High Voltage, Precision Operational Amplifier

Preliminary Technical Data

ADA4700-1

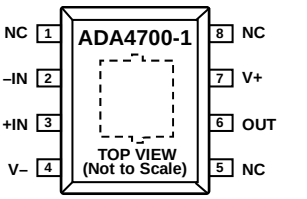
FEATURES

- Low input offset voltage: ≤0.2 mV typical
- High output current drive: 20mA, 50 mA
- Wide range of operating voltage: ±5 V to ±50 V
- Specified at ±5 V, ±24 V, and ±50 V
- High slew rate: 20 V/µs typical
- High gain bandwidth product: ≥3 MHz typical
- On-board thermal shutdown at 165°C
- Ambient temperature range of −40°C to +85°C
- Low input bias current: I_{BIAS} ≤ 15 nA typical

APPLICATIONS

- Automated and bench top test equipment
- High voltage regulators and power amplifiers
- Data acquisition and signal conditioning
- Piezo drivers and predrivers
- General-purpose current sensing

PIN CONFIGURATION



NOTES
1. NC = NO CONNECT. DO NOT CONNECT TO THIS PIN.
2. THE EXPOSED PAD MUST BE CONNECTED TO V–.

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Figure 1.

GENERAL DESCRIPTION

The ADA4700-1 is a high voltage precision operational amplifier with a wide operating voltage (±5 V to ±50 V) and relatively high output current drive available as a single op amp in an SOIC package. It combines low power consumption, high bandwidth, and a slew rate with unity-gain stability and phase inversion free performance. The ability to swing near rail-to-rail at the output enables designers to maximize signal-to-noise ratios (SNRs).

The ADA4700-1 is designed for applications requiring both ac and precision dc performance, making the ADA4700-1 useful in a wide variety of applications, including high voltage test equipment and instrumentation, high voltage regulators and power amplifiers, power supply control and protection, and as an amplifier or buffer for transducers with wide output ranges. It is particularly well suited for high intensity LED testing applications where it provides highly accurate voltage and current feedback as well as a predriver to provide accurate voltage and/or current sourcing stimulus to the LED string under test.

The ADA4700-1 is specified over the industrial temperature range of −40°C to +85°C and includes an on-board thermal shutdown at 165°C internal junction temperature as well as an internal current limit for safety. The ADA4700-1 is available in a thermally enhanced, 8-lead SOIC package that uses a small exposed metal pad on the bottom of the package to allow the customer to heat sink the part to the printed circuit board (PCB). For proper operation, the exposed pad must be connected to V−.

Rev. PrB

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

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SPECIFICATIONS

V_{SY} = ±50 V ELECTRICAL CHARACTERISTICS

V_{SY} = ±50 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}			0.2	2	mV
		−40°C < T_A < +85°C			2.5	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +85°C		2	13	µV/°C
Input Bias Current	I_B			15	30	nA
		−40°C < T_A < +85°C			50	nA
Input Offset Current	I_{OS}			2	25	nA
		−40°C < T_A < +85°C			30	nA
Input Voltage Range	IVR	−40°C < T_A < +85°C	(V−) + 3		(V+) − 3	V
Common-Mode Rejection Ratio	CMRR	(V−) + 3 V < V_{CM} < (V+) − 3 V	103	108		dB
		−40°C < T_A < +85°C	103			dB
Large Signal Voltage Gain	A_{VO}	−47 V < V_{OUT} < +47 V, R_L = 2kΩ	103	106		dB
		−40°C < T_A < +85°C	100			dB
Input Capacitance						
Common-Mode	C_{INCM}			TBD		pF
Differential	C_{INDM}			TBD		pF
Input Resistance	R_{IN}	Common mode and differential mode		TBD		MΩ
OUTPUT CHARACTERISTICS						
Output Voltage High		R_L = 10 kΩ to GND	48	48.5		V
		−40°C < T_A < +85°C	47.8			V
		R_L = 2 kΩ to GND	47.5	48		V
		−40°C < T_A < +85°C	47.3			V
Output Voltage Low		R_L = 10 kΩ to GND		-48.5	-48	V
		−40°C < T_A < +85°C			-47.8	V
		R_L = 2 kΩ to GND		−48	-47.5	V
		−40°C < T_A < +85°C			-47.3	V
Capacitive Load Drive	C_L	A_V = +1		TBD		nF
		A_V = +10		TBD		nF
Short Circuit Limit	I_{SC}	Sourcing and sinking	TBD	TBD		mA
Closed-Loop Impedance	Z_{OUT}	f = 10 MHz, A_V = +1		TBD		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = ±4.5 V to ±55 V	110	130		dB
		−40°C to +85°C	110			dB
Supply Current per Amplifier	I_{SY}	V_O = V_S/2		1.7	2.2	mA
		−40°C < T_A < +85°C			2.4	mA
DYNAMIC PERFORMANCE						
Slew Rate	SR	V_0 = ±45 V step, R_L = 2 kΩ, C_L = 300 pF		20		V/µs
Gain Bandwidth Product	GBP	V_{IN} = 5 mV p-p, A_V = +100		2.5		MHz
Unity-Gain Crossover	UGC	V_{IN} = 5 mV p-p, A_V = +1		TBD		MHz
−3 dB Bandwidth	−3 dB	V_{IN} = 5 mV p-p, A_V = −1		TBD		MHz
Phase Margin	ΦM	V_{IN} = 5 mV p-p, R_L = 1MΩ, C_L = 35 pF; A_V = -1		65		Degrees
Settling Time to 0.1%	t_S	V_{IN} = 30 V p-p, R_L = 10 kΩ, C_L = 5 pF, A_V = -1		TBD		µs
Settling Time to 0.01%	t_S	V_{IN} = 30 V p-p, R_L = 10 kΩ, C_L = 5 pF, A_V = -1		TBD		µs

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
NOISE PERFORMANCE						
Total Harmonic Distortion + Noise	THD + N	G= +1, V_{IN} = 10 V_{p-p} at 1 kHz; R_L = 10kΩ				
Bandwidth = 80 kHz				TBD		%
Bandwidth = 500 kHz				TBD		%
Peak-to-Peak Noise	$e_{n\ p-p}$	f = 0.1 Hz to 10 Hz		TBD		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		13		nV/√Hz
		f = 10 Hz		40		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		TBD		fA/√Hz

V_{SY} = ±24 V ELECTRICAL CHARACTERISTICS

V_{SY} = ±24 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}			0.2	2	mV
		−40°C < T_A < +85°C			2.5	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +85°C		2.5	15	µV/°C
Input Bias Current	I_B			5	30	nA
		−40°C < T_A < +85°C			50	nA
Input Offset Current	I_{OS}			2	25	nA
		−40°C < T_A < +85°C			30	nA
Input Voltage Range	IVR	−40°C < T_A < +85°C	(V–) + 3		(V+) – 3	V
Common-Mode Rejection Ratio	CMRR	(V–) + 3 V < V_{CM} < (V+) – 3 V	100	103		dB
		−40°C < T_A < +85°C	100			dB
Large Signal Voltage Gain	A_{VO}	−21 V< V_{OUT} < +21 V, RL=2kΩ	103	105		dB
		−40°C < T_A < +85°C	100			dB
Input Capacitance						
Common-Mode	C_{INCM}			TBD		pF
Differential	C_{INDM}			TBD		pF
Input Resistance	R_{IN}	Common mode and differential mode		TBD		MΩ
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 10 kΩ to GND	22.2	22.5		V
		−40°C < T_A < +85°C	22.0			V
		R_L = 2 kΩ to GND	22.0	22.4		V
		−40°C < T_A < +85°C	21.8			V
Output Voltage Low	V_{OL}	R_L = 10 kΩ to GND		−22.5	-22.2	V
		−40°C < T_A < +85°C			-22.0	V
		R_L = 2 kΩ to GND		−22.4	-22.0	V
		−40°C < T_A < +85°C			-21.8	V
Capacitive Load Drive	C_L	A_V = +1		TBD		nF
		A_V = +10		TBD		nF
Short Circuit Limit	I_{SC}	Sourcing and sinking	TBD	TBD		mA
Closed-Loop Impedance	Z_{out}	f = 10 MHz, A_V = +1		TBD		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = ±4.5 V to ±55 V	110	130		dB
		−40°C to +85°C	TBD			dB
Supply Current per Amplifier	I_{SY}	V_O = V_S/2		1.65	2.1	mA
		−40°C < T_A < +85°C			TBD	mA
DYNAMIC PERFORMANCE						
Slew Rate	SR	V_0 = TBD V step, R_L = 2 kΩ, C_L = 100 pF		20		V/µs
Gain Bandwidth Product	GBP	V_{IN} = 5 mV p-p, A_V = +100		2.5		MHz
Unity Gain Crossover	UGC	V_{IN} = 5 mV p-p, A_V = +1		TBD		MHz
−3 dB Bandwidth	−3 dB	V_{IN} = 5 mV p-p, A_V = −1		TBD		MHz
Phase Margin	ΦM	V_{IN} = 5 mV p-p, R_L = 1MΩ, C_L = 35 pF; A_V=-1		65		Degrees
Settling Time to 0.1%	t_S	V_{IN} = 20 V p-p, R_L = 10 kΩ, C_L = 5 pF, A_V = -1		TBD		µs
Settling Time to 0.01%	t_S	V_{IN} = 20 V p-p, R_L = 10 kΩ, C_L = 5 pF, A_V = -1		TBD		µs

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
NOISE PERFORMANCE						
Total Harmonic Distortion + Noise	THD + N	G= +1, V_{IN} = 10 V p-p at 1 kHz; R_L = 10kΩ				
Bandwidth = 80 kHz				TBD		%
Bandwidth = 500 kHz				TBD		%
Peak-to-Peak Noise	$e_{n\ p-p}$	f = 0.1 Hz to 10 Hz		TBD		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		13		nV/√Hz
		f = 10 Hz		40		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		TBD		fA/√Hz

V_{SY} = ±5 V ELECTRICAL CHARATERISTICS

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

Table 3.

Parameter	Symbol	Test Conditions/Comments	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}			0.2	2	mV
		−40°C < T_A < +85°C			2.5	mV
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	−40°C < T_A < +85°C		3		µV/°C
Input Bias Current	I_B			5	30	nA
		−40°C < T_A < +85°C			50	nA
Input Offset Current	I_{OS}			2	25	nA
		−40°C < T_A < +85°C			30	nA
Input Voltage Range	IVR	−40°C < T_A < +85°C	−2		+2	V
Common-Mode Rejection Ratio	CMRR	−2 V ≤V_{CM} ≤+2 V	86	89		dB
		−40°C < T_A < +85°C	86			dB
Large Signal Voltage Gain	A_{VO}	−2 V< V_{OUT} < +2 V, R_L=2kΩ	97	99		dB
		−40°C < T_A < +85°C	95			dB
Input Capacitance						
Common-Mode	C_{INCM}			TBD		pF
Differential	C_{INDM}			TBD		pF
Input Resistance	R_{IN}	Common mode and differential mode		TBD		MΩ
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	R_L = 2 kΩ to GND	3.4	3.6		V
		−40°C < T_A < +85°C	3.2			V
Output Voltage Low	V_{OL}	R_L = 2 kΩ to GND		−3.6	-3.4	V
		−40°C < T_A < +85°C			-3.2	V
Capacitive Load Drive	C_L	A_V = +1		TBD		nF
		A_V = +10		TBD		nF
Short Circuit Limit	I_{SC}	Sourcing and sinking	TBD	±75		mA
Closed-Loop Impedance	Z_{out}	f = 10 MHz, A_V = +1		TBD		Ω
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V_S = ±4.5 V to ±55 V	110	130		dB
		−40°C to +85°C	110			dB
Supply Current per Amplifier	I_{SY}	V_O = V_S/2		1.5	2	mA
		−40°C < T_A < +85°C			2.2	mA
DYNAMIC PERFORMANCE						
Slew Rate	SR	V_0 = TBD V step, R_L = 2 kΩ, C_L = 100 pF		TBD		V/µs
Gain Bandwidth Product	GBP	V_{IN} = 5 mV p-p, A_V = +100		2.5		MHz
Unity Gain Crossover	UGC	V_{IN} = 5 mV p-p, A_V = +1		TBD		MHz
−3 dB Bandwidth	−3 dB	V_{IN} = 5 mV p-p, A_V = −1		TBD		MHz
Phase Margin	ΦM	V_{IN} = 5 mV p-p, R_L = 1MΩ, C_L = 35 pF; A_V=-1		65		Degrees
Settling Time to 0.1%	t_S	V_{IN} = 6 V p-p, R_L = 10 kΩ, C_L = 5 pF, A_V = -1		TBD		µs
NOISE PERFORMANCE						
Total Harmonic Distortion + Noise	THD + N	G= +1, V_{IN} = 3V_{p-p} at 1 kHz; R_L = 10kΩ				
Bandwidth = 80 kHz				TBD		%
Bandwidth = 500 kHz				TBD		%
Peak-to-Peak Noise	$e_{n\ p-p}$	f = 0.1 Hz to 10 Hz		TBD		µV p-p
Voltage Noise Density	e_n	f = 1 kHz		13		nV/√Hz
Current Noise Density	i_n	f = 1 kHz		TBD		fA/√Hz

ABSOLUTE MAXIMUM RATINGS

Table 4.

Parameter	Rating
Supply Voltage	110 V
Input Voltage	$V- \le V_{IN} \le V+$
Differential Input Voltage	$V- \le V_{IN} \le V+$
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	−40°C to +85°C
Junction Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 60 sec)	300°C

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.

MAXIMUM POWER DISSIPATION

The maximum power that can be safely dissipated by a plastic encapsulated package is limited by the junction temperature. The maximum safe junction temperature for plastic encapsulated devices, as determined by the glass transition temperature of the plastic, is approximately 150°C. Exceeding this limit temporarily may cause a shift in the parametric performance due to a change in the stresses exerted on the die by the package. Exceeding a junction temperature of 175°C for an extended period can result in device failure.

THERMAL RESISTANCE

θ_{JA} is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 5. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
8-Lead SOIC_N_EP (RD-8-2)	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.

PIN CONFIGURATION AND FUNCTION DESCRIPTION

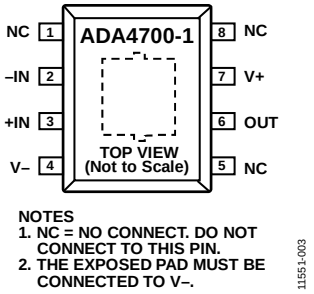

Figure 2. Pin Configuration

Table 6. Pin Function Descriptions

Pin No.	Mnemonic	Description
1, 5, 8	NC	No Connect. Do not connect to this pin.
2	–IN	Inverting Input.
3	+IN	Noninverting Input.
4	V–	Negative Supply Voltage.
6	OUT	Output.
7	V+	Positive Supply Voltage.
	EPAD	Exposed Pad. Connect the exposed pad to V–.

OUTLINE DIMENSIONS

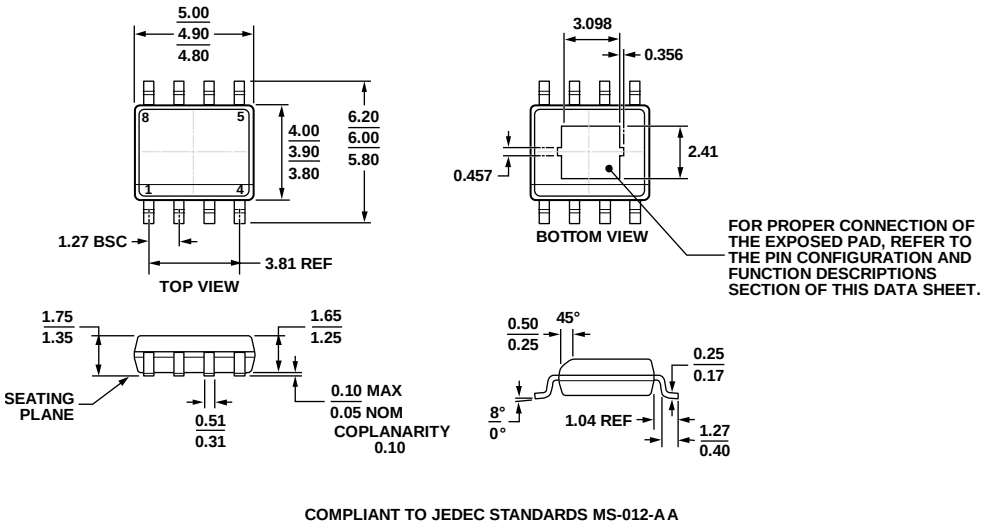

Figure 3. 8-Lead Standard Small Outline Package with Exposed Pad [SOIC_N_EP]
Narrow Body
(RD-8-2)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1]	Temperature Range	Package Description	Package Option	Branding
ADA4700-1ARDZ	−40°C to +85°C	8-Lead Standard Small Outline Package with Exposed Pad [SOIC_N_EP]	RD-8-2	??
ADA4700-1ARDZ-R7	−40°C to +85°C	8-Lead Standard Small Outline Package with Exposed Pad [SOIC_N_EP]	RD-8-2	
ADA4700-1ARDZ-RL	−40°C to +85°C	8-Lead Standard Small Outline Package with Exposed Pad [SOIC_N_EP]	RD-8-2	

[1] Z = RoHS Compliant Part.

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