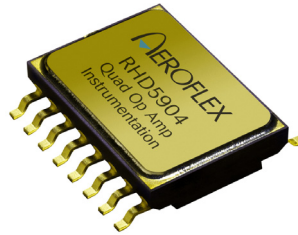


RadHard-by-Design**RHD5904 Quad Operational Amplifier
Instrumentation Amplifier with Enables**www.aeroflex.com/RHDseries

September 26, 2012

**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: $>1\text{Mrad(Si)}$; Dose rate = 50 - 300 rads(Si)/s
 - ELDRS Immune
 - SEL Immune $>100\text{ MeV-cm}^2/\text{mg}$
 - Neutron Displacement Damage $>10^{14}\text{ neutrons/cm}^2$
- High Speed
- 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
 - 16-pin, .417"L x .300"W x 0.105"Ht SOIC
 - Typical Weight 0.8 grams

GENERAL DESCRIPTION

Aeroflex's RHD5904 is a radiation hardened, single supply, high speed, quad operational amplifier with enable in a 16-pin SOIC package. The RHD5904 design uses specific circuit topology and layout methods to mitigate total ionizing dose effects and single event latchup. These characteristics make the RHD5904 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 RHD5904 is ideal for demanding military and space applications.

ORGANIZATION AND APPLICATION

The RHD5904 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 $100\text{ MeV-cm}^2/\text{mg}$. Total dose degradation is minimal to above 1Mrad(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 RHD5904 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.

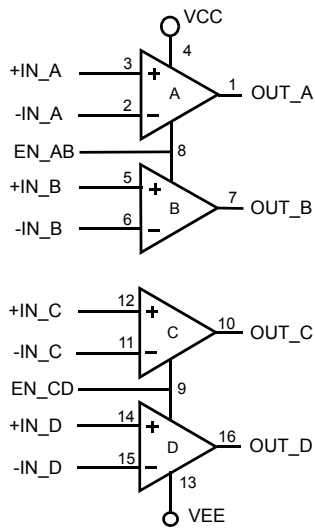
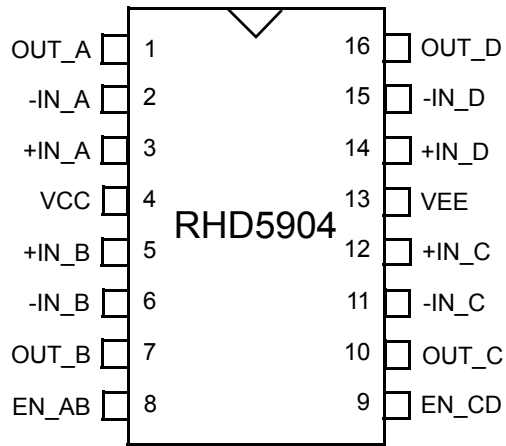


FIGURE 1: BLOCK DIAGRAM



16-Pin SOIC

FIGURE 2: PACKAGE PIN-OUT

Notes:

1. Package and lid are electrically isolated from signal pads.
2. EN_AB enables amplifiers A & B. EN_CD enables amplifiers C & D.

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 V _{CC} - V _{EE}	+6.0	V
Input Voltage	V _{CC} +0.4 V _{EE} -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
+V _{CC}	Power Supply Voltage	3.3 to 5.0	V
V _{CM}	Input Common Mode Range	V _{CC} to V _{EE}	V

ELECTRICAL PERFORMANCE CHARACTERISTICS

(T_C = -55°C TO +125°C, +V_{CC} = +5.0V -- UNLESS OTHERWISE SPECIFIED)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Offset Voltage	V _{OS}		-2		2	mV
Input Offset Current	I _{OS}		-10		10	pA
Input Bias Current	I _B		-20		20	pA
Input Offset TempCo $\frac{\mu V}{^\circ C}$	V _{IOST}				10	$\mu V/^\circ C$
Common Mode Rejection Ratio	CMRR		70			dB
Power Supply Rejection Ratio	PSRR		70			dB
Output Voltage High	V _{OH}	R _{OUT} = 3.6 Kohms to GND	4.9			V
Output Voltage Low	V _{OL}	R _{OUT} = 3.6 Kohms to V _{CC}			0.1	V
Short Circuit Output Current $\frac{mA}{2}$	I _{O(SINK)}	V _{OUT} to V _{CC}	-63			mA
	I _{O(SOURCE)}	V _{OUT} to V _{EE}			45	mA
Slew Rate	SR	R _L = 8K	2.5			V/ μS
Open Loop Gain $\frac{dB}{2}$	AOL	No Load	100			dB
Unity Gain Bandwidth	UGBW	R _L = 10K	5			MHz

ELECTRICAL PERFORMANCE CHARACTERISTICS (continued)

(T_C = -55°C TO +125°C, +V_{CC} = +5.0V -- UNLESS OTHERWISE SPECIFIED)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Input Voltage - Enable (EN_AB, EN_CD)	V _{HI}	High (Enabled)	70% V _{CC} - V _{EE}			V
	V _{LO}	Low (Disabled)			30% V _{CC} - V _{EE}	V
Input Current - Enable (EN_AB, EN_CD)	I _{EN}				100	nA
Quiescent Supply Current	I _{CCQ}	All Amplifiers Enabled, No Load			5.5	mA
		All Amplifier Disabled			1	uA
Channel Separation <u>2/</u>		R _L = 2K, f = 1.0KHz	90			dB
Input-Referred Voltage Noise <u>2/</u>	e _n	F = 1 kHz			TBD	V _r /√Hz
Phase Margin <u>2/</u>	Φ _m		TBD			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

(T_C = -55°C TO +125°C, +V_{CC} = +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

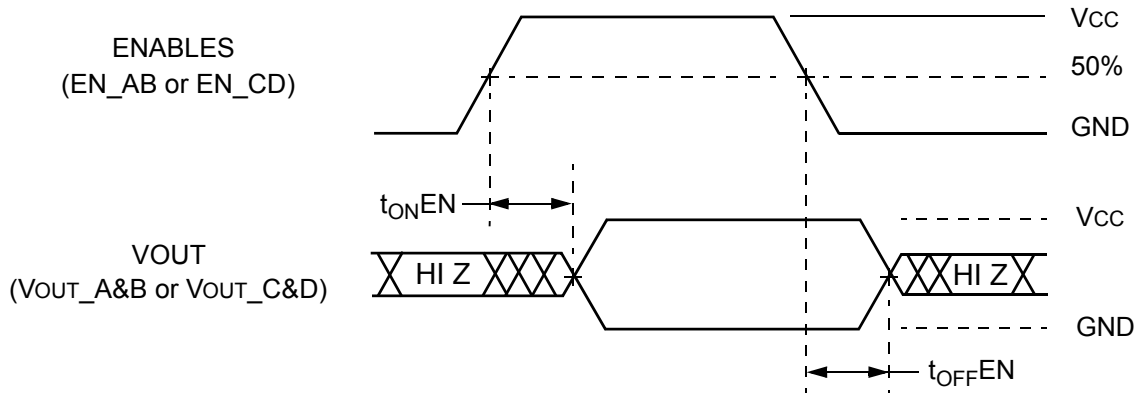


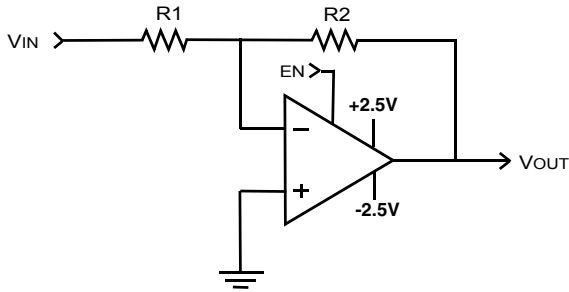
FIGURE 3: RHD5904 SWITCHING DIAGRAM

RHD5904 QUAD OPERATIONAL AMPLIFIER APPLICATION NOTES

APPLICATION NOTE 1: DUAL POWER SUPPLY AMPLIFIER

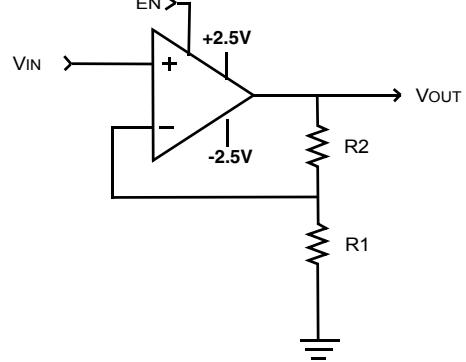
Inverting Amplifier

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



Non Inverting Amplifier

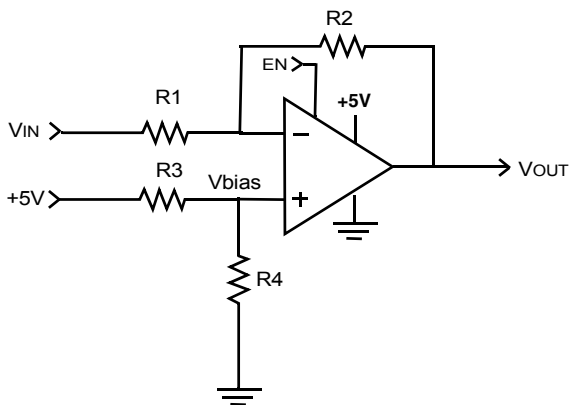
$$V_{OUT} = V_{IN} \left(1 + \frac{R_2}{R_1} \right)$$



APPLICATION NOTE 2: SINGLE POWER SUPPLY AMPLIFIER

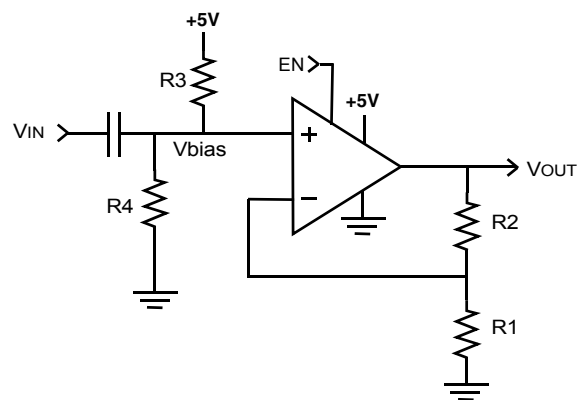
Inverting Amplifier

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



Non Inverting Amplifier

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

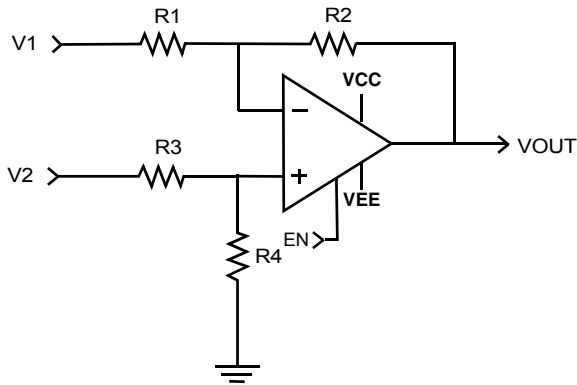


Note: For V_{OUT} DC @ mid range of common mode voltage range, $V_{BIAS} = 2.5 / (1 + R_2/R_1)$, $V_{BIAS} = +5 * R_4 / (R_3 + R_4)$

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

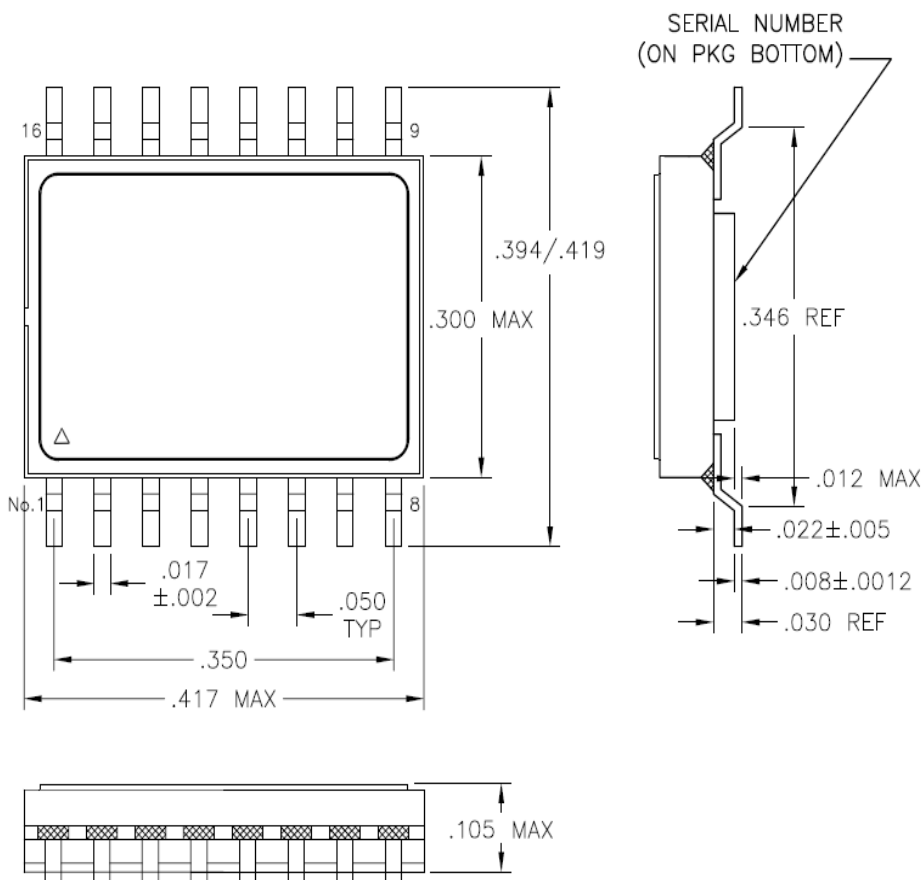
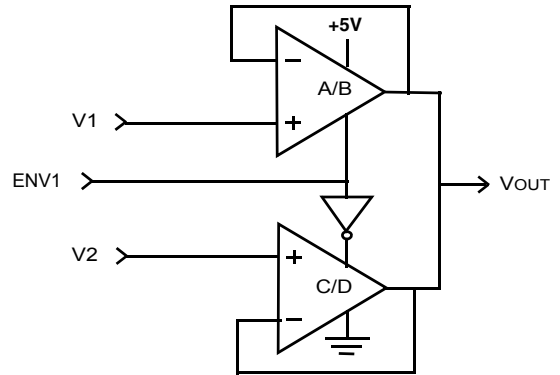


FIGURE 4: PACKAGE OUTLINE

ORDERING INFORMATION

Model	DSCC SMD #	Screening	Package
RHD5904-7	-	Commercial Flow, +25°C testing only	16-pin SOIC Package
RHD5904-S	-	Military Temperature, -55°C to +125°C Screened in accordance with the individual Test Methods of MIL-STD-883 for Space Applications	
RHD5904-201-1S	5962-1024104KXC	DSCC SMD Pending	
RHD5904-201-2S	5962-1024104KXA		
RHD5904-901-1S	5962H1024104KXC	DSCC SMD and Radiation Certification Pending	
RHD5904-901-2S	5962H1024104KXA		

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

Toll Free: 800-THE-1553
Fax: 516-694-6715

INTERNATIONAL

Tel: 805-778-9229
Fax: 805-778-1980

NORTHEAST

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Tel: 719-594-8017
Fax: 719-594-8468

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

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