# Very Low-Noise Quad Operational Amplifier

# OP470

## 1.0 SCOPE

This specification documents the detailed requirements for Analog Devices space qualified die including die qualification as described for Class K in MIL-PRF-38534, Appendix C, Table C-II except as modified herein.

The manufacturing flow described in the STANDARD DIE PRODUCTS PROGRAM brochure at http://www.analog.com/marketSolutions/militaryAerospace/pdf/Die_Broc.pdf is to be considered a part of this specification.

This data sheet 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 www.analog.com/OP470

## 2.0 Part Number. The complete part number(s) of this specification follow:

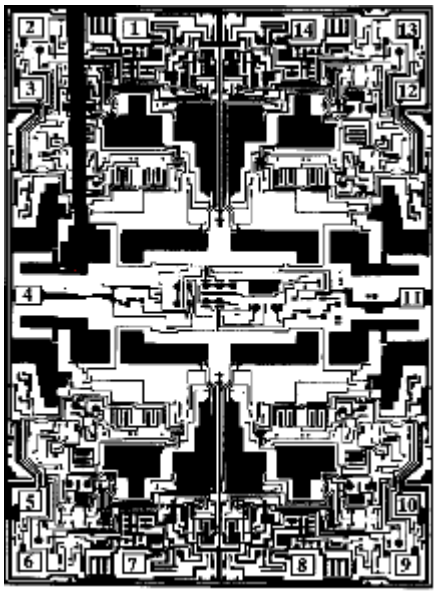
| Part Number | Description |
|---|---|
| OP470-000C | Very Low-Noise Quad Operational Amplifier |
| OP470R000C | Radiation Tested Very Low-Noise Quad Operational Amplifier |

## 3.0 Die Information

### 3.1 Die Dimensions

| Die Size | Die Thickness | Bond Pad Metalization |
|---|---|---|
| 106 mil x 163 mil | 19 mil ± 2 mil | Al/Cu |

### 3.2 Die Picture



1. OUT A
2. -IN A
3. +IN A
4. $+V_{CC}$
5. +IN B
6. -IN B
7. OUT B
8. OUT C
9. -IN C
10. +IN C
11. $-V_{CC}$
12. +IN D
13. -IN D




One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106, U.S.A.
Tel: 781.329.4700 www.analog.com
Fax: 781.326.8703 

### 3.3 Absolute Maximum Ratings 1/

| | |
|---|---|
| Supply Voltage ($V_{CC}$) | ±18V dc |
| Differential Input Voltage 2/ | ±1V dc |
| Differential Input Current 2/ | ±25mA |
| Input Voltage | Supply Voltage |
| Output Short Circuit Duration | Continuous |
| Storage Temperature Range | -65°C to +150°C |
| Ambient Operating Temperature Range | -55°C to +125°C |
| Junction Temperature ($T_J$) | +150°C |

Absolute Maximum Ratings Notes:

1/ Stresses above the absolute maximum rating may cause permanent damage to the device. Extended operation at the maximum levels may degrade performance and affect reliability.

2/ The inputs are protected by back-to-back diodes. Current limiting resistors are not used in order to achieve low noise performance. If the differential input voltage exceeds ±1V, the input current should be limited to ±25mA.

### 4.0 Die Qualification

In accordance with class-K version of MIL-PRF-38534, Appendix C, Table C-II, except as modified herein.

(a) Qual Sample Size and Qual Acceptance Criteria – 10/0

(b) Qual Sample Package – DIP

(c) Pre-screen electrical test over temperature performed post-assembly prior to die qualification.

**Table I - Dice Electrical Characteristics**

| Parameter | Symbol | Conditions 1/ | Limit Min | Limit Max | Units |
|---|---|---|---|---|---|
| Input Offset Voltage | $V_{IO}$ | | | ±0.4 | mV |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V | | ±10 | nA |
| Input Bias Current | $I_{IB}$ | $V_{CM}$ = 0V | | ±25 | nA |
| Large-Signal Voltage Gain | $A_{VS}$ | $V_O$ = ±10V, $R_L$ = 10kΩ | 1000 | | V/mV |
| | | $V_O$ = ±10V, $R_L$ = 2kΩ | 500 | | |
| Output Voltage Swing | $V_{OP}$ | $R_L$ = 2kΩ | ±12 | | V |
| Supply Current 2/ | $I_S$ | No Load | | 11 | mA |
| Input Voltage Range | IVR | | ±11 | | V |
| Common-Mode Rejection | CMR | $V_{CM}$ = IVR | 110 | | dB |
| Power Supply Rejection Ratio | PSRR | $V_{CC}$ = ±4.5V to ±18V | | 1.8 | μV/V |

Table I Notes:

1/ $V_{CC}$ = ±15V, $R_S$ = 50Ω, and $T_A$ = +25°C, unless otherwise specified.

2/ $I_S$ limit equals the total of all amplifiers.

| Table II - Electrical Characteristics for Qual Samples | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Conditions 1/** | **Sub-groups** | **Limit Min** | **Limit Max** | **Units** |
| Input Offset Voltage | $V_{IO}$ | | 1 | | ±0.4 | mV |
| | | | 2, 3 | | ±0.6 | |
| | | M, D, L. R 3/ | 1 | | ±0.6 | |
| Input Offset Current | $I_{IO}$ | $V_{CM}$ = 0V | 1 | | ±10 | nA |
| | | | 2, 3 | | ±20 | |
| | | M, D, L. R 3/ | 1 | | ±50 | |
| Input Bias Current | $I_{IB}$ | $V_{CM}$ = 0V | 1 | | ±25 | |
| | | | 2, 3 | | ±50 | |
| | | M, D, L. R 3/ | 1 | | ±500 | |
| Large-Signal Voltage Gain | $A_{VS}$ | $V_O$ = ±10V, $R_L$ = 10kΩ | 4 | 1000 | | V/mV |
| | | | 5, 6 | 750 | | |
| | | M, D, L. R 3/ | 4 | 100 | | |
| | | $V_O$ = ±10V, $R_L$ = 2kΩ | 4 | 500 | | |
| | | | 5, 6 | 400 | | |
| Output Voltage Swing 4/ | $V_{OP}$ | $R_L$ = 2kΩ | 4, 5, 6 | ±12 | | V |
| Supply Current 2/ | $I_S$ | No Load | 1, 2, 3 | | 11 | mA |
| | | M, D, L. R 3/ | 1 | | 11 | |
| Slew Rate 4/ | SR | $A_{VCL}$ = ±21, $R_L$ = 10kΩ | 7 | 1.4 | | V/µs |
| Input Voltage Range 4/ | IVR | | 1, 2, 3 | ±11 | | V |
| Common-Mode Rejection 4/ | CMR | $V_{CM}$ = IVR | 1 | 110 | | dB |
| | | | 2, 3 | 100 | | |
| Power Supply Rejection Ratio 4/ | PSRR | $V_{CC}$ = ±4.5V to ±18V | 1 | | 1.8 | µV/V |
| | | | 2, 3 | | 5.6 | |

Table II Notes:

1/ $V_{CC}$ = ±15V, $R_S$ = 50Ω, unless otherwise specified.
2/ $I_S$ limit equals the total for all amplifiers.
3/ Devices tested at 100Krad irradiation.
4/ Parameter not tested post irradiation.

| Table III - Life Test Endpoint and Delta Parameter (Product is tested in accordance with Table II with the following exceptions) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | Symbol | Sub-groups | Post Burn In Limit | | Post Life Test Limit | | Life Test Delta | Units |
| | | | Min | Max | Min | Max | | |
| Input Offset Voltage | $V_{IO}$ | 1 | | ±0.4 | | ±0.5 | 0.1 | mV |
| | | 2, 3 | | ±0.6 | | ±0.8 | | |
| Input Bias Current | $I_{IB}$ | 1 | | ±25 | | ±30 | 5 | nA |
| | | 2, 3 | | ±50 | | ±60 | | |
| Input Offset Current | $I_{IO}$ | 1 | | ±10 | | ±20 | | nA |
| | | 2, 3 | | ±20 | | ±40 | | |

## 5.0 Life Test/Burn-In Information

5.1 HTRB is not applicable for this drawing.
5.2 Burn-in is per MIL-STD-883 Method 1015 test condition B or C.
5.3 Steady state life test is per MIL-STD-883 Method 1005.

| Rev | Description of Change | Date |
|---|---|---|
| A | Initiate | 20-DEC-01 |
| B | Update web address. Add radiation part number and limits. | 17-APR-03 |
| C | Corrected Die Pad Numbering | 11-Apr-07 |
| D | Update 1.0 Scope description. | 8-Aug-07 |
| E | Update header/footer & add to 1.0 Scope description. | Mar. 3, 2008 |
| F | Add Junction Temperature ($T_J$)...+150°C to 3.3 Absolute Maximum Ratings | April 3, 2008 |
| G | Updated Section 4.0c note to indicate pre-screen temp testing being performed | 6-JUN-2009 |
| H | Updated fonts and sizes to ADI standards | 3-Oct-2011 |
| | | |