Standard Products

# RadHard-by-Design
# RHD5902 Quad Operational Amplifier
# High Speed with Enables

**www.aeroflex.com/RHDseries**

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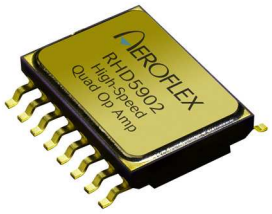



## FEATURES

- Single power supply operation (3.3V to 5.0V) or dual power supply operation (±1.65 to ±2.5V)
- Radiation performance
  - Total dose: > 1 Mrad(Si); Dose rate = 50 - 300 rads(Si)/s
  - ELDRS Immune
  - SEL Immune > 100 MeV-cm$^2$/mg
  - Neutron Displacement Damage > $10^{14}$ neutrons/cm$^2$
- Unity Gain Bandwidth 35 MHz Typical
- 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, .411"L x .293"W x .090"Ht
  - Weight - 0.8 grams max
- **Aeroflex Plainview's Radiation Hardness Assurance Plan is DLA Certified to MIL-PRF-38534, Appendix G.**

## GENERAL DESCRIPTION

Aeroflex's RHD5902 is a radiation hardened, single supply, high speed quad operational amplifier with enable in a 16-pin SOIC package. The RHD5902 design uses specific circuit topology and layout methods to mitigate total ionizing dose effects and single event latchup. These characteristics make the RHD5902 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 RHD5902 is ideal for demanding military and space applications.

## ORGANIZATION AND APPLICATION

The RHD5902 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$^2$/mg. Total dose degradation is minimal to above 1 Mrad(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 RHD5902 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.

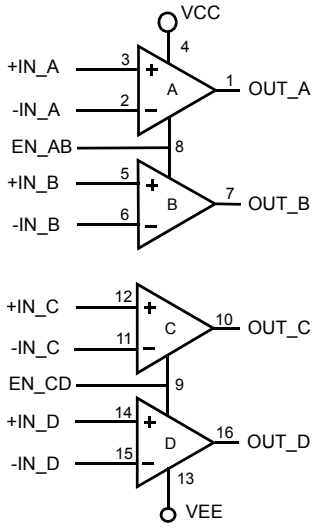
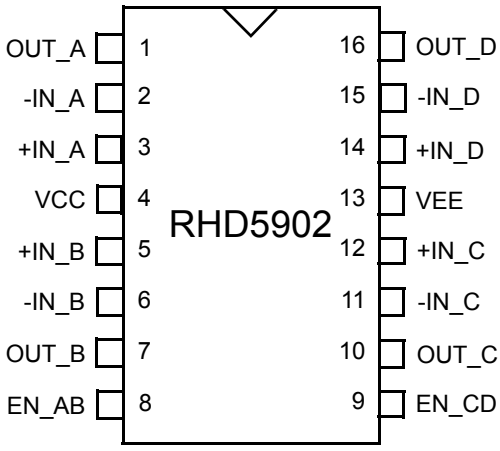



**FIGURE 1: BLOCK DIAGRAM**




**16-Pin SOIC**

**FIGURE 2: PACKAGE PIN-OUT**

Notes:

1. Package and Lid are electrically isolated from signal pads.
2. 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 | Output of Amplifier A. |
| 2 | -IN_A | Inverting input of Amplifier A. |
| 3 | +IN_A | Non-Inverting input of Amplifier A. |
| 4 | VCC | + Voltage Supply. |
| 5 | +IN_B | Non-Inverting input of Amplifier B. |
| 6 | -IN_B | Inverting input of Amplifier B. |
| 7 | OUT_B | Output of Amplifier B. |
| 8 | EN_AB | A Logic Low will disable Amplifiers A & B so that the outputs are high impedance. |
| 9 | EN_CD | A Logic Low will disable Amplifiers C & D so that the outputs are high impedance. |
| 10 | OUT_C | Output of Amplifier C. |
| 11 | -IN_C | Inverting input of Amplifier C. |
| 12 | +IN_C | Non-Inverting input of Amplifier C. |
| 13 | VEE | - Voltage Supply. |
| 14 | +IN_D | Non-Inverting input of Amplifier D. |
| 15 | -IN_D | Inverting input of Amplifier D. |
| 16 | OUT_D | 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<br>VCC - VEE | +6.0 | V |
| Input Voltage | VCC +0.4<br>VEE -0.4 | V |
| Lead Temperature (soldering, 10 seconds) | 300 | °C |
| Thermal Resistance, Junction to Case, Θjc | 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 2/ | VIOST | | | 10 | uV/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 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/uS |

## 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 2/ | AOL | No Load | 100 | | dB |
| Unity Gain Bandwidth 2/ | 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 | ICCQ | All Amplifiers Enabled, No Load | | 5.5 | mA |
| | | All Amplifier Disabled | | 1 | uA |
| Channel Separation 2/ | | RL = 2K, f = 1.0KHz | 90 | | dB |
| Input-Referred Voltage Noise 2/ | $e_n$ | 46 Typical @ F = 5 kHz | | | $nV/\sqrt{Hz}$ |
| Phase Margin 2/ | $\Phi_m$ | | 30 | | Deg |

Notes:

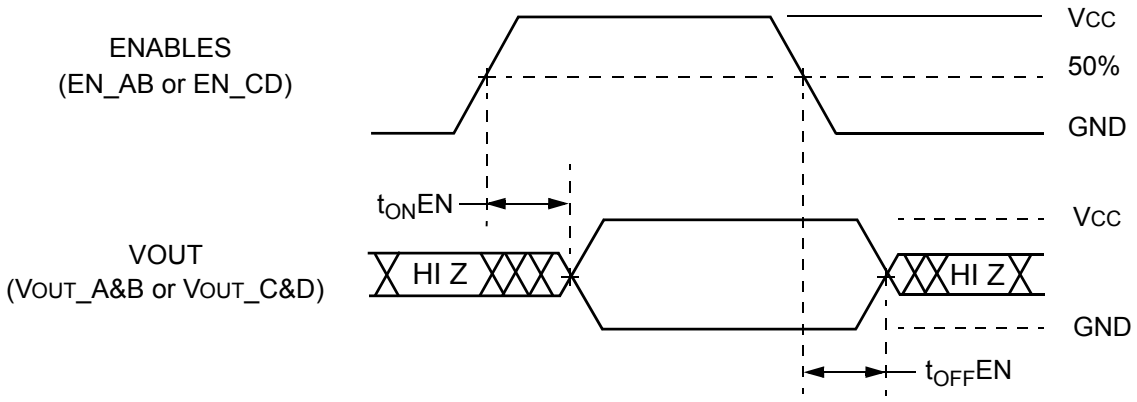
1/ Specification derated to reflect Total Dose exposure to 1 Mrad(Si) @ +25°C.

2/ Not tested. Shall be guaranteed by design, characterization, or correlation to other test parameters.

## SWITCHING CHARACTERISTICS

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

| Parameter | Symbol | Conditions | Min | Max | Units |
|---|---|---|---|---|---|
| Output Delay (Enabled) | $t_{ON}EN$ | | | 100 | ns |
| Output Delay (Disabled) | $t_{OFF}EN$ | | | 100 | ns |



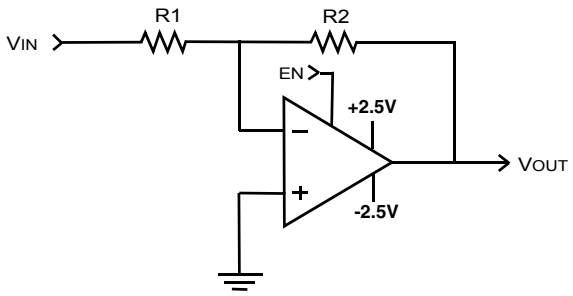

## FIGURE 3: RHD5902 SWITCHING DIAGRAM

# RHD5902 QUAD OPERATIONAL AMPLIFIER APPLICATION NOTES

## APPLICATION NOTE 1: DUAL POWER SUPPLY AMPLIFIER

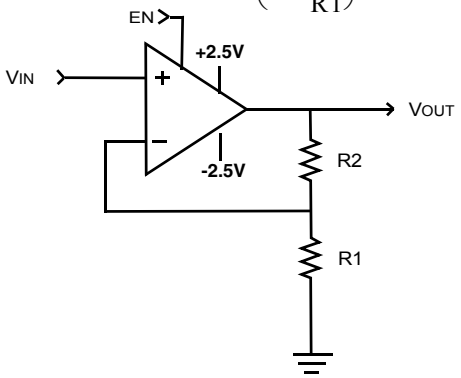
### Inverting Amplifier

$$VOUT = -VIN\left(\frac{R2}{R1}\right)$$




### Non Inverting Amplifier

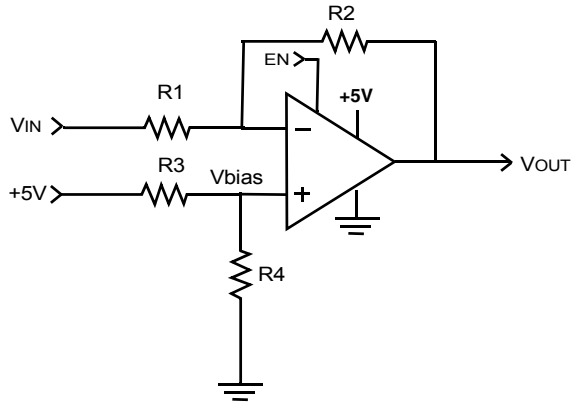
$$VOUT = VIN\left(1 + \frac{R2}{R1}\right)$$




## APPLICATION NOTE 2: SINGLE POWER SUPPLY AMPLIFIER

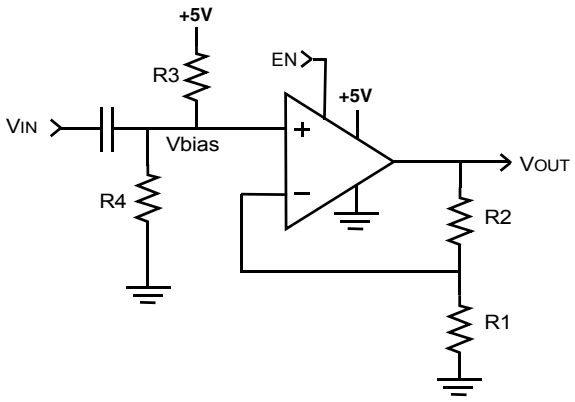
### Inverting Amplifier

$$VOUT = -VIN\left(\frac{R2}{R1}\right)$$




### Non Inverting Amplifier

$$VOUT = VIN\left(1 + \frac{R2}{R1}\right)$$

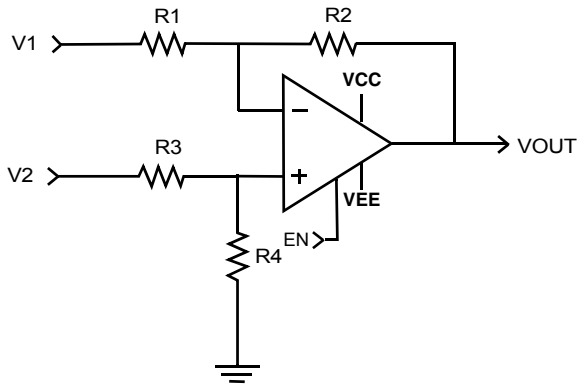



Note: For VOUT DC @ mid range of common mode voltage range, VBIAS = 2.5/(1+R2/R1), VBIAS = +5*R4/(R3+R4)

## APPLICATION NOTE 3: DIFFERENTIAL INPUT AMPLIFIER

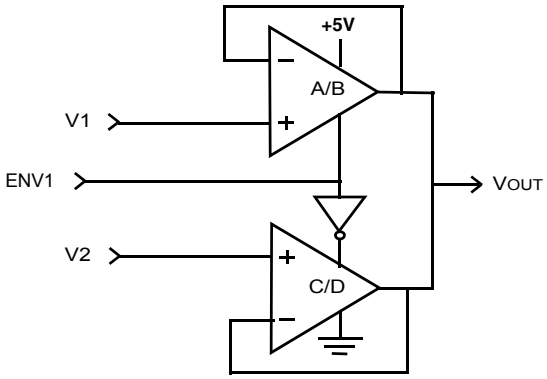
Differential Input Amplifier

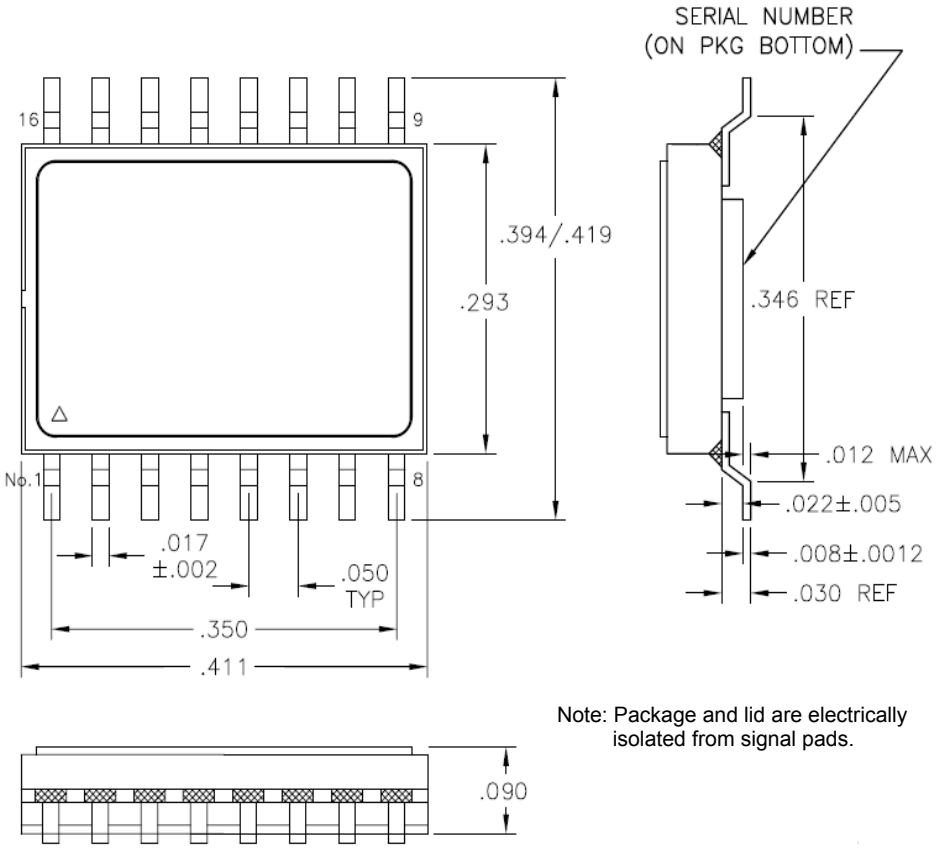
$$VOUT = \left(V2\left(\frac{R4}{R3+R4}\right)\left(1+\frac{R2}{R1}\right)\right) - \left(V1\frac{R2}{R1}\right)$$




## 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 |
|---|---|---|---|
| RHD5902-7 | - | Commercial Flow, +25°C testing only | 16-pin SOIC Package |
| RHD5902-S | - | Military Temperature, -55°C to +125°C Screened in accordance with the individual Test Methods of MIL-STD-883 for Space Applications | |
| RHD5902-201-1S | 5962-1024103KXC | DLA SMD Pending | |
| RHD5902-201-2S | 5962-1024103KXA | | |
| RHD5902-901-1S | 5962H1024103KXC | DLA SMD and Radiation Certification Pending | |
| RHD5902-901-2S | 5962H1024103KXA | | |

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