ANALOG DEVICES

Zero-Drift, Single-Supply Rail-to-Rail Input/Output Operational Amplifier

AD8629S

1.0 Scope

1.1. This specification documents the detail requirements for space qualified product manufactured on Analog Devices, Inc.'s QML certified line per MIL-PRF-38535 Level V except as modified herein.

1.2. The manufacturing flow described in the STANDARD SPACE LEVEL PRODUCTS PROGRAM brochure is to be considered a part of this specification. http://www.analog.com/aeroinfo

1.3. This data specifically details the space grade version of this product. A more detailed operational description and a complete data sheet for commercial product grades can be found at http://www.analog.com/AD8629

2.0 Part Number

2.1. The complete part number(s) of this specification follows:

Specific Part Number	Description
AD8629D703L	Dual, Zero Drift, Single-Supply, Rail-to-Rail I/O, Operational Amplifier. Radiation tested to 10Krads (Si)

3.0 Case Outline

3.1. The case outline(s) are as designated in MIL-STD-1835 and as follows:

Outline Letter	Descriptive Designator	Terminals	Package style
L	GDFP1-F10	10 lead	Ceramic flatpack (CERPAK)

Package: L			
Pin Number	Terminal Symbol	Pin Type	Pin Description
1	OUT A	Analog output	Operational amplifier output, Amp-A
2	-IN A	Analog input	Operational amplifier negative input, Amp-A
3	NC	NC	Not connected
4	+IN A	Analog input	Operational amplifier positive input, Amp-A
5	-Vs	power	Negative power supply
6	+IN B	Analog input	Operational amplifier positive input, Amp-B
7	-IN B	Analog input	Operational amplifier negative input, Amp-B
8	NC	NC	Not connected
9	OUT B	Analog output	Operational amplifier output, Amp-B
10	+Vs	power	Positive power supply

Figure 1 – Terminal Connections

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4.0 Specifications

4.1. Absolute Maximum Ratings (TA = 25°C, unless otherwise noted) 1/

Supply voltage ($+V_S$ to $-V_S$) .... +6 V
Input voltage (V_{IN}) 4/ .... $-V_S$ -0.3V to $+V_S$ +0.3V
Differential input voltage 2/ .... ±5.0V
Output short circuit duration to GND .... Indefinite
Storage temperature range .... -65°C to +150°C
Junction temperature maximum (T_J) .... -65°C to +150°C
Lead temperature (soldering, 60 seconds) .... +300°C
Thermal resistance, junction-to-case (θ_{JC}) .... 22 °C/W
Thermal resistance, junction-to-ambient (θ_{JA}) .... 132 °C/W

4.2. Recommended Operating Conditions

Supply voltage ($+V_S$ to $-V_S$) .... +2.7 V to +5.0 V
Ambient operating temperature range (T_A) .... -55°C to +125°C

4.3. Nominal Operating Performance Characteristics 3/

Output Current (I_o) .... +/-10 mA at $+V_{S = 2.7}$
.... +/-30 mA at $+V_{S = 5.0}$
Input Capacitance (C_{IN}) .... 1.5 pF Differential
.... 8.0 pF Common Mode
Slew Rate (SR, $R_{L=}$10KΩ) .... 1.0 V/µS
Overload Recovery Time .... 0.05 mS
Voltage Noise ($e_{n\ P\text{-}P,}$ 0.1 to 10 Hz BW) .... 500 nV p-p
($e_{n\ P\text{-}P,}$ 0.1 to 1.0 Hz BW) .... 160 nV p-p
Voltage Noise Density ($e_{n,}$ f=1K Hz) .... 22 nV / √Hz
Voltage Noise Density ($i_{n,}$ f=10 Hz) .... 5 fA / √Hz

4.4. Radiation Features

Maximum total dose available (dose rate = 50 – 300 rads(Si)/s)….10 k rads(Si)

1/ 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 outside of those indicated in the operation sections of this specification is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.
2/ Differential input voltage is limited to ±5V or the supply voltage, whichever is less
3/ Unless otherwise specified, $+V_S$ = 5V, $-V_s$=GND, VCM = 2.5V, and T_A = 25ºC.
4/ See section 7.2

TABLE IA – ELECTRICAL PERFORMANCE CHARACTERISTICS (Vs = 5.0V)

Parameter See notes at end of table	Symbol	Conditions 1/ Unless otherwise specified		Sub-Group	Limit Min	Limit Max	Units
INPUT CHARACTERISTICS							
Offset Voltage	VOS			1	-10	10	µV
				2,3	-15	15	µV
			M,D	1	-10	10	µV
Input Bias Current	I_B			1	-500	500	pA
				2,3	-1.5	1.5	nA
			M,D	1	-500	500	pA
Input Offset Current	I_{OS}			1	-400	400	pA
				2,3	-500	500	pA
			M,D	1	-400	400	pA
Input Voltage Range	IVR			1,2,3	0	5.0	V
			M,D	1	0	5.0	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0 to 5V		1	120		dB
				2,3	115		dB
			M,D	1	120		dB
Large Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, V_O = 0.3V to 4.7V		1	125		dB
				2,3	120		dB
			M,D	1	125		dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	3/		2,3		0.06	µV/°C
OUTPUT CHARACTERISTICS							
Output Voltage High	V_{OH}	R_L = 100 kΩ to ground		1	4.99		V
				2,3	4.99		V
			M,D	1	4.99		V
		R_L = 10 kΩ to ground		1	4.95		V
				2,3	4.95		V
			M,D	1	4.95		V
Output Voltage Low	V_{OL}	R_L = 100 kΩ to +Vs		1		5	mV
				2,3		5	mV
			M,D	1		5	mV
		R_L = 10 kΩ to +Vs		1		20	mV
				2,3		20	mV
			M,D	1		20	mV
Short-Circuit Limit	I_{SC}			1	±25		mA
				2,3	±20		mA
			M,D	1	±25		mA

TABLE IA – ELECTRICAL PERFORMANCE CHARACTERISTICS (Vs = 5.0V) – Cont.

POWER SUPPLY							
Power Supply Rejection Ratio	PSRR	Vs = 2.7V to 5.5V		1,2,3	115		dB
			M,D	1	115		dB
Total Supply Current (Both Amps)	I_{SY}	$V_O = V_S/2$		1		2.2	mA
				2,3		2.4	mA
			M,D	1		2.2	mA
DYNAMIC PERFORMANCE							
Gain Bandwidth Product	GBP	2/ 3/		4	2.5		MHz

TABLE IA NOTES:

1/ $+V_S$ = 5.0V, -Vs=GND, V_{CM} = 2.5V, TA nom = 25ºC, TA max = 125ºC, TA min = -55ºC unless otherwise noted

2/ Guaranteed by characterization analysis – not production tested. Characterization will be repeated in conjunction with any major design changes.

3/ Parameter is not tested post irradiation

TABLE IB – ELECTRICAL PERFORMANCE CHARACTERISTICS (Vs = 2.7V)

Parameter See notes at end of table	Symbol	Conditions 1/ Unless otherwise specified		Sub-Group	Limit Min	Limit Max	Units
INPUT CHARACTERISTICS							
Offset Voltage	VOS			1	-10	10	µV
				2,3	-15	15	µV
			M,D	1	-10	10	µV
Input Bias Current	I_B			1	-500	500	pA
				2,3	-1.5	1.5	nA
			M,D	1	-500	500	pA
Input Offset Current	I_{OS}			1	-400	400	pA
				2,3	-500	500	pA
			M,D	1	-400	400	pA
Input Voltage Range	IVR			1,2,3	0	2.7	V
			M,D	1	0	2.7	V
Common-Mode Rejection Ratio	CMRR	V_{CM} = 0 to 2.7V		1	115		dB
				2,3	110		dB
			M,D	1	115		dB
Large Signal Voltage Gain	A_{VO}	R_L = 10 kΩ, V_O = 0.3V to 2.4V		1	110		dB
				2,3	105		dB
			M,D	1	110		dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	3/		2,3		0.06	µV/°C
OUTPUT CHARACTERISTICS							
Output Voltage High	V_{OH}	R_L = 100 kΩ to ground		1	2.68		V
				2,3	2.68		V
			M,D	1	2.68		V
		R_L = 10 kΩ to ground		1	2.67		V
				2,3	2.67		V
			M,D	1	2.67		V

TABLE IB – ELECTRICAL PERFORMANCE CHARACTERISTICS (Vs = 2.7V) – Cont.

Parameter See notes at end of table	Symbol	Conditions 1/ Unless otherwise specified		Sub-Group	Limit Min	Limit Max	Units
Output Voltage Low	V_{OL}	R_L = 100 kΩ to +Vs		1		5	mV
				2,3		5	mV
			M,D	1		5	mV
		R_L = 10 kΩ to +Vs		1		20	mV
				2,3		20	mV
			M,D	1		20	mV
Short-Circuit Limit	I_{SC}			1	±10		mA
				2,3	±5		mA
			M,D	1	±10		mA
POWER SUPPLY							
Total Supply Current (Both Amps)	I_{SY}	$V_O = V_S/2$		1		2.0	mA
				2,3		2.4	mA
			M,D	1		2.0	mA
DYNAMIC PERFORMANCE							
Gain Bandwidth Product	GBP	2/ 3/		4	2.0		MHz

TABLE IB NOTES:

1/ $+V_S$ = 2.7V, $-V_s$=GND, V_{CM} = 1.35V, TA nom = 25ºC, TA max = 125ºC, TA min = -55ºC unless otherwise noted.

2/ Guaranteed by characterization analysis – not production tested. Characterization will be repeated in conjunction with any major design changes.

3/ Parameter is not tested post irradiation

TABLE IIA – ELECTRICAL TEST REQUIREMENTS:

Table IIA	
Test Requirements	Subgroups (in accordance with MIL-PRF-38535, Table III)
Interim Electrical Parameters	1
Final Electrical Parameters	1,2,3 1/ 2/
Group A Test Requirements	1,2,3
Group C end-point electrical parameters	1,2,3 2/
Group D end-point electrical parameters	1,2,3
Group E end-point electrical parameters	1 3/

Table IIA Notes:
1/ PDA applies to subgroup 1 only. Delta's excluded from PDA.
2/ See Table IIB for delta parameters
3/ Parameters noted in Table IA, IB are not tested post irradiation.

TABLE IIB – LIFE TEST/BURN-IN DELTA LIMITS

Table IIB			
Parameter	Symbol	Delta	Units
Offset voltage Vs = 5.0V, Vcm = 2.5V	V_{OS}	±5	µV
Input Bias Current Vs = 5.0V	I_B	±170	pA
Supply Current Vs = 5.0V	I_{SY}	±116	µA

5.0 Burn-In Life Test, and Radiation

5.1. Burn-In Test Circuit, Life Test Circuit

5.1.1. The test conditions and circuit shall be maintained by the manufacturer under document revision level control and shall be made available to the preparing or acquiring activity upon request. The test circuit shall specify the inputs, outputs, biases, and power dissipation, as applicable, in accordance with the intent specified in method 1015 test condition B of MIL-STD-883.

5.1.2. HTRB is not applicable for this drawing.

5.2. Radiation Exposure Circuit

5.2.1. The radiation exposure circuit shall be maintained by the manufacturer under document revision level control and shall be made available to the preparing and acquiring activity upon request. Total dose irradiation testing shall be performed in accordance with MIL-STD-883 method 1019, condition A.

6.0 MIL-PRF-38535 QMLV Exceptions

6.1. Wafer Fabrication

Wafer fabrication occurs at MIL-PRF-38535 QML Class Q certified facility.

6.2. Wafer Lot Acceptance (WLA)

Full WLA per MIL-STD-883 TM 5007 is not available for this product. SEM inspection only is available per MIL-STD-883, TM2018.

7.0 Application Notes

7.1. Functional Description

The AD8629 is a single-supply, ultrahigh precision rail-to-rail input and output operational amplifier. The typical offset voltage of less than 1 μV allows this amplifier to be easily configured for high gains without risk of excessive output voltage errors. The extremely small temperature drift ensures a minimum offset voltage error over their entire temperature range of −55°C to +125°C, making this amplifier ideal for a variety of sensitive measurement applications in harsh operating environments.

The AD8629 achieves a high degree of precision through a patented combination of auto-zeroing and chopping. This unique topology allows the AD8629 to maintain its low offset voltage over a wide temperature range. The AD8629 also optimizes the noise and bandwidth over previous generations of auto-zero amplifiers, offering the lowest voltage noise of any auto-zero amplifier by more than 50%.

Previous designs used either auto-zeroing or chopping to add precision to the specifications of an amplifier. Auto-zeroing results in low noise energy at the auto-zeroing frequency, at the expense of higher low frequency noise due to aliasing of wideband noise into the auto-zeroed frequency band. Chopping results in lower low frequency noise at the expense of larger noise energy at the chopping frequency. The AD8629 uses both auto-zeroing and chopping in a patented ping-pong arrangement to obtain lower low frequency noise together with lower energy at the chopping and auto-zeroing frequencies, maximizing the signal-to-noise ratio for the majority of applications without the need for additional filtering. The relatively high clock frequency of 15 kHz simplifies filter requirements for a wide, useful noise-free bandwidth.

The AD8629 has low noise over a relatively wide bandwidth (0 Hz to 10 kHz) and can be used where the highest dc precision is required. In systems with signal bandwidths of from 5 kHz to 10 kHz, the AD8629 provides true 16-bit accuracy, making it the best choice for very high resolution systems.

7.2. Input Overvoltage Protection

Although the AD8629 are rail-to-rail input amplifiers, care should be taken to ensure that the potential difference between the inputs does not exceed the supply voltage. Under normal negative feedback operating conditions, the amplifier corrects its output to ensure that the two inputs are at the same voltage. However, if either input exceeds either supply rail by more than 0.3 V, large currents begin to flow through the ESD protection diodes in the amplifier.

These diodes are connected between the inputs and each supply rail to protect the input transistors against an electrostatic discharge event, and they are normally reverse-biased. However, if the input voltage exceeds the supply voltage, these ESD diodes can become forward-biased. Without current limiting, excessive amounts of current could flow through these diodes, causing permanent damage to the device. If inputs are subject to overvoltage, appropriate series resistors should be inserted to limit the diode current to less than 5 mA maximum.

7.3. Output Phase Reversal

Output phase reversal occurs in some amplifiers when the input common-mode voltage range is exceeded. As common-mode voltage is moved outside the common-mode range, the outputs of these amplifiers can suddenly jump in the opposite direction to the supply rail. This is the result of the differential input pair shutting down, causing a radical shifting of internal voltages that result in the erratic output behavior.

The AD8629 amplifiers have been carefully designed to prevent any output phase reversal, provided that both inputs are maintained within the supply voltages. If one or both inputs could exceed either supply voltage, a resistor should be placed in series with the input to limit the current to less than 5 mA. This ensures that the output does not reverse its phase.

7.4. Overload Recovery Time

Many auto-zero amplifiers are plagued by a long overload recovery time, often in ms, due to the complicated settling behavior of the internal nulling loops after saturation of the outputs. The AD8629 has been designed so that internal settling occurs within two clock cycles after output saturation occurs. This results in a much shorter recovery time, less than 10 μs, when compared to other auto-zero amplifiers. The wide bandwidth of the AD8629 enhances performance when the parts are used to drive loads that inject transients into the outputs. This is a common situation when an amplifier is used to drive the input of switched capacitor ADCs.

Revision History		
Rev	Description of Change	Date
A	Initial Release	3/29/10
B	Updated Hyper-Link for Commercial Datasheet.	4/8/2010
C	Corrected font errors introduced in previous revisions.	5/26/2010

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