

RadHard-by-Design RHD5905 Quad Operational Amplifier Instrumentation Differential Amplifier with Enable

www.aeroflex.com/RHDseries

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FEATURES

- Single power supply operation (3.3V to 5.0V) or dual power supply operation (± 1.65 to $\pm 2.5V$)
- Radiation performance
 - Total dose: $>1\text{Mrad}(\text{Si})$; Dose rate = 50 - 300 rads(Si)/s
 - ELDRS Immune
 - SEL Immune $>100\text{ MeV}\cdot\text{cm}^2/\text{mg}$
 - Neutron Displacement Damage $>10^{14}\text{ neutrons}/\text{cm}^2$
- 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 $+125^{\circ}\text{C}$. 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 $100\text{ MeV}\cdot\text{cm}^2/\text{mg}$. Total dose degradation is minimal to above $1\text{Mrad}(\text{Si})$. Displacement damage environments to neutron fluence equivalents in the mid 10^{14} neutrons per cm^2 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.

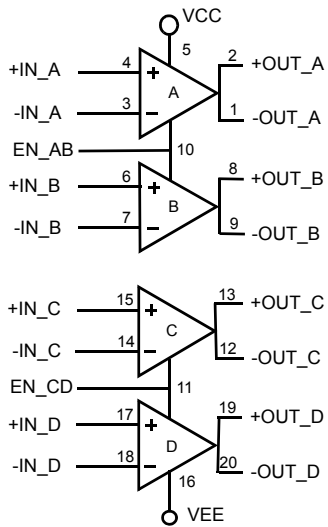
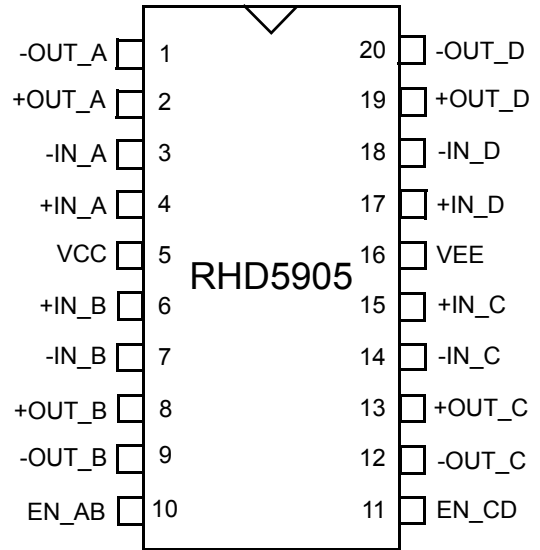


FIGURE 1: BLOCK DIAGRAM



20-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, θ_{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	Ios	Tc = +25°C, -55°C	-100	100	pA
		Tc = +125°C	-500	500	
Input Bias Current	Ib	Tc = +25°C, -55°C	-100	100	pA
		Tc = +125°C	-1000	1000	
Input Offset TempCo $\frac{\mu V}{C}$	VIoST			10	$\mu V/C$
Common Mode Rejection Ratio	CMRR		70		dB
Power Supply Rejection Ratio	PSRR		70		dB
Output Voltage High	VOH	ROUT = 720 ohms to GND	4.9		V
Output Voltage Low	VOL	ROUT = 720 ohms to Vcc		0.1	V
Short Circuit Output Current $\frac{mA}{2}$	Io(SINK)	VOUT to Vcc	-63		mA
	Io(SOURCE)	VOUT to VEE		45	mA
Slew Rate	SR	RL = 8K, Gain = 1	13.5		V/ μS

ELECTRICAL PERFORMANCE CHARACTERISTICS (continued)

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

Parameter	Symbol	Conditions	Min	Max	Units
Open Loop Gain <u>2/</u>	AOL	No Load	100		dB
Unity Gain Bandwidth <u>2/</u>	UGBW	35 Typical @ RL = 10K			MHz
Input Voltage - Enable (EN_AB, EN_CD)	VHI	High (Enabled)	70% VCC - VEE		V
	VLO	Low (Disabled)		30% VCC - VEE	V
Input Current - Enable (EN_AB, EN_CD)	IEN			100	nA
Quiescent Supply Current	ICCG	All Amplifiers Enabled, No Load		5.5	mA
		All Amplifier Disabled		1	uA
Channel Separation <u>2/</u>		RL = 2K, f = 1.0KHz	90		dB
Input-Referred Voltage Noise <u>2/</u>	e _n	46 Typical @ F = 5 kHz			nV/ $\sqrt{\text{Hz}}$
Phase Margin <u>2/</u>	Φ_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°C TO +125°C, +VCC = +5.0V -- UNLESS OTHERWISE SPECIFIED)

Parameter	Symbol	Conditions	Min	Max	Units
Output Delay (Enabled)	t _{ONEN}			100	ns
Output Delay (Disabled)	t _{OFFEN}			100	ns

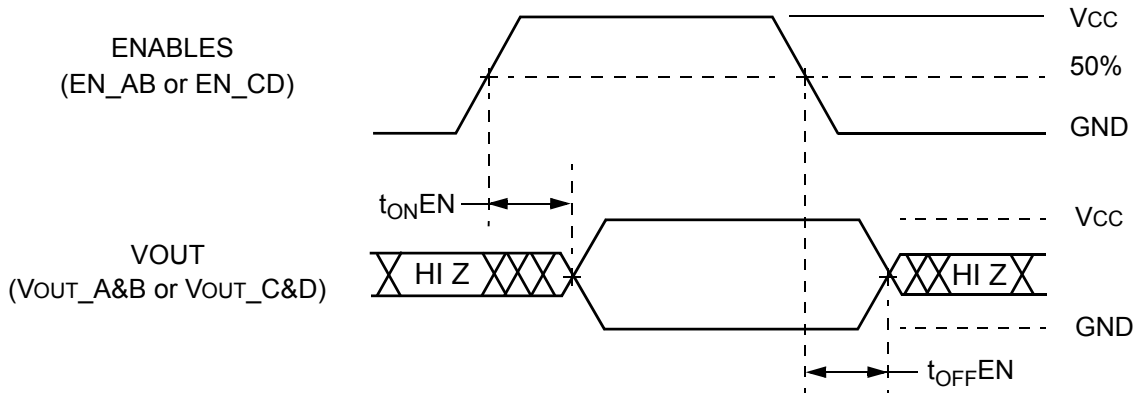


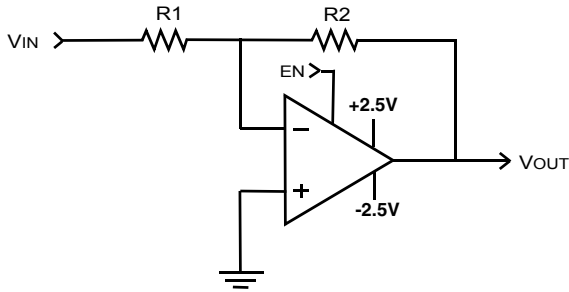
FIGURE 3: RHD5905 SWITCHING DIAGRAM

RHD5905 QUAD OPERATIONAL AMPLIFIER APPLICATION NOTES

APPLICATION NOTE 1: DUAL POWER SUPPLY AMPLIFIER

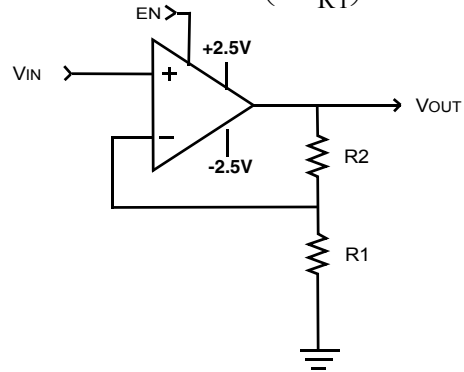
Inverting Amplifier

$$V_{OUT} = -V_{IN} \left(\frac{R_2}{R_1} \right)$$



Non Inverting Amplifier

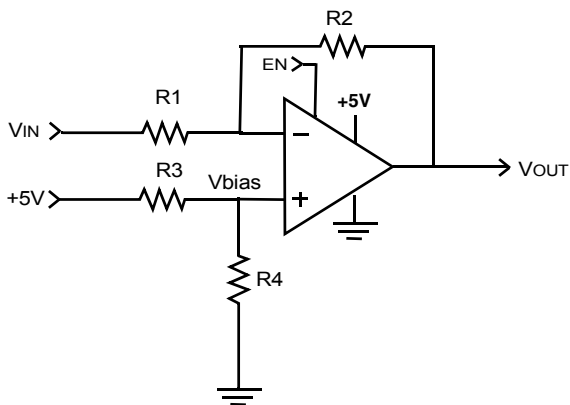
$$V_{OUT} = V_{IN} \left(1 + \frac{R_2}{R_1} \right)$$



APPLICATION NOTE 2: SINGLE POWER SUPPLY AMPLIFIER

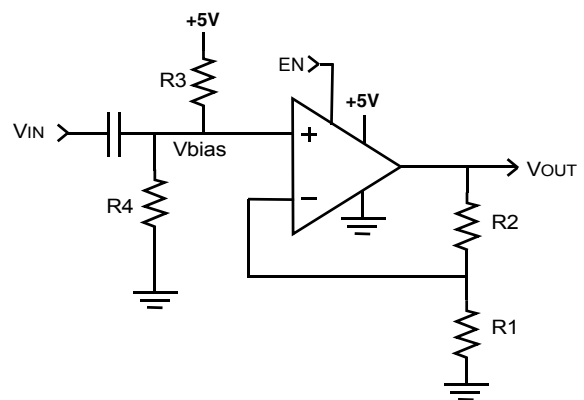
Inverting Amplifier

$$V_{OUT} = -V_{IN} \left(\frac{R_2}{R_1} \right)$$



Non Inverting Amplifier

$$V_{OUT} = V_{IN} \left(1 + \frac{R_2}{R_1} \right)$$

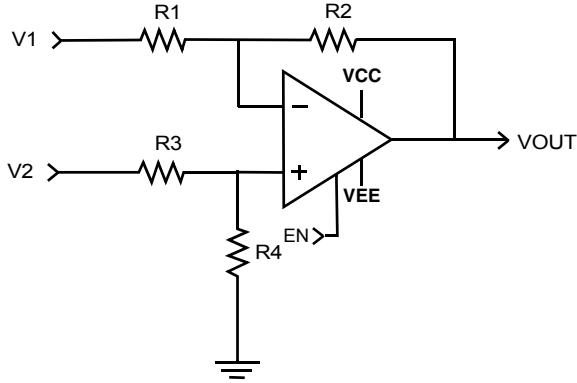


Note: For V_{OUT} DC @ mid range of common mode voltage range, $V_{BIAS} = 2.5 / (1 + R_2/R_1)$, $V_{BIAS} = +5 * R_4 / (R_3 + R_4)$

**APPLICATION NOTE 3:
DIFFERENTIAL INPUT AMPLIFIER**

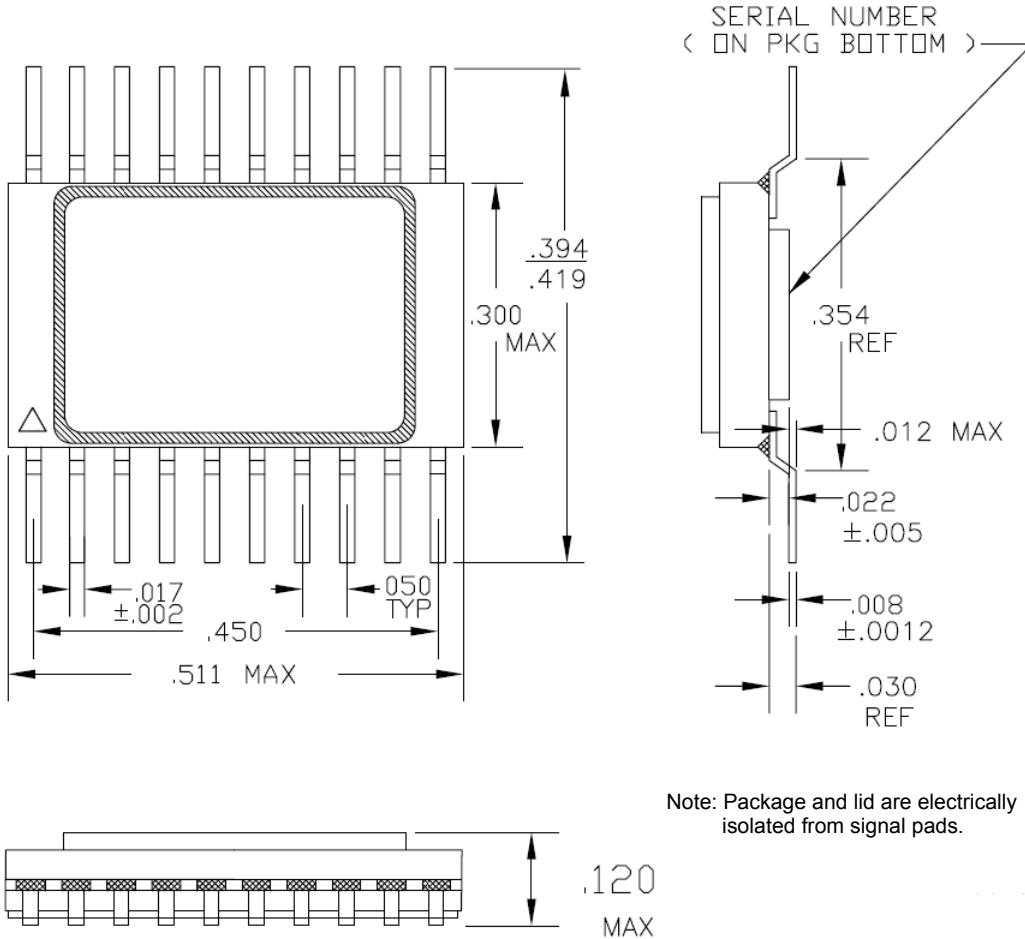
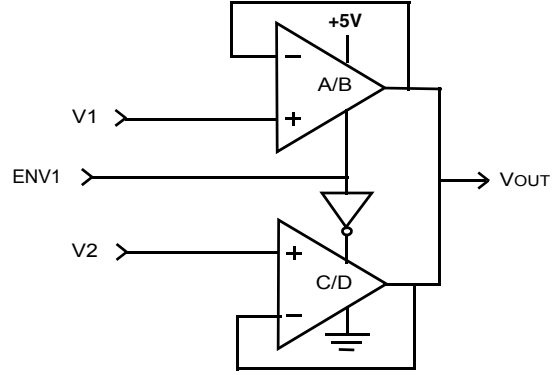
Differential Input Amplifier

$$V_{OUT} = \left(V_2 \left(\frac{R_4}{R_3 + R_4} \right) \left(1 + \frac{R_2}{R_1} \right) \right) - \left(V_1 \frac{R_2}{R_1} \right)$$



**APPLICATION NOTE 4:
MULTIPLE AMPLIFIERS**

Multiple Amplifiers - Selectable Output



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	20-pin SOIC Package
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	
RHD5905-201-2S	5962-1223702KXA		
RHD5905-901-1S	5962H1223702KXC	DLA SMD and Radiation Certification Pending	
RHD5905-901-2S	5962H1223702KXA		

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