### **Standard Products**

### Preview

### RadHard-by-Design

# RHD5905 Quad Operational Amplifier Instrumentation Differential Amplifier

with Enable

www.aeroflex.com/RHDseries September 22, 2012



### **FEATURES**

- $\Box$  Single power supply operation (3.3V to 5.0V) or dual power supply operation ( $\pm 1.65$  to  $\pm 2.5$ V)
- Radiation performance
  - Total dose: >1Mrad(Si); Dose rate = 50 300 rads(Si)/s
  - ELDRS Immune
  - SEL Immune >100 MeV-cm<sup>2</sup>/mg - Neutron Displacement Damage >10<sup>14</sup> neutrons/cm<sup>2</sup>
- Differential Outputs
- □ Rail-to-Rail input and output range
- □ Enable pin to Enable/Disable amplifiers in pairs.
- □ Short Circuit Tolerant
- □ Full military temperature range
- Designed for aerospace and high reliability space applications
- □ Packaging Hermetic ceramic SOIC
  - 20-pin, 0.30"W x 0.50" L x 0.12"Ht SOIC
  - Typical Weight 1.6 grams

### **GENERAL DESCRIPTION**

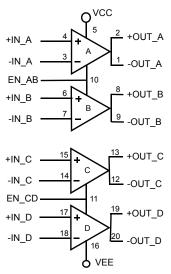
Aeroflex's RHD5905 is a radiation hardened, single supply, differential, instrumentation, quad operational amplifier with enable in a 20-pin SOIC package. The RHD5905 design uses specific circuit topology and layout methods to mitigate total ionizing dose effects and single event latchup. These characteristics make the RHD5905 especially suited for the harsh environment encountered in Deep Space missions. It is guaranteed operational from -55°C to +125°C. Available screened in accordance with MIL-PRF-38534 Class K, the RHD5905 is ideal for demanding military and space applications.

### ORGANIZATION AND APPLICATION

The RHD5905 amplifiers are capable of rail-to-rail input and outputs. Performance characteristics listed are for general purpose operational 5V CMOS amplifier applications. The amplifiers will drive substantial resistive or capacitive loads and are unity gain stable under normal conditions. Resistive loads in the low kohm range can be handled without gain derating and capacitive loads of several nF can be tolerated. CMOS device drive has a negative temperature coefficient and the devices are therefore inherently tolerant to momentary shorts, although on chip thermal shutdown is not provided. All inputs and outputs are diode protected.

The devices will not latch with SEU events to above 100 MeV-cm<sup>2</sup>/mg. Total dose degradation is minimal to above 1Mrad(Si). Displacement damage environments to neutron fluence equivalents in the mid 10<sup>14</sup> neutrons per cm<sup>2</sup> range are readily tolerated. There is no sensitivity to low-dose rate (ELDRS) effects. SEU effects are application dependant.

The RHD5905 is configured with enable/disable control. Pairs of amplifiers are put in a power-down condition with their outputs in a high impedance state. Several useful operational amplifier configurations are supported where more than one amplifier can feed an output with others disabled.



**FIGURE 1: BLOCK DIAGRAM** 

#### 20 OUT\_D -OUT A +OUT\_A 19 +OUT\_D 18 -IN\_D -IN A +IN\_A 17 +IN\_D VCC 16 VEE RHD5905 6 15 +IN\_B +IN\_C -IN\_B 14 -IN\_C +OUT\_C +OUT\_B 13 -OUT\_B 12 -OUT C EN\_AB EN\_CD 11

20-Pin SOIC

### **FIGURE 2: PACKAGE PIN-OUT**

#### Notes:

- 1. Package and Lid are electrically isolated from signal pads.
- 2. It is recommended that the Lid be grounded to prevent any ESD or static buildup.
- 3. EN\_AB enables amplifiers A & B. EN\_CD enables amplifiers C & D.

Pin	Signal Name	Definition		
1	- OUT_A	Negative Output of Amplifier A.		
2	+ OUT_A	Positive Output of Amplifier A.		
3	-IN_A	Inverting input of Amplifier A.		
4	+IN_A	Non-Inverting input of Amplifier A.		
5	VCC	+ Voltage Supply.		
6	+IN_B	Non-Inverting input of Amplifier B.		
7	-IN_B	Inverting input of Amplifier B.		
8	+ OUT_B	Positive Output of Amplifier B.		
9	- OUT_B	Negative Output of Amplifier B.		
10	EN_AB	A Logic Low will disable Amplifiers A & B so that the outputs are high impedance.		
11	EN_CD	A Logic Low will disable Amplifiers C & D so that the outputs are high impedance.		
12	- OUT_C	Negative Output of Amplifier C.		
13	+ OUT_C	Positive Output of Amplifier C.		
14	-IN_C	Inverting input of Amplifier C.		
15	+IN_C	Non-Inverting input of Amplifier C.		
16	VEE	- Voltage Supply.		
17	+IN_D	Non-Inverting input of Amplifier D.		
18	-IN_D	Inverting input of Amplifier D.		
19	+ OUT_D	Positive Output of Amplifier D.		
20	- OUT_D	Negative Output of Amplifier D.		

**TABLE 1: PIN-OUT DESCRIPTION** 

### **ABSOLUTE MAXIMUM RATINGS**

Parameter	Range	Units
Case Operating Temperature Range	-55 to +125	°C
Storage Temperature Range	-65 to +150	°C
Junction Temperature	+150	°C
Supply Voltage Vcc - Vee	+6.0	V
Input Voltage	VCC +0.4 VEE -0.4	V
Lead Temperature (soldering, 10 seconds)	300	°C
Thermal Resistance, Junction to Case, ⊝jc	7	°C/W
ESD Rating	2.0	KV
Power @ 25°C	200	mW

NOTICE: Stresses above those listed under "Absolute Maximums Rating" may cause permanent damage to the device. These are stress rating only; functional operation beyond the "Operation Conditions" is not recommended and extended exposure beyond the "Operation Conditions" may affect device reliability.

### **RECOMMENDED OPERATING CONDITIONS**

Symbol	Parameter	Typical	Units
+Vcc	Power Supply Voltage	3.3 to 5.0	V
Vcm	Input Common Mode Range	VCC to VEE	V

### **ELECTRICAL PERFORMANCE CHARACTERISTICS**

(Tc = -55°C to +125°C, +Vcc = +5.0V -- UNLESS OTHERWISE SPECIFIED)

Parameter	Symbol	Conditions	Min	Max	Units
Input Offset Voltage	Vos		-2	2	mV
Input Offset Current	loo	Tc = +25°C, -55°C	-100	100	рA
Input Offset Current	los	Tc = +125°C	-500	500	
Input Pige Current	ln.	Tc = +25°C, -55°C	-100	100	рА
Input Bias Current	lв	Tc = +125°C	-1000	1000	
Input Offset TempCo 2/	Viost			10	uV/C
Common Mode Rejection Ratio	CMRR		70		dB
Power Supply Rejection Ratio	PSRR		70		dB
Output Voltage High	Voн	ROUT = 720 ohms to GND	4.9		V
Output Voltage Low	Vol	ROUT = 720 ohms to VCC		0.1	V
Short Circuit	lo(sink)	Vout to Vcc	-63		mA
Output Current 2/	Io(SOURCE)	VOUT to VEE		45	mA
Slew Rate	SR	RL = 8K, Gain = 1	13.5		V/uS

### **ELECTRICAL PERFORMANCE CHARACTERISTICS (continued)**

(Tc =  $-55^{\circ}$ C TO  $+125^{\circ}$ C, +Vcc = +5.0V -- UNLESS OTHERWISE SPECIFIED)

Parameter	Symbol	Conditions	Min	Max	Units
Open Loop Gain 2/	Aol	No Load	100		dB
Unity Gain Bandwidth 2/	UGBW	35 Typical @ RL = 10K			MHz
Input Voltage - Enable (EN AB,	VHI	High (Enabled)	70% VCC - VEE		V
EN_CD)	VLO	Low (Disabled)		30% VCC - VEE	V
Input Current - Enable (EN_AB, EN_CD)	len			100	nA
Ouisseent Supply Current	Iccq	All Amplifiers Enabled, No Load		5.5	mA
Quiescent Supply Current		All Amplifier Disabled		1	uA
Channel Separation 2/		RL = 2K, f = 1.0KHz	90		dB
Input-Referred Voltage Noise 2/	e <sub>n</sub>	46 Typical @ F = 5 kHz			nVl√Hz
Phase Margin 2/	$\Phi_{m}$		30		Deg

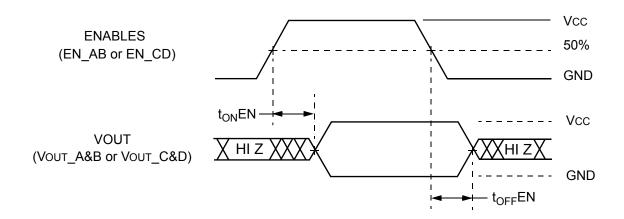
#### Notes:

- 1/ Specification derated to reflect Total Dose exposure to 1 Mrad(Si) @ +25°C.
- 2/ Not tested. Shall be guaranteed by design, characterization, or correlation to other test parameters.

### **SWITCHING CHARACTERISTICS**

(Tc =  $-55^{\circ}$ C to  $+125^{\circ}$ C, +Vcc = +5.0V -- Unless otherwise specified)

Parameter	Symbol	Conditions	Min	Max	Units
Output Delay (Enabled)	t <sub>ON</sub> EN			100	ns
Output Delay (Disabled)	t <sub>OFF</sub> EN			100	ns

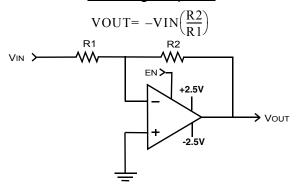


### FIGURE 3: RHD5905 SWITCHING DIAGRAM

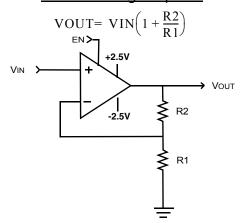
### RHD5905 QUAD OPERATIONAL AMPLIFIER APPLICATION NOTES

### **APPLICATION NOTE 1: DUAL POWER SUPPLY AMPLIFIER**

### **Inverting Amplifier**

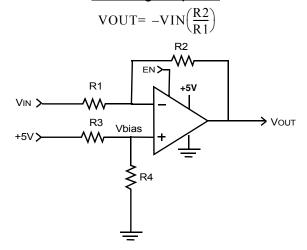


### Non Inverting Amplifier



### **APPLICATION NOTE 2: SINGLE POWER SUPPLY AMPLIFIER**

### **Inverting Amplifier**



### Non Inverting Amplifier

VOUT= VIN(I+
$$\frac{1}{R1}$$
)

+5V

R3

EN>
+5V

Vout

R4

R2

R1

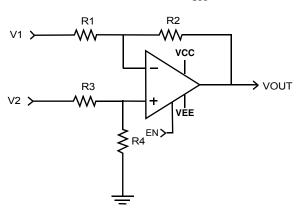
Note: For Vout DC @ mid range of common mode voltage range, VBIAS = 2.5/(1+R2/R1), VBIAS = +5\*R4/(R3+R4)

# APPLICATION NOTE 3: DIFFERENTIAL INPUT AMPLIFIER

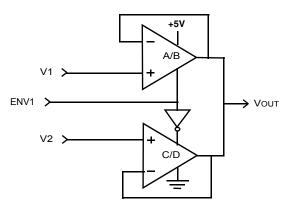
# **APPLICATION NOTE 4: MULTIPLE AMPLIFIERS**

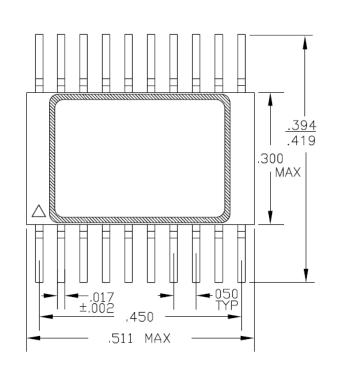
### **Differential Input Amplifier**

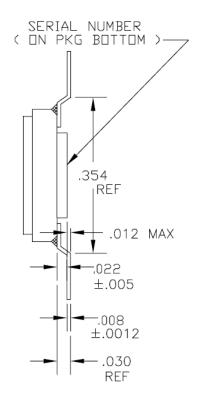
$$VOUT = \left(V2\left(\frac{R4}{R3 + R4}\right)\left(1 + \frac{R2}{R1}\right)\right) - \left(V1\frac{R2}{R1}\right)$$



### Multiple Amplifiers - Selectable Output







.120 MAX

Note: Package and lid are electrically isolated from signal pads.

**FIGURE 4: PACKAGE OUTLINE** 

### **ORDERING INFORMATION**

Model	DLA SMD#	Screening	Package	
RHD5905-7	-	Commercial Flow, +25°C testing only		
RHD5905-S	-	Military Temperature, -55°C to +125°C Screened in accordance with the individual Test Methods of MIL-STD-883 for Space Applications		
RHD5905-201-1S 5962-1223702KXC		DLA SMD Pending	20-pin SOIC Package	
RHD5905-201-2S 5962-1223702KXA		DLA SIND Feliding		
RHD5905-901-1S 5962H1223702KXC		DLA SMD and Radiation Certification Pending		
RHD5905-901-2S	5962H1223702KXA	DLA SIND and Nadiation Certification Femaling		

### EXPORT CONTROL:

This product is controlled for export under the International Traffic in Arms Regulations (ITAR). A license from the U.S. Department of State is required prior to the export of this product from the United States.

### **EXPORT WARNING:**

Aeroflex's military and space products are controlled for export under the International Traffic in Arms Regulations (ITAR) and may not be sold or proposed or offered for sale to certain countries. (See ITAR 126.1 for complete information.)

 PLAINVIEW, NEW YORK
 INTERNATIONAL
 NORTHEAST

 Toll Free: 800-THE-1553
 Tel: 805-778-9229
 Tel: 603-888-3975

 Fax: 516-694-6715
 Fax: 805-778-1980
 Fax: 603-888-4585

 SE AND MID-ATLANTIC
 WEST COAST
 CENTRAL

 Tel: 321-951-4164
 Tel: 949-362-2260
 Tel: 719-594-8017

 Fax: 321-951-4254
 Fax: 949-362-2266
 Fax: 719-594-8468

www.aeroflex.com info-ams@aeroflex.com

Aeroflex Microelectronic Solutions reserves the right to change at any time without notice the specifications, design, function, or form of its products described herein. All parameters must be validated for each customer's application by engineering. No liability is assumed as a result of use of this product. No patent licenses are implied.





A passion for performance.



Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused