Dual 3.2MHz, 0.8V/µs Low Power, Over-The-Top Precision Op Amp

RH6016S

1.0 SCOPE

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

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

This datasheet 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 https://www.analog.com/en/products/lt6016

2.0 Part Number

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

Specific Part Number	Description
RH6016MW	Dual 3.2MHz, 0.8V/µs Low Power, Over-The-Top Precision Op Amp

3.0 Case Outline

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

Outline Letter	Descriptive Designator	Terminals	Lead Finish	Package style
X	CDFP3-F10	10- lead	Hot Solder Dip	Bottom Brazed Flat Pack

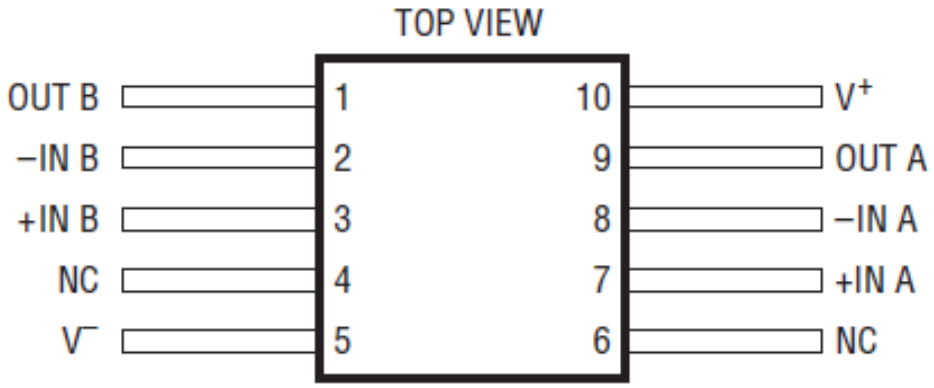

Figure 1 – Functional Block Diagram

1/ Package Top View

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Package: X			
Pin Number	**Terminal Symbol**	**Pin Type**	**Pin Description**
1	OUT B	Analog Output	Operational amplifier output, Amplifier B
2	-IN B	Analog Input	Operational amplifier negative input, Amplifier B.
3	+IN B	Analog Input	Operational amplifier positive input, Amplifier B
4	NC	N/A	No connection or ground for this terminal
5	V-	Power	Negative power supply.
6	NC	N/A	No connection or ground for this terminal
7	+IN A	Analog Input	Operational amplifier positive input, Amplifier A.
8	-IN A	Analog Input	Operational amplifier negative input, Amplifier A.
9	OUT A	Analog Output	Operational amplifier output, Amplifier A
10	V+	Power	Positive power supply.

4.0 Specifications

4.1. Absolute Maximum Ratings 1/

Supply Voltage (V+ to V–) ..... 60 V, –50 V
Input Differential Voltage ..... ±80
Input Voltage..... 80 V, –25 V
Input Current..... ±10 mA
Output Short-Circuit Duration ..... Continuous
Operating Temperature Range ..... –55 °C to 150 °C
Storage Temperature Range ..... –65 °C to 150 °C
Maximum Junction Temperature ..... 150 °C
Thermal Resistance: Junction to Ambient (ΘJ_A) ..... 85 °C/W
Thermal Resistance: Junction to Case (ΘJ_C)..... 3.9 °C/W
Lead Temperature (Soldering, 10sec) ..... 300 °C
ESD Sensitivity (CDM) ..... Class C3
ESD Sensitivity (HBM)..... Class 2

4.2. Recommended Operating Conditions

Supply voltage (V_s) ..... ±15.0 V
Ambient operating temperature range (T_A)…… -55 °C to +125 °C

4.3. Nominal Operating Performance Characteristics (25 °C)

Input Resistance Differential (R_{IN}) 0 < V_{CM} < V_+ –1.75V……1 MΩ
Common Mode Input resistance (R_{INCM})…… >1 GΩ
Setting Time Due to Input Step (t_s) 0.1% Settling …… 3.5 µs
Output Impedance (R_O) ΔI_O = ±5mA…….. 0.15 Ω
Input Referral Noise Voltage 0.1Hz to 10Hz, V_{CM} < V_+ –1.25V…… 0.5 µVP-P
fO = 1kHz, V_{CM} < V_+ –1.75V
Input Referral Noise Voltage Density ……..18 nV/$\sqrt{}$Hz
Input Referral Noise Current Density(in) …….. 0.1 pA/$\sqrt{}$Hz

4.4. Radiation Features

Maximum total dose available (dose rate = 50 – 300 rads(Si)/s)….100 krads(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.

TABLE I – ELECTRICAL PERFORMANCE CHARACTERISTICS

Parameter See notes at end of table	Symbol	Conditions 1/ 2/ 3/ Unless otherwise specified	Sub-Group	Limit Min	Limit Max	Units
Input Offset Voltage	V_{OS}		1	-700	700	uV
			2,3	-900	900	uV
		M, D, P, L, R	1	-700	700	uV
Input Offset Current	I_{OS}		1	-15	15	nA
			2,3	-50	50	nA
		M, D, P, L, R	1	-25	25	nA
Input Bias Current	I_B		1	-35	35	nA
			2,3	-50	50	nA
		M, D, P, L, R	1	-50	50	nA
Open Loop Gain	A_{VOL}	R_L=10 kΩ ΔV_{OUT} = 3 V 3/	1	100		V/mV
			2	60		V/mV
			3	201		V/mV
		M, D, P, L, R	1	100		V/mV
		RL=10 kΩ ΔV_{OUT} = 3 V	1, 2,3	301		V/mV
		2/ M, D, P, L, R	1	50		V/mV
Supply Rejection Ratio	PSRR	VS=±2.5V to ±25V ;VCM=VOUT= 0 V	1	90		dB
			2,3	98		dB
		M, D, P, L, R	1	85		dB
Input Common Mode Rejection Ratio	CMRR	V_{CM} = –15 V to 13.25 V	1,2	90		dB
			3	110		dB
		M, D, P, L, R	1	84		dB
Output Voltage Swing Low	V_{OL}	No Load	1		9.5	mV
			2,3		53	mV
		M, D, P, L, R	1		12	mV
		I_{SINK} = 5 mA	1		373	mV
			2,3		498	mV
		M, D, P, L, R	1		425	mV
Output Voltage Swing High	V_{OH}	No Load	1		558	mV
			2,3		698	mV
		M, D, P, L, R	1		580	mV
		I_{SOURCE} = 5 mA	1		1500	mV
			2,3		1650	mV
		M, D, P, L, R	1		1850	mV
Short-Circuit Current	I_{SC}	50 Ω to GND	1	22.1	60	mA
			2,3	10.2	60	mA
		M, D, P, L, R	1	18	75	mA
Gain Bandwidth Product	GBW	f_{TEST} = 100 kHz	4,5	1.95		MHz
			6	2.57		MHz
		M, D, P, L, R	4	1.9		MHz
Slew Rate	SR	V_{OUT} = 3 V	4	0.6		V/µs
			5	0.25		V/µs

Parameter See notes at end of table	Symbol	Conditions 1/ 2/ 3/ Unless otherwise specified	Sub-Group	Limit Min	Limit Max	Units
			6	0.52		V/µs
		M, D, P, L, R	4	0.5		V/µs
Supply Current per Amplifier	ISY		1		400	µA
			2		600	µA
			3		525	uA
		M, D, P, L, R	1		410	uA

Table I Notes:

1/ Device supplied to this drawing have been characterized through all levels M, D, P, L, R of irradiation. However, device is only tested at the "R" level. Pre and Post irradiation values are identical unless otherwise specified in Table I. When performing post irradiation electrical measurements for any RHA level,

TA = +25°C.

2/ VS = ±2.5 V, VCM = VOUT = Mid-Supply.

3/ VS = ±15 V, VCM = VOUT = Mid-Supply.

TABLE IIA – ELECTRICAL TEST REQUIREMENTS

Test Requirements	Subgroups (in accordance with MIL-PRF-38535, Table III)
Interim Electrical Parameters	1, 4
Final Electrical Parameters	1, 2, 3, 4, 5, 6 1/ 2/
Group A Test Requirements	1, 2, 3, 4, 5, 6
Group C end-point electrical parameters	1, 2, 3, 4, 5, 6 2/
Group D end-point electrical parameters	1, 4
Group E end-point electrical parameters	1, 4

Table IIA Notes:
1/ PDA applies to Table I subgroup 1 and 4 and Table IIB delta parameters.
2/ See Table IIB for delta parameters

TABLE IIB – LIFE TEST/BURN-IN DELTA LIMITS (1/,2/,3/)

VS = ±15 V and ±2.5 V			
Parameter	**Symbol**	**Delta**	**Units**
Supply Current	ISY	+/- 15	%
Input Offset Voltage	VOS	+/- 350	uV
Input Offset Current	IOS	+/-7.5	nA

TABLE IIB Notes:
1/ 240-hour burn-in and 1000-hourr life test end point electrical parameters.
2/ Deltas are performed at TA = +25 °C only
3/ Product is tested in accordance with conditions in Table I.

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.

6.0 MIL-PRF-38535 QMLV Exceptions

6.1 Wafer Fabrication

Wafer Lot Acceptance (WLA) per MIL-STD-883 TM 5007 and Scanning Electron Microscopy (SEM) inspection per MIL-STD-883 TM2018 are not available for this product.

7.0 Application Notes

7.1 Supply Voltage

The positive supply pin of the RH6016S should be bypassed with a small capacitor (typically 0.1µF) as close to the supply pins as possible. When driving heavy loads an additional 4.7µF electrolytic capacitor should be added. When using split supplies, the same is true for the V^- supply pin.

7.2 Shutdown

While there are no dedicated shutdown pins, the amplifiers can effectively be shut down into a low-power state by removing V^+. In this condition the input bias current is typically less than 1nA with the inputs biased between V^- and 76V above V^-, and if the inputs are taken below V^-, they appear as a diode in series with 1k of resistance.

7.3 Reverse Battery

The RH6016S is protected against reverse battery voltages up to 50V. In the event a reverse battery condition occurs, the supply current is typically less than 5µA (assuming the inputs are biased within a diode drop from V^-).

8.0 Package Outline Dimensions

The W package and outline dimensions can also be found at http://www.analog.com or upon request.

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
RH6016MW	–55°C to +125°C	10-Lead Bottom Brazed Flat Pack	CDFP3-F10

Revision History		
Rev	**Description of Change**	**Date**
A	Initial Production Release	05/05/2023

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