, whichever is less.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

THERMAL RESISTANCE

θ_{JA} is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages and measured using a standard 4-layer board, unless otherwise specified.

Table 4. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
8-Lead SOIC_N (R-8)	155	45	°C/W
8-Lead LFCSP (CP-8-6)	115	40	°C/W
9-Ball WLCSP (CB-9-3)	77	N/A	°C/W
10-Lead LFCSP (CP-10-11)	132	46	°C/W
14-Lead TSSOP (RU-14)	112	35	°C/W
16-Lead LFCSP	TBD	TBD	°C/W

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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