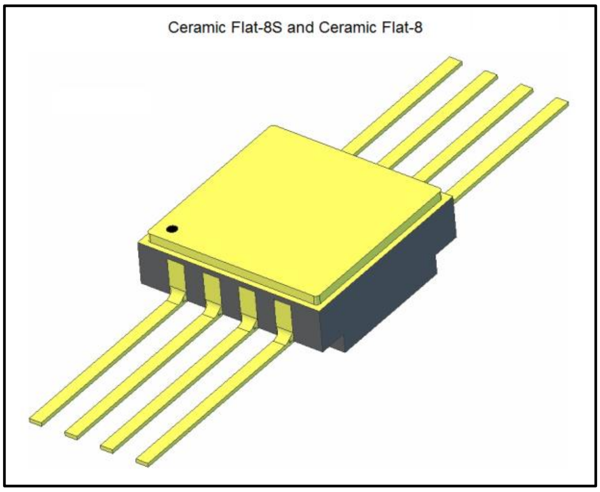
RHF330, RHF330A

Rad-hard 1 GHz low noise operational amplifier

Datasheet - production data



Ceramic Flat-8S and Ceramic Flat-8

Features

- Bandwidth: 1 GHz (gain = 2)
- Slew rate: 1800 V/µs
- Input noise: 1.3 nV/√ Hz
- Distortion: SFDR = -78 dBc (10 MHz, 2 V_{pp})
- 100 Ω load optimized output stage
- 5 V power supply
- ELDRS free up to 300 krad
- SEL immune at 110 MeV.cm^2/mg
- SET characterized

Applications

- Space data acquisition systems
- Aerospace instrumentation
- Nuclear and high energy physics
- Harsh environments
- ADC drivers

Description

The RHF330, RHF330A device is a current feedback, single operational amplifier that uses very high-speed complementary technology to provide a large bandwidth of 1 GHz in gains of 2 while drawing only 16.6 mA of quiescent current. The RHF330, RHF330A also offers 0.1 dB gain flatness up to 160 MHz with a gain of 2. With a slew rate of 1800 V/µs and an output stage optimized for standard 100 Ω loads, this device is highly suitable for applications where speed and low distortion are the main requirements. The RHF330 is mounted in a Flat-8 hermetic package with 3 mm leads (Flat-8S) while the RHF330A is mounted in a Flat-8 hermetic package with 8 mm leads (Flat-8).

Table 1: Device summary

Parameter	RHF330K1	RHF330K-01V	RHF330AK1	RHF330AK01V
SMD (1)	—	5962F07231	—	5962F07231
Quality level	Engineering model	QML-V flight	Engineering model	QML-V flight
Package Mass	Flat-8S 0.45 g		Flat-8, 0.45 g	
EPPL(2)	—	Yes	—	Yes
Temp. range	-55 °C to 125 °C			

Notes:

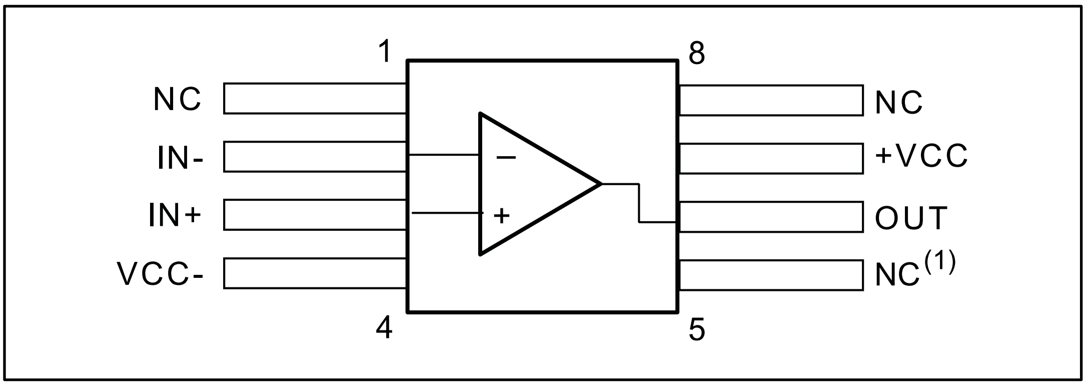
(1)SMD: standard microcircuit drawing

(2)EPPL = European preferred part list

Contents

1 Pin description

Figure 1: Pin connections of Ceramic Flat-8S and Ceramic Flat-8 (top view)



1. In the case of the Ceramic Flat-8, the upper metallic lid is electrically connected to pin 5

2 Absolute maximum ratings and operating conditions

Table 2: Absolute maximum ratings

Symbol	Parameter		Value	Unit
V_{CC}	Supply voltage (voltage difference between -Vcc and Vcc pins) (1)		6	V
V_{id}	Differential input voltage (2)		±0.5	
V_{in}	Input voltage range (3)		±2.5	
T_{stg}	Storage temperature		-65 to 150	°C
T_j	Maximum junction temperature		150	
R_{thja}	Thermal resistance junction to ambient area		150	°C/W
R_{thjc}	Thermal resistance junction to case		22	
P_{max}	Maximum power dissipation (4) (at T_{amb} = 25 °C) for T_j = 150 °C		830	mW
ESD	HBM: human body model (5)	Pins 1, 4, 5, 6, 7 and 8	2	kV
		Pins 2 and 3	0.6	
	MM: machine model (6)	Pins 1, 4, 5, 6, 7 and 8	200	V
		Pins 2 and 3	80	
	CDM: charged device model (7)	Pins 1, 4, 5, 6, 7 and 8	1.5	kV
		Pins 2 and 3	1	
	Latch-up immunity		200	mA

Notes:

(1)All voltage values are measured with respect to the ground pin.

(2)The differential voltage is the non-inverting input terminal with respect to the inverting input terminal.

(3)The magnitude of the input and output voltages must never exceed V_{CC} + 0.3 V.

(4)Short-circuits can cause excessive heating. Destructive dissipation can result from short-circuits on all amplifiers.

(5)Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.

(6)This is a minimum value. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.

(7)Charged device model: all pins and package(s) are charged together to the specified voltage and then discharged directly to ground through only one pin.

Table 3: Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	4.5 to 5.5	V
V_{icm}	Common-mode input voltage	$(-V_{CC}) + 1.5$ to $(V_{CC}) - 1.5$	
T_{amb}	Operating free-air temperature range (1)	-55 to 125	°C

Notes:

(1)Tj must never exceed 150 °C. $P = (T_j - T_{amb} / R_{thja} = (T_j - T_{case}) / R_{thjc}$ where P is the power that the RHF330, RHF330A must dissipate in the application.

3 Electrical characteristics

Table 4: Electrical characteristics for V_{CC} = ±2.5 V, T_{amb} = 25 °C (unless otherwise specified)

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
DC performance							
V_{io}	Input offset voltage		125 °C	-3.1		3.1	mV
			25 °C	-3.1	0.18	3.1	
			-55 °C	-3.1		3.1	
I_{ib+}	Non-inverting input bias current		125 °C			55	µA
			25 °C		26	55	
			-55 °C			55	
I_{ib-}	Inverting input bias current		125 °C			34	
			25 °C		7	22	
			-55 °C			34	
CMR	Common mode rejection ratio, 20 log ($\Delta V_{ic}/\Delta V_{io}$)	ΔV_{ic} = ±1 V	125 °C	48			dB
			25 °C	48	54		
			-55 °C	48			
SVR	Supply voltage rejection ratio, 20 log ($\Delta V_{CC}/\Delta V_{out}$)	ΔV_{CC} = 3.5 V to 5 V	125 °C	45			
			25 °C	60	74		
			-55 °C	45			
PSRR	Power supply rejection ratio, 20 log ($\Delta V_{CC}/\Delta V_{out}$)	ΔV_{CC} = 200 mV_{pp} at 1 kHz	25 °C		56		
I_{CC}	Supply current	No load	125 °C			20.2	mA
			25 °C		16.6	20.2	
			-55 °C			20.2	
Dynamic performance and output characteristics							
R_{OL}	Transimpedance	ΔV_{out} = ±1 V, R_L = 100 Ω	125 °C	85			kΩ
			25 °C	104	153		
			-55 °C	85			
Bw	-3 dB bandwidth	V_{out} = 20 mV_{pp}, R_L = 100 Ω, A_V = 2	25 °C		1000		MHz
		RHF330, R_L = 100 Ω, A_V = -4	125 °C	400			
			25 °C	400	630		
			-55 °C	400			
		RHF330A, R_L = 100 Ω, A_V = -4	25 °C		630		
	Gain flatness at 0.1 dB	V_{out} = 20 mV_{pp}, R_L = 100 Ω, A_V = 2	25 °C		160		
SR	Slew rate (1)	V_{out} = 2 V_{pp}, A_V = 2, R_L = 100 Ω	25 °C		1800		V/µs

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
V_{OH}	High level output voltage	R_L = 100 Ω	125 °C	1.35			V
			25 °C	1.5	1.64		
			-55 °C	1.35			
V_{OL}	Low level output voltage	R_L = 100 Ω	125 °C			-1.35	
			25 °C		-1.55	-1.5	
			-55 °C			-1.35	
I_{out}	I_{sink}	Output to GND	125 °C	360			mA
			25 °C	360	453		
			-55 °C	360			
	I_{source}	Output to GND	125 °C	-320			
			25 °C	-320	-400		
			-55 °C	-320			
Noise and distortion							
eN	Equivalent input noise voltage *(2)*	F = 100 kHz	25 °C		1.3		nV/ √Hz
iN	Equivalent positive input noise current *(1)*	F = 100 kHz	25 °C		22		pA/ √Hz
	Equivalent negative input noise current *(1)*	F = 100 kHz	25 °C		16		
SFDR	Spurious free dynamic range	A_V = 2, V_{out} = 2 V_{pp}, R_L = 100 Ω, F = 10 MHz	25 °C		-78		dBc
		A_V = 2, V_{out} = 2 V_{pp}, R_L = 100 Ω, F = 20 MHz	25 °C		-73		
		A_V = 2, V_{out} = 2 V_{pp}, R_L = 100 Ω, F = 100 MHz	25 °C		-48		
		A_V = 2, V_{out} = 2 V_{pp}, R_L = 100 Ω, F = 150 MHz	25 °C		-37		

Notes:

(1) Guaranteed by characterization of initial design release and upon design or process changes which affect this parameter.

(2) See *Section 6.2: "Noise measurements"*

Table 5: Closed-loop gain and feedback components

Gain (V/V)	1	-1	2	-2	4	-4	10	-10
R_{fb} (Ω)	300	270	300	270	240	240	200	200

4 Electrical characteristic curves

Figure 2: Frequency response, positive gain

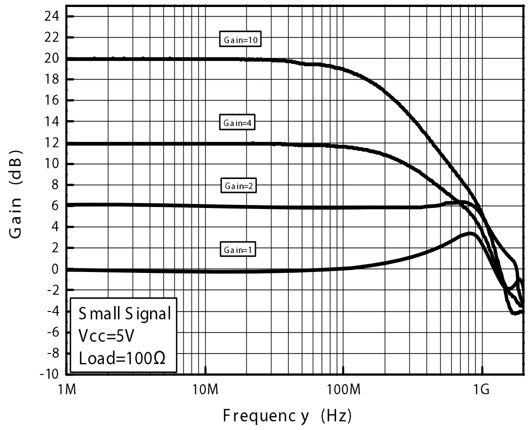


Figure 3: Flatness, gain = 2 compensated

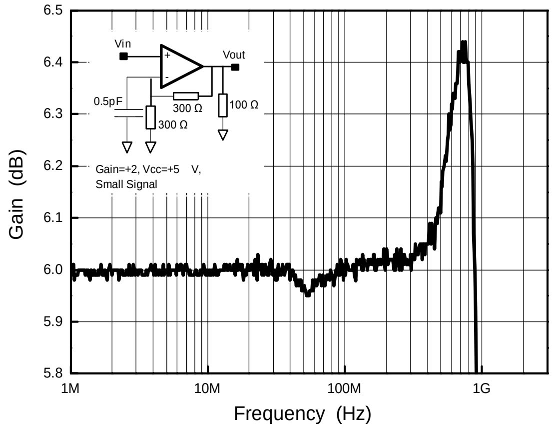


Figure 4: Flatness, gain = 4 compensated

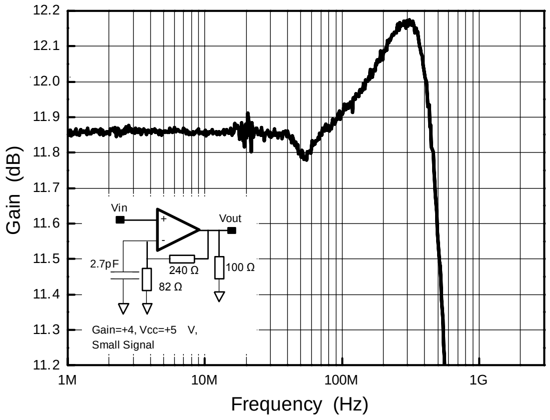


Figure 5: Flatness, gain = 10 compensated

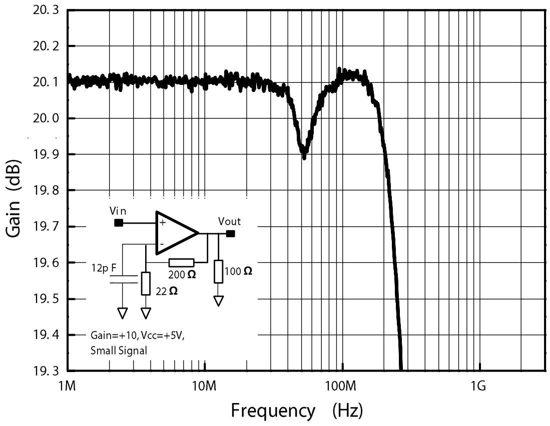


Figure 6: Quiescent current vs. VCC

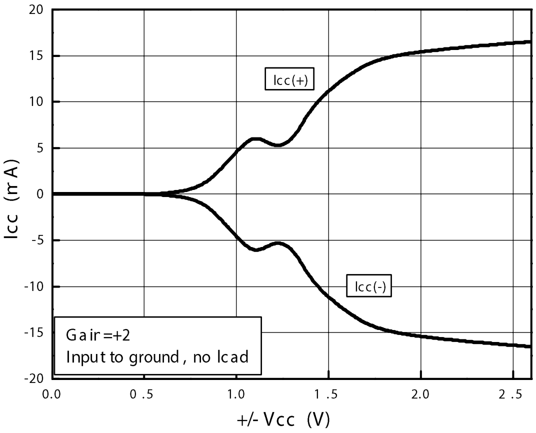


Figure 7: Positive slew rate

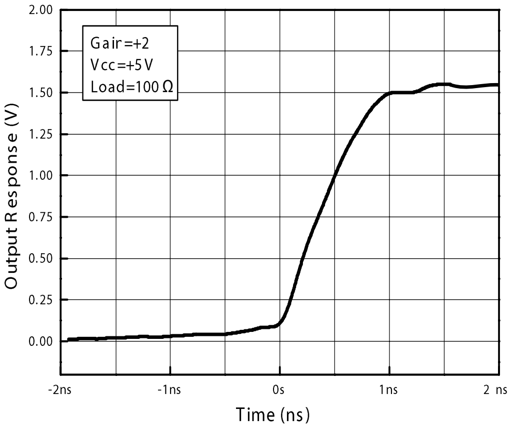


Figure 8: Negative slew rate

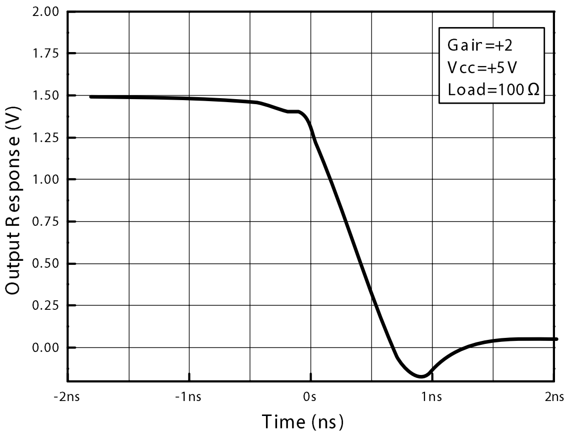


Figure 9: Output amplitude vs. load

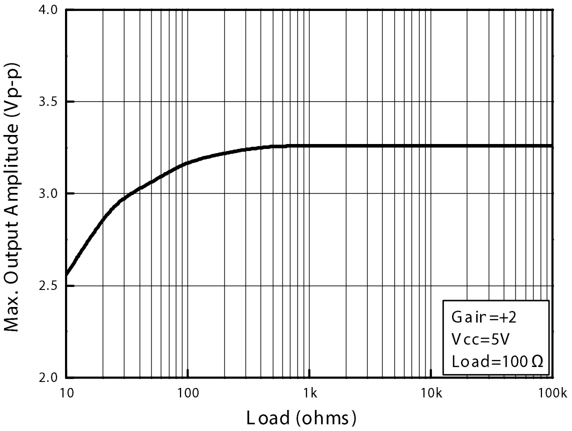


Figure 10: Distortion vs. amplitude

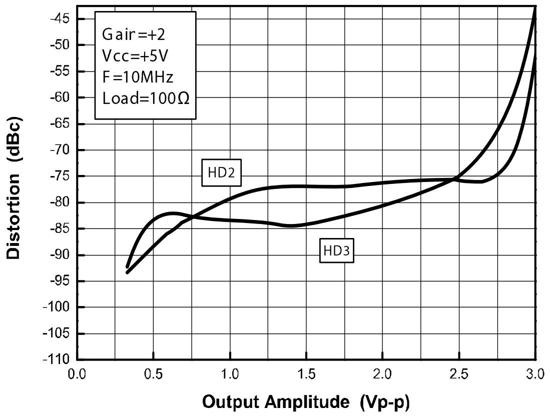


Figure 11: I_{source}

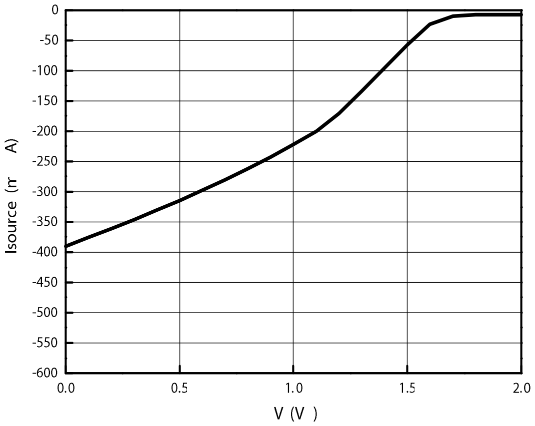


Figure 12: I_{sink}

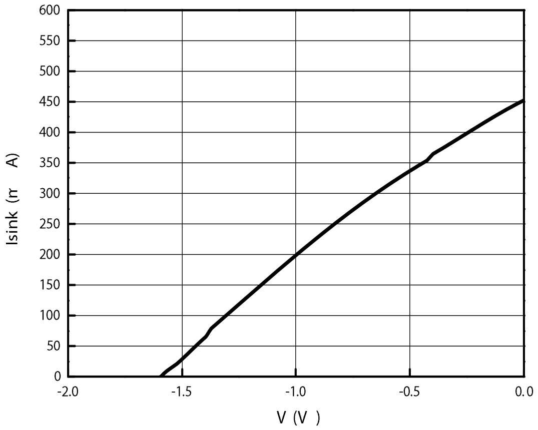


Figure 13: Noise figure

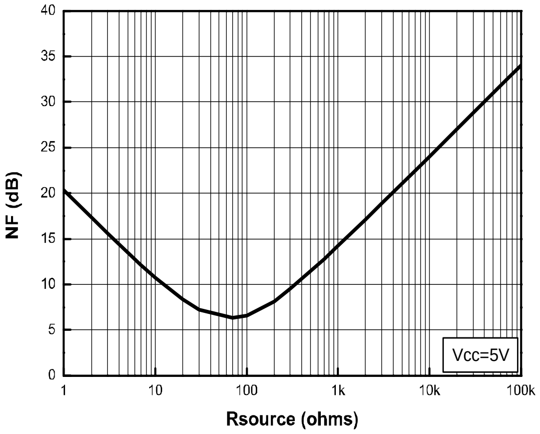


Figure 14: Input current noise vs. frequency

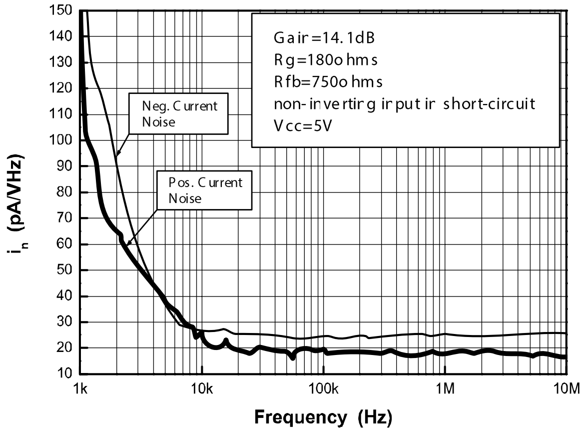


Figure 15: Input voltage noise vs. frequency

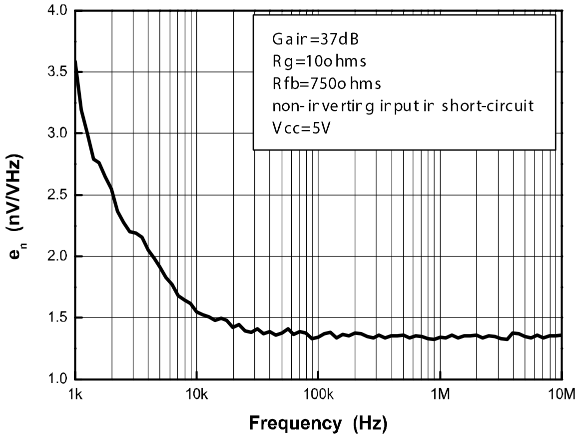


Figure 16: Reverse isolation vs. frequency

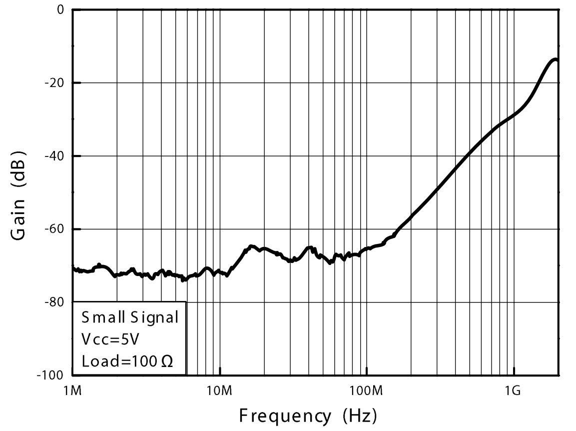


Figure 17: I_{out} vs. temperature

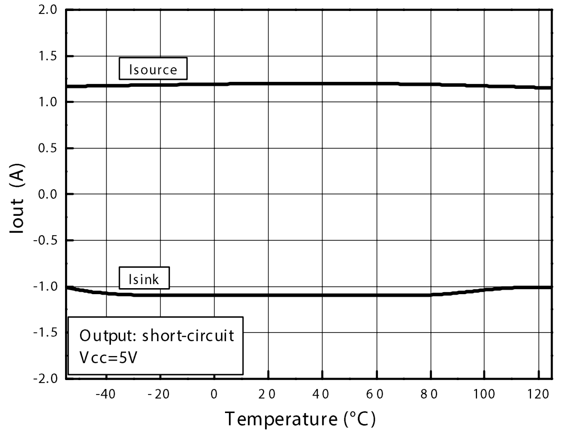


Figure 18: CMR vs. temperature

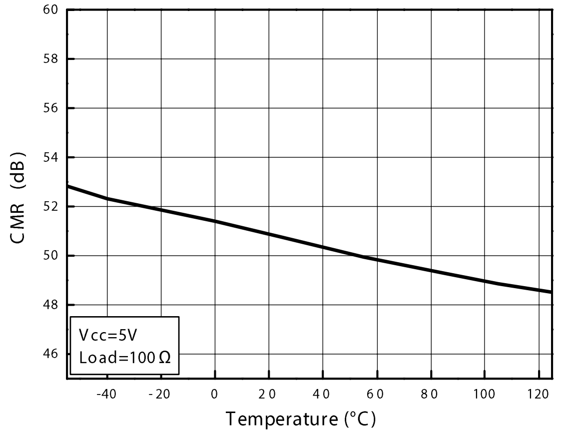


Figure 19: SVR vs. temperature

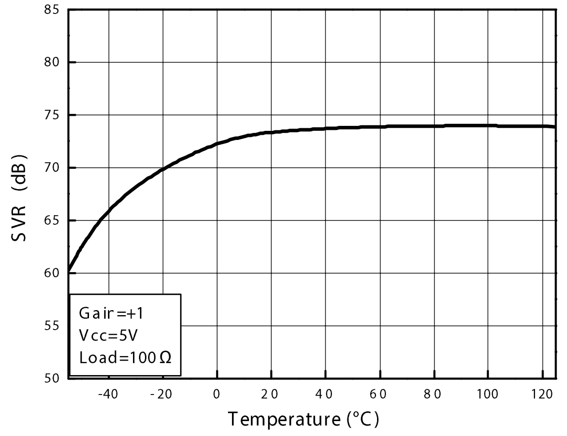


Figure 20: R_{OL} vs. temperature

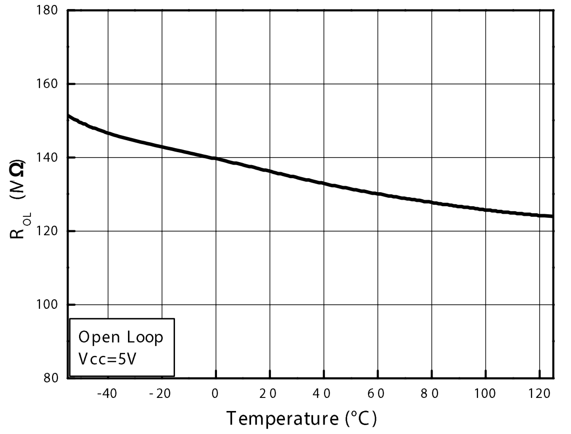


Figure 21: V_{OH} and V_{OL} vs. temperature

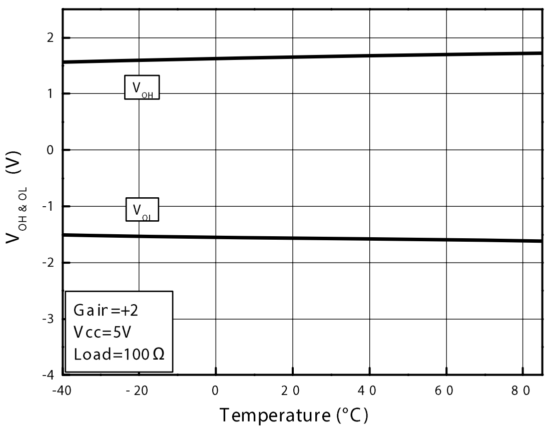


Figure 22: I_{bias} vs. temperature

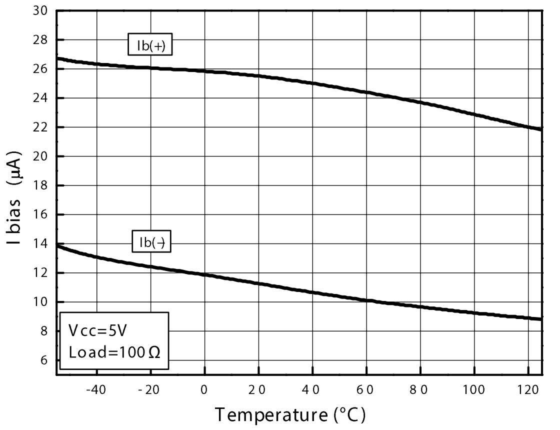


Figure 23: I_{CC} vs. temperature

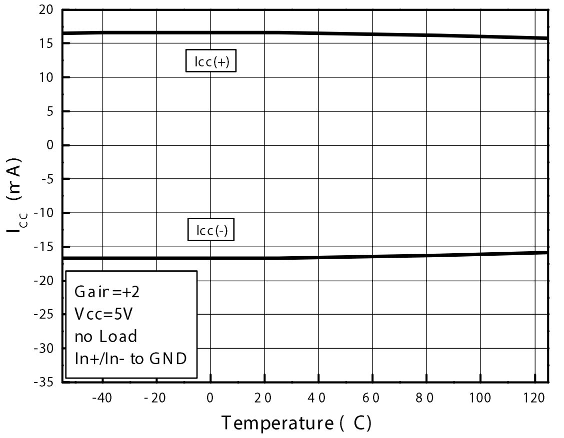
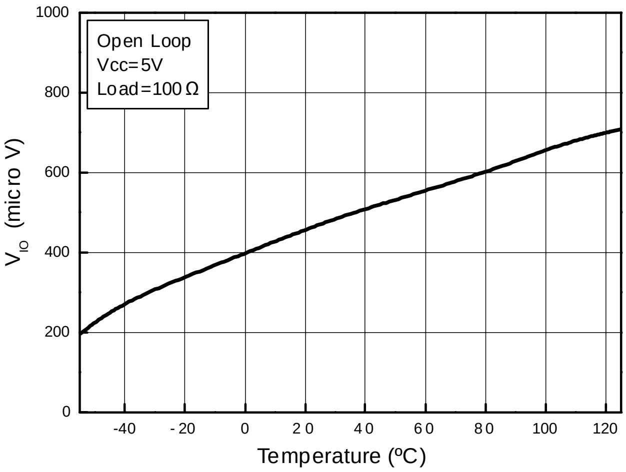


Figure 24: V_{io} vs. temperature



5 Radiations

5.1 Introduction

Table 6 summarizes the radiation performance of the RHF330, RHF330A.

Table 6: Radiations

Type	Features		Value	Unit
TID	High-dose rate		300	krad
	Low-dose rate		300	
	ELDRS		300	
Heavy ions	SEL immunity (at 125 °C) up to:		110	MeV.cm^2/mg
	SET characterized	Inverting	LET$_{th}$ = 19	MeV.cm^2/mg
			σ = 4.00E-06	cm^2/device
		Non-inverting	LET$_{th}$ = 18	MeV.cm^2/mg
			σ = 2.00E-06	cm^2/device
		Subtracting	LET$_{th}$ = 1	MeV.cm^2/mg
			σ = 6.00E-04	cm^2/device

5.2 Total ionizing dose (TID)

The products guaranteed in radiation within the RHA QML-V system fully comply with the MIL-STD-883 test method 1019 specification.

The RHF330, RHF330A is RHA QML-V qualified, and is tested and characterized in full compliance with the MIL-STD-883 specification. It uses a mixed bipolar and CMOS technology and is tested both below 10 mrad/s (low dose rate) and between 50 and 300 rad/s (high dose rate).

- The ELDRS characterization is performed in qualification only on both biased and unbiased parts, on a sample of ten units from two different wafer lots.
- Each wafer lot is tested at high-dose rate only, in the worst bias case condition, based on the results obtained during the initial qualification.

5.3 Heavy ions

The heavy ion trials are performed on qualification lots only. No additional test is performed.

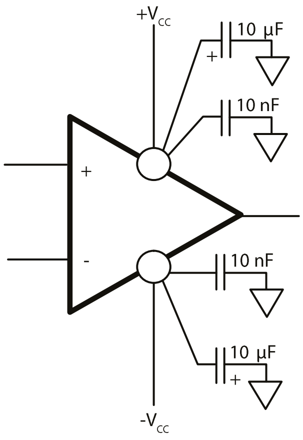
6 Device description and operation

6.1 Power supply considerations

Correct power supply bypassing is very important for optimizing the performance of the device in high-frequency ranges. The bypass capacitors should be placed as close as possible to the IC pins to improve high-frequency bypassing. A capacitor greater than 1 µF is necessary to minimize the distortion. For better quality bypassing, a capacitor of 10 nF can be added, which should also be placed as close as possible to the IC pins. The bypass capacitors must be incorporated for both the negative and positive supply.

For example, on the RHF3xx single op amp demonstration board, these capacitors are C6, C7, C8, and C9.

Figure 25: Circuit for power supply bypassing



6.1.1 Single power supply

If you use a single-supply system, biasing is necessary to obtain a positive output dynamic range between the 0 V and V_{CC} supply rails. Considering the values of V_{OH} and V_{OL}, the amplifier provides an output swing from 0.9 V to 4.1 V on a 100 Ω load.

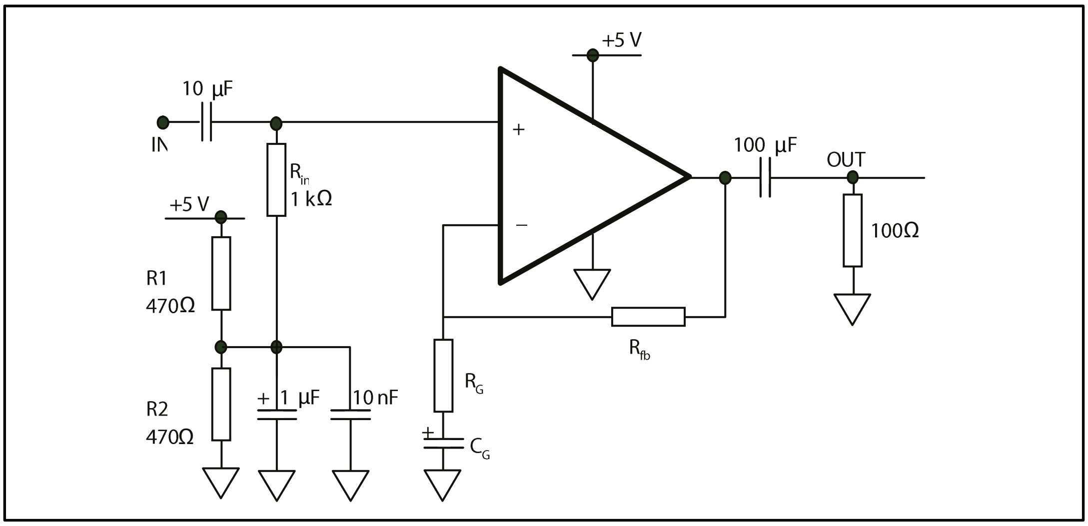
The amplifier must be biased with a mid-supply (nominally $V_{CC}/2$) in order to maintain the DC component of the signal at this value. Several options are possible to provide this bias supply, such as a virtual ground using an operational amplifier or a two-resistance divider (which is the cheapest solution). A high resistance value is required to limit the current consumption. On the other hand, the current must be high enough to bias the non-inverting input of the amplifier. If we consider this bias current (55 µA maximum) as 1 % of the current through the resistance divider, two resistances of 470 Ω can be used to maintain a mid-supply.

The input provides a high-pass filter with a break frequency below 10 Hz, which is necessary to remove the original 0 V DC component of the input signal and to set it at $V_{CC}/2$.

Figure 26 illustrates a 5 V single power supply configuration for the RHF3xx single op amp demonstration board.

A capacitor C_G is added in the gain network to ensure a unity gain at low frequencies to keep the right DC component at the output. C_G contributes to a high-pass filter with $R_{fb}//R_G$ and its value is calculated with regard to the cut-off frequency of this low-pass filter.

Figure 26: Circuit for 5 V single supply

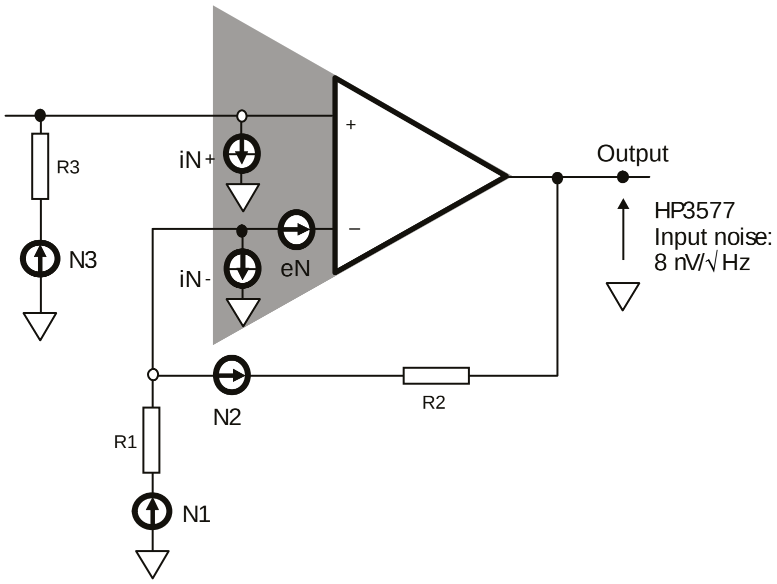


6.2 Noise measurements

The noise model is shown in *Figure 27*.

- eN: input voltage noise of the amplifier
- iNn: negative input current noise of the amplifier
- iNp: positive input current noise of the amplifier

Figure 27: Noise model



The thermal noise of a resistance R is:

$$\sqrt{4kTR\Delta F}$$

Where ΔF is the specified bandwidth, and k is the Boltzmann's constant, equal to 1,374.10-23J/°K. T is the temperature (°K).

On a 1 Hz bandwidth the thermal noise is reduced to:

$$\sqrt{4kTR}$$

The output noise eNo is calculated using the superposition theorem. However, eNo is not the simple sum of all noise sources but rather the square root of the sum of the square of each noise source, as shown in *Equation 1*.

Equation 1

$$eNo = \sqrt{V1^2 + V2^2 + V3^2 + V4^2 + V5^2 + V6^2}$$

Equation 2

$$eNo^2 = eN^2 \cdot \ g^2 + iNn^2 \cdot \ R2^2 + iNp^2 \cdot \ R3^2 \cdot \ g^2 + \frac{R2^2}{R1} \cdot \ 4kTR1 + 4kTR2 + 1 \quad \frac{R2^2}{R1} \cdot \ 4kTR3$$

The input noise of the instrumentation must be extracted from the measured noise value. The real output noise value of the driver is shown in *Equation 3*.

Equation 3

$$eNo = \sqrt{(\text{Measured})^2 - (\text{instrumentation})^2}$$

The input noise is called **equivalent input noise** because it is not directly measured but is evaluated from the measurement of the output divided by the closed loop gain (eNo/g).

After simplification of the fourth and fifth terms of *Equation 2*, you obtain *Equation 4*.

Equation 4

$$eNo^2 = eN^2 \cdot \ g^2 + iNn^2 \cdot \ R2^2 + iNp^2 \cdot \ R3^2 \cdot \ g^2 + g \cdot \ 4kTR2 + 1 \quad \frac{R2^2}{R1} \cdot \ 4kTR3$$

6.2.1 Measurement of the input voltage noise eN

Assuming a short-circuit on the non-inverting input (R3 = 0), from *Equation 4* you can derive *Equation 5*.

Equation 5

$$eNo = \sqrt{eN^2 \cdot \ g^2 + iNn^2 \cdot \ R2^2 + g \cdot \ 4kTR2}$$

To easily extract the value of eN, the resistance R2 must be as low as possible. On the other hand, the gain must be high enough. R3 = 0 and gain (g) = 100.

6.2.2 Measurement of the negative input current noise iNn

To measure the negative input current noise iNn, R3 is set to zero and *Equation 5* is used. This time, the gain must be lower in order to decrease the thermal noise contribution. R3 = 0 and gain (g) = 10.

6.2.3 Measurement of the positive input current noise iNp

To extract iNp from *Equation 3*, a resistance R3 is connected to the non-inverting input. The value of R3 must be selected so that its thermal noise contribution is as low as possible against the iNp contribution. R3 = 100 Ω and gain (g) = 10.

6.3 Intermodulation distortion product

The non-ideal output of the amplifier can be described by the following series of equations.

$$V_{out} = C_0 + C_1 V_{in} + C_2 V^2{}_{in} + \ldots + C_n V^n{}_{in}$$

Where the input is $V_{in} = A\sin\omega t$, C_0 is the DC component, $C_1(V_{in})$ is the fundamental and C_n is the amplitude of the harmonics of the output signal V_{out}.

A one-frequency (one-tone) input signal contributes to harmonic distortion. A two-tone input signal contributes to harmonic distortion and to the intermodulation product.

The study of the intermodulation and distortion for a two-tone input signal is the first step in characterizing the driving capability of multi-tone input signals.

In this case:

$$V_{in} = A\sin\omega_1 t + A\sin\omega_2 t$$

Therefore:

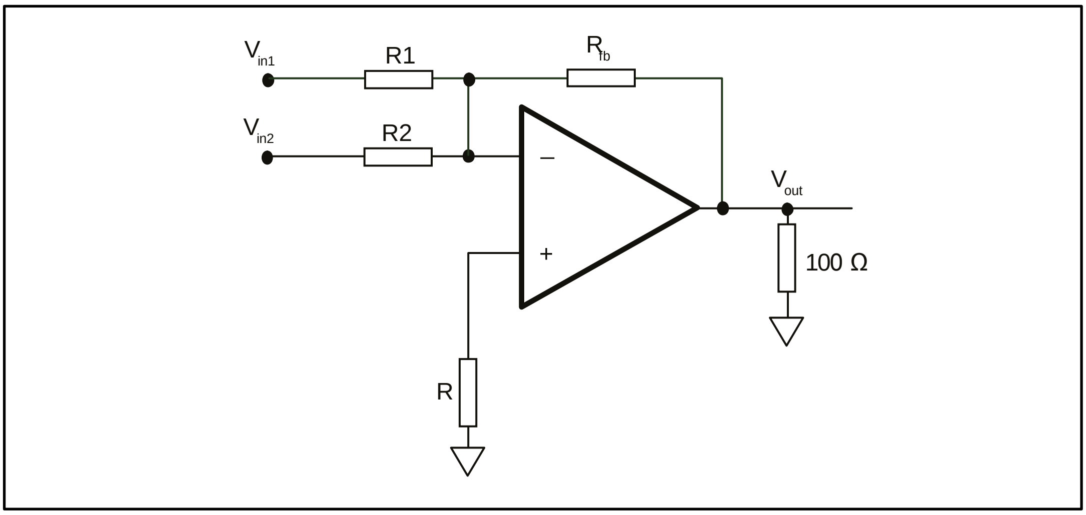
$$V_{out} = C_0 + C_1 (A\sin\omega_1 t + A\sin\omega_2 t) + C_2 (A\sin\omega_1 t + A\sin\omega_2 t)^2 \quad + C_n (A\sin\omega_1 t + A\sin\omega_2 t)^n$$

From this expression, we can extract the distortion terms and the intermodulation terms from a single sine wave.

- Second-order intermodulation terms IM2 by the frequencies $(\omega_1-\omega_2)$ and $(\omega_1+\omega_2)$ with an amplitude of $C2A^2$.
- Third-order intermodulation terms IM3 by the frequencies $(2\omega_1-\omega_2)$, $(2\omega_1+\omega_2)$, $(-\omega_1+2\omega_2)$ and $(\omega_1+2\omega_2)$ with an amplitude of $(3/4)C3A^3$.

The intermodulation product of the driver is measured by using the driver as a mixer in a summing amplifier configuration (*Figure 28*). In this way, the non-linearity problem of an external mixing device is avoided.

Figure 28: Inverting summing amplifier



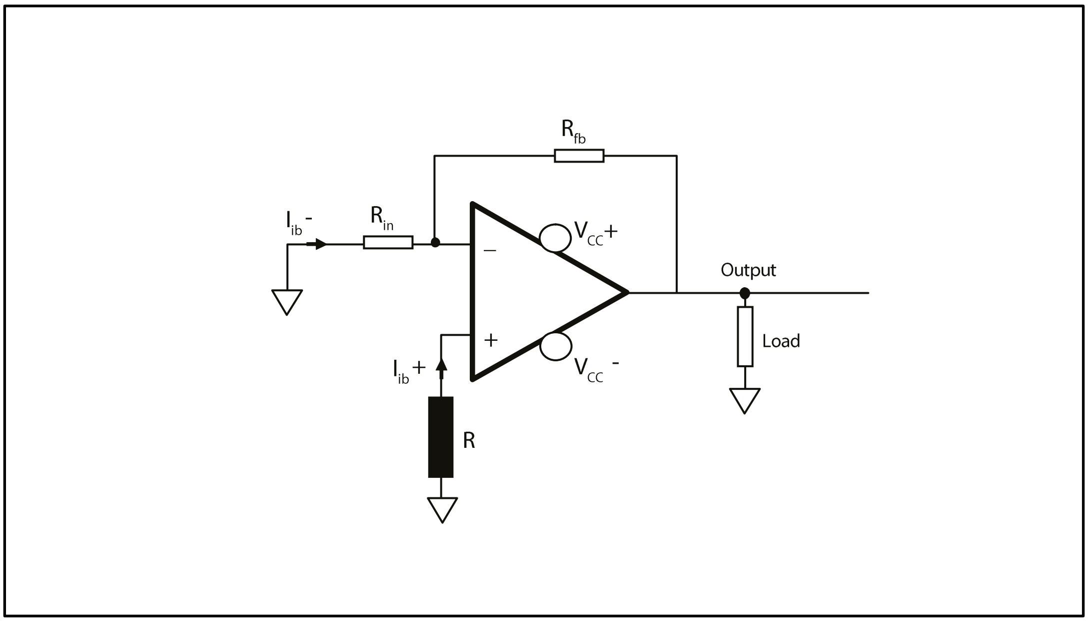
6.4 Bias of an inverting amplifier

A resistance is necessary to achieve good input biasing, such as resistance R shown in *Figure 29*.

The value of this resistance is calculated from the negative and positive input bias current. The aim is to compensate for the offset bias current, which can affect the input offset voltage and the output DC component. Assuming I_{ib-}, I_{ib+}, R_{in}, R_{fb} and a 0 V output, the resistance R is:

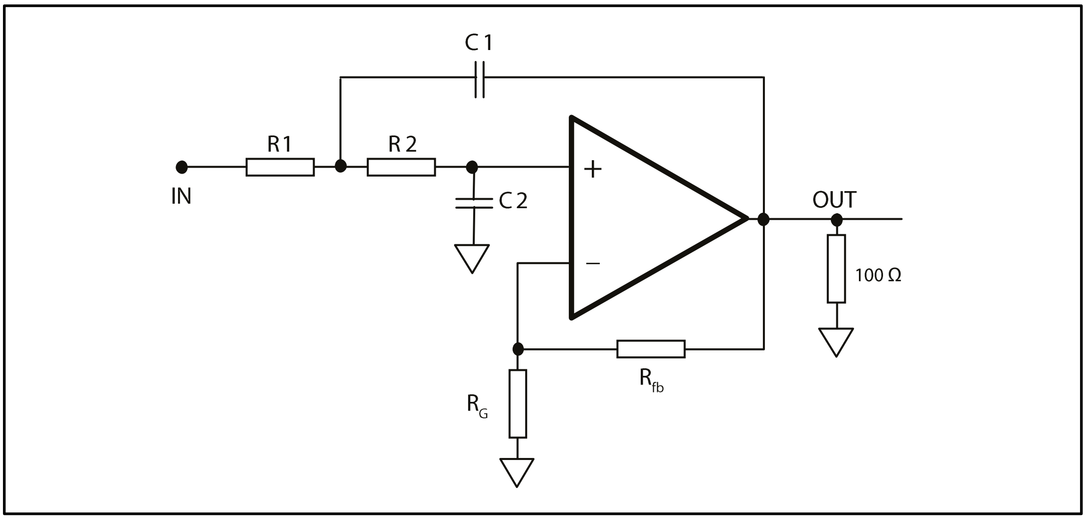
$$R = \frac{R_{in} \cdot R_{fb}}{R_{in} + R_{fb}}$$

Figure 29: Compensation of the input bias current



6.5 Active filtering

Figure 30: Low-pass active filtering, Sallen-Key



From the resistors R_{fb} and R_G it is possible to directly calculate the gain of the filter in a classic non-inverting amplification configuration.

$$A_V = g = 1 + \frac{R_{fb}}{R_g}$$

The response of the system is assumed to be:

$$T_{j\omega} = \frac{Vout_{j\omega}}{Vin_{j\omega}} = \frac{g}{1+2\zeta\frac{j\omega}{\omega_c}+\frac{(j\omega)^2}{\omega_c{}^2}}$$

The cut-off frequency is not gain-dependent and so becomes:

$$\omega_c = \frac{1}{\sqrt{R1R2C1C\,2}}$$

The damping factor is calculated using the following expression.

$$\zeta = \frac{1}{2}\omega_c(C_1R_1 + C_1R_2 + C_2R_1 - C_1R_1g)$$

The higher the gain, the more sensitive the damping factor. When the gain is higher than 1, it is preferable to use very stable resistor and capacitor values. In the case of R1 = R2 = R:

$$\zeta = \frac{2C_2 - C_1\frac{R_{fb}}{R_g}}{2\sqrt{C_1C_2}}$$

Due to a limited selection of capacitor values in comparison with the resistors, you can set C1 = C2 = C, so that:

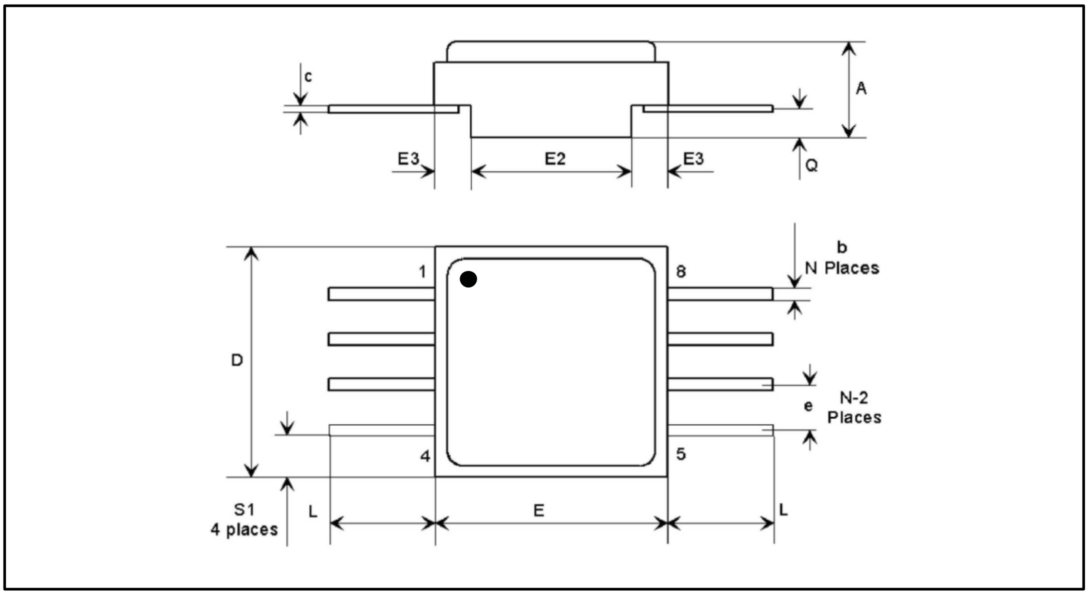
$$\zeta = \frac{2R_2 - R_1\frac{R_{fb}}{R_g}}{2\sqrt{R_1R_2}}$$

7 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: ***www.st.com***. ECOPACK® is an ST trademark.

7.1 Ceramic Flat-8S package information

Figure 31: Ceramic Flat-8S package outline



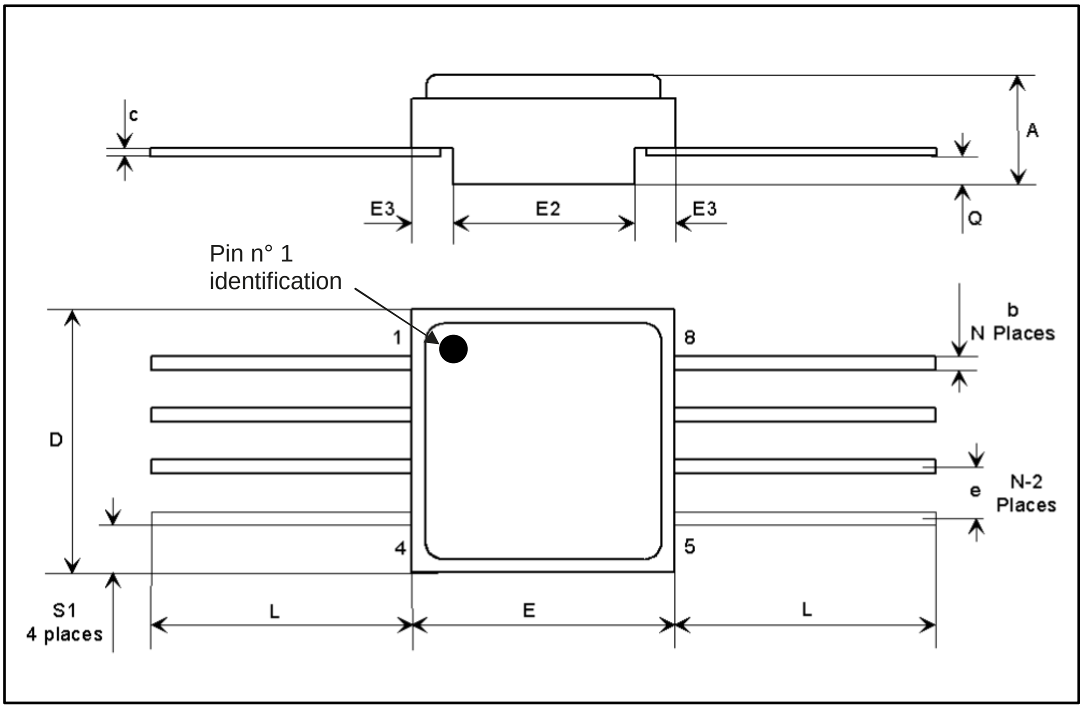
The upper metallic lid is not electrically connected to any pins, nor to the IC die inside the package. Connecting unused pins or metal lid to ground or to the power supply will not affect the electrical characteristics.

Table 7: Ceramic Flat-8S mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.24	2.44	2.64	0.088	0.096	0.104
b	0.38	0.43	0.48	0.015	0.017	0.019
c	0.10	0.13	0.16	0.004	0.005	0.006
D	6.35	6.48	6.61	0.250	0.255	0.260
E	6.35	6.48	6.61	0.250	0.255	0.260
E2	4.32	4.45	4.58	0.170	0.175	0.180
E3	0.88	1.01	1.14	0.035	0.040	0.045
e		1.27			0.050	
L		3.00			0.118	
Q	0.66	0.79	0.92	0.026	0.031	0.092
S1	0.92	1.12	1.32	0.036	0.044	0.052
N	8			8		

7.2 Ceramic Flat-8 package information

Figure 32: Ceramic Flat-8 package outline



The upper metallic lid is electrically connected to pin 5. No other pin is electrically connected to the metallic lid nor to the IC die inside the package.

Table 8: Ceramic Flat-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.24	2.44	2.64	0.088	0.096	0.104
b	0.38	0.43	0.48	0.015	0.017	0.019
c	0.10	0.13	0.16	0.004	0.005	0.006
D	6.35	6.48	6.61	0.250	0.255	0.260
E	6.35	6.48	6.61	0.250	0.255	0.260
E2	4.32	4.45	4.58	0.170	0.175	0.180
E3	0.88	1.01	1.14	0.035	0.040	0.045
e		1.27			0.050	
L	6.51		7.38	0.256		0.291
Q	0.66	0.79	0.92	0.026	0.031	0.036
S1	0.92	1.12	1.32	0.036	0.044	0.052
N	08			08		

8 Ordering information

Table 9: Order codes

Order code	SMD pin	Quality level	Package	Lead finish	Marking (1)	Packing
RHF330K1	—	Engineering model	Flat-8S	Gold	RHF330K1	Strip pack
RHF330AK1			Flat-8			
RHF330K-01V	5962F07231	QML-V flight	Flat-8S		5962F0723101VXC	
RHF330AK01V			Flat-8		5962F0723102VYC	

Notes:

(1)Specific marking only. Complete marking includes the following:
- SMD pin (as indicated in above table)
- ST logo
- Date code (date the package was sealed) in YYWWA (year, week, and lot index of week)
- QML logo (Q or V)
- Country of origin (FR = France).

Contact your ST sales office for information regarding the specific conditions for products in die form and QML-Q versions.

9 Other information

9.1 Date code

The date code is structured as shown below:

- EM xyywwz
- QML-V yywwz
  where:
  - x (EM only) = 3 and the assembly location is Rennes, France
  - yy = last two digits of the year
  - ww = week digits
  - z = lot index in the week

9.2 Documentation

Table 10: Documentation provided for each type of product

Quality level	Documentation
Engineering model	—
QML-V flight	Certificate of conformance
	QCI (groups A, B, C, D, and E) (1)
	Screening electrical data
	Precap report
	PIND test (2)
	SEM inspection report (3)
	X-ray report

Notes:

(1)QCI = quality conformance inspection

(2)PIND = particle impact noise detection

(3)SEM = scanning electron microscope

10 Revision history

Table 11: Document revision history

Date	Revision	Changes
20-May-2009	1	Initial release.
04-May-2010	2	Modified temperature limits in Table 4 Changed order codes in Ordering information table
27-May-2010	3	Added Mass in Features on cover page. Added full ordering information in Table 1
17-Jan-2013	4	Document status promoted from preliminary data to production data Added note to the Package information section and in the "Pin connections" diagram on the cover page.
06-Feb-2015	5	Replaced package name with “Flat-8S” instead of “Flat-8. Replaced package silhouette and added marker to show the position of pin 1 on package silhouette, pinout, and drawing. Features: updated Device summary: updated Table 4: "Electrical characteristics for VCC = ±2.5 V, Tamb = 25 °C (unless otherwise specified)": removed footnotes 1 and 2. Added Radiations Added Device description and operation and updated document layout accordingly. Added Ordering information Added Other information
31-Mar-2016	6	Updated document layout Table 1: "Device summary": updated footnote 1, SMD = standard microcircuit drawing.
03-Apr-2017	7	Added part number RHF330A Replaced cover image Updated *Features* Updated *Applications* Updated *Description* Added *Section 1: "Pin description"* *Section 2: "Absolute maximum ratings and operating conditions"*: updated R_{thja} and R_{thjc} values. *Table 4*: updated Bw and SR parameters *Section 5.2: "Total ionizing dose (TID)"*: corrected typos *Section 6: "Device description and operation"*: removed "Demonstration board schematics". Added *Section 7.2: "Ceramic Flat-8 package information"* *Table 9: "Order codes"*: updated table title, removed column “EPPL”, added order codes RHF330AK1 and RHF330AK01V, and updated footnotes.