1.8 V, Micropower, Zero-Drift, Rail-to-Rail Input/Output Op Amp

Preliminary Technical Data

ADA4051-1

FEATURES

- Very low supply current: 13 µA
- Low offset voltage: 15 µV maximum
- Offset voltage drift: 20 nV/°C
- Single-supply operation: 1.8 V to 5.5 V
- High PSRR: 110 dB minimum
- High CMRR: 110 dB minimum
- Rail-to-rail input and output
- Unity gain stable
- Extended industrial temperature range

APPLICATIONS

- Pressure and position sensors
- Temperature measurements
- Electronic scales
- Medical instrumentation
- Battery-powered equipment
- Handheld test equipment

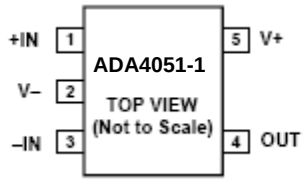
GENERAL DESCRIPTION

The ADA4051-1 is a single CMOS, micropower, zero-drift operational amplifier utilizing an innovative chopping technique. This amplifier features rail-to-rail input and output swing and extremely low offset voltage while operating from a 1.8 V to 5.5 V power supply. This amplifier also offers high PSRR and CMRR, while operating with a supply current of only 13 µA per amplifier. This combination of features makes the ADA4051-1 amplifier an ideal choice for battery-powered applications where high precision as well as low power consumption is important. The ADA4051-1 is specified for the extended industrial temperature range of −40°C to +125°C. The ADA4051-1 amplifier is available in the standard 5-pin SOT23 and 5-pin SC70.

PIN CONFIGURATION

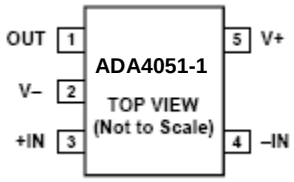
5-Lead SC70

(KS Suffix)



5-Lead SOT23

(RJ Suffix)



The ADA4051-1 is a member of a growing series of zero-drift op amps offered by Analog Devices, Inc. Refer to Table 1 for a list of these devices.

Table 1. Op Amps

Supple	Micro Power, 5V	Low Power, 5 V	5 V	16 V
Single		AD8538	AD8628	AD8638
Dual	ADA4051-2	AD8539	AD8629	AD8639
Quad			AD8630	

Rev. PrA

One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781.329.4700 www.analog.com
Fax: 781.461.3113

SPECIFICATIONS

ELECTRICAL CHARACTERISTICS—5 V OPERATION

V_{SY} = 5.0 V, V_{CM} = V_{SY}/2 V, T_A = 25°C, unless otherwise noted.

Table 2.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	0 V ≤ V_{CM} ≤ 5 V		2	15	µV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C ≤ T_A ≤ +125°C		0.02	0.1	µV/°C
Input Bias Current	I_B			20	70	pA
		−40°C ≤ T_A ≤ +125°C			200	pA
Input Offset Current	I_{OS}			40	100	pA
		−40°C ≤ T_A ≤ +125°C			150	pA
Input Voltage Range		−40°C ≤ T_A ≤ +125°C	0		5	V
Common-Mode Rejection Ratio	CMRR	0 V ≤ V_{CM} ≤ 5 V	110	135		dB
		−40°C ≤ T_A ≤ +125°C	106			dB
Large-Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, 0.1 V ≤ V_{OUT} ≤ V_{SY} − 0.1 V	115	135		dB
		−40°C ≤ T_A ≤ +125°C	106			dB
Input Resistance	R_{IN}			8		MΩ
Input Capacitance, Differential Mode	C_{INDM}			2		pF
Input Capacitance, Common Mode	C_{INCM}			5		pF
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 10 kΩ to V_{CM}	4.96	4.99		V
		−40°C ≤ T_A ≤ +125°C	4.9			V
		R_L = 100 kΩ to V_{CM}	4.996	4.998		V
		−40°C ≤ T_A ≤ +125°C	4.985			V
Output Voltage Low	V_{OL}	R_L = 10 kΩ to V_{CM}		9	30	mV
		−40°C ≤ T_A ≤ +125°C			90	mV
		R_L = 100 kΩ to V_{CM}		1	4	mV
		−40°C ≤ T_A ≤ +125°C			13	mV
Short-Circuit Current	I_{SC}	V_{OUT} = V_{SY} or GND		15		mA
Closed-Loop Output Impedance	Z_{OUT}	f = 1 kHz, G = 10		1		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	1.8 V ≤ V_{SY} ≤ 5.5 V	110	135		dB
		−40°C ≤ T_A ≤ +125°C	106			dB
Supply Current per Amplifier	I_{SY}	V_{OUT} = V_{SY}/2		13	17	µA
		−40°C ≤ T_A ≤ +125°C			20	µA
DYNAMIC PERFORMANCE						
Slew Rate	SR^+	R_L = 10 kΩ, C_L = 100 pF, G = 1		0.06		V/µs
	SR^-	R_L = 10 kΩ, C_L = 100 pF, G = 1		0.04		V/µs
Settling Time	t_S	To 0.1%, V_{IN} = 1 V p-p, R_L = 10 kΩ, C_L = 100 pF		110		µs
Gain Bandwidth Product	GBP	C_L = 100 pF, G = 1		125		kHz
Phase Margin	Φ_M	C_L = 100 pF, G = 1		40		Degrees
Channel Separation	CS	V_{IN} = 4.99 V, f = 100 Hz		140		dB
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	f = 0.1 Hz to 10 Hz		1.96		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		95		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		100		fA/√Hz

ELECTRICAL CHARACTERISTICS—1.8 V OPERATION

V_{SY} = 1.8 V, V_{CM} = V_{SY}/2 V, T_A = 25°C, unless otherwise noted.

Table 3.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	0 V ≤ V_{CM} ≤ 1.8 V		2	15	µV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C ≤ T_A ≤ +125°C		0.02	0.1	µV/°C
Input Bias Current	I_B			5	50	pA
		−40°C ≤ T_A ≤ +125°C			200	pA
Input Offset Current	I_{OS}			10	100	pA
		−40°C ≤ T_A ≤ +125°C			150	pA
Input Voltage Range		−40°C ≤ T_A ≤ +125°C	0		1.8	V
Common-Mode Rejection Ratio	CMRR	0 V ≤ V_{CM} ≤ 1.8 V	105	125		dB
		−40°C ≤ T_A ≤ +125°C	100			dB
Large-Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, 0.1 V ≤ V_{OUT} ≤ V_{SY} − 0.1 V	106	130		dB
		−40°C ≤ T_A ≤ +125°C	100			dB
Input Resistance	R_{IN}			8		MΩ
Input Capacitance, Differential Mode	C_{INDM}			2		pF
Input Capacitance, Common Mode	C_{INCM}			5		pF
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 10 kΩ to V_{CM}	1.76	1.796		V
		−40°C ≤ T_A ≤ +125°C	1.7			V
		R_L = 100 kΩ to V_{CM}	1.796	1.799		V
		−40°C ≤ T_A ≤ +125°C	1.79			V
Output Voltage Low	V_{OL}	R_L = 10 kΩ to V_{CM}		3	20	mV
		−40°C ≤ T_A ≤ +125°C			40	mV
		R_L = 100 kΩ to V_{CM}		1	3	mV
		−40°C ≤ T_A ≤ +125°C			9	mV
Short-Circuit Current	I_{SC}	V_{OUT} = V_{SY} or GND		13		mA
Closed-Loop Output Impedance	Z_{OUT}	f = 1 kHz, G = 10		1		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	1.8 V ≤ V_{SY} ≤ 5.5 V	110	135		dB
		−40°C ≤ T_A ≤ +125°C	106			dB
Supply Current per Amplifier	I_{SY}	V_{OUT} = V_{SY}/2		13	17	µA
		−40°C ≤ T_A ≤ +125°C			20	µA
DYNAMIC PERFORMANCE						
Slew Rate	SR^+	R_L = 10 kΩ, C_L = 100 pF, G = 1		0.04		V/µs
	SR^-	R_L = 10 kΩ, C_L = 100 pF, G = 1		0.03		V/µs
Settling Time	t_S	To 0.1%, V_{IN} = 1 V p-p, R_L = 10 kΩ, C_L = 100 pF		120		µs
Gain Bandwidth Product	GBP	C_L = 100 pF, G = 1		115		kHz
Phase Margin	Φ_M	C_L = 100 pF, G = 1		40		Degrees
Channel Separation	CS	V_{IN} = 1.7 V, f = 100 Hz		140		dB
NOISE PERFORMANCE						
Voltage Noise	e_n p-p	f = 0.1 Hz to 10 Hz		1.96		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		95		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		100		fA/√Hz

ABSOLUTE MAXIMUM RATINGS

Table 4.

Parameter	Rating
Supply Voltage	6 V
Input Voltage	$\pm V_{SY} \pm 0.3$ V
Input Current[1]	±10 mA
Differential Input Voltage[2]	$\pm V_{SY}$
Output Short-Circuit Duration to GND	Indefinite
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] The input pins have clamp diodes to the power supply pins. Limit input current to 10 mA or less whenever input signals exceed the power supply rail by 0.3 V.

[2] Inputs are protected against high differential voltages by internal series 1.33 kΩ resistors and back-to-back diode-connected N-MOSFETs (with a typical V_T of 0.7 V for V_{CM} of 0 V).

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 with the device soldered on a circuit board with its exposed paddle soldered to a pad (if applicable) on a 4-layer JEDEC standard PC board with zero air flow, unless otherwise specified.

Table 5. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
5-Lead SOT23	TBD	TBD	°C/W
5-Lead SC70	TBD	TBD	°C/W

POWER SEQUENCING

The op amp supplies must be established simultaneously with, or before, any input signals are applied. If this is not possible, the input current must be limited to 10 mA.

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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