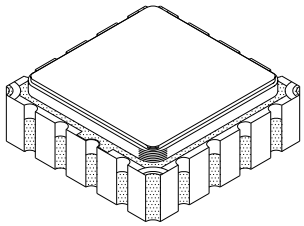
RAD HARD DUAL PRECISION OP-AMP

198RHL

FEATURES:

- Manufactured using LINEAR TECHNOLOGY Space Qualified RH1498 Die
- MIL-PRF-38534 Class K Processing & Screening
- Total Dose Hardened to 100 Krads(Si) (Method 1019.7 Condition A)
- Rail - to - Rail Input and Output
- 800µV Max Vos from V+ to V-
- Gain - Bandwidth Prduct: 10MHz
- Slew Rate: 6V/uS Typical
- Low Supply Current per Amplifier: 1.7mA
- Stable for Capacitive Loads Up to 10,000pF
- Large Output Drive Current: 30mA
- Wide Supply Range: 4.5V to ±15V
- Contact MSK for MIL-PRF-38534 Qualification and Radiation Status



DESCRIPTION:

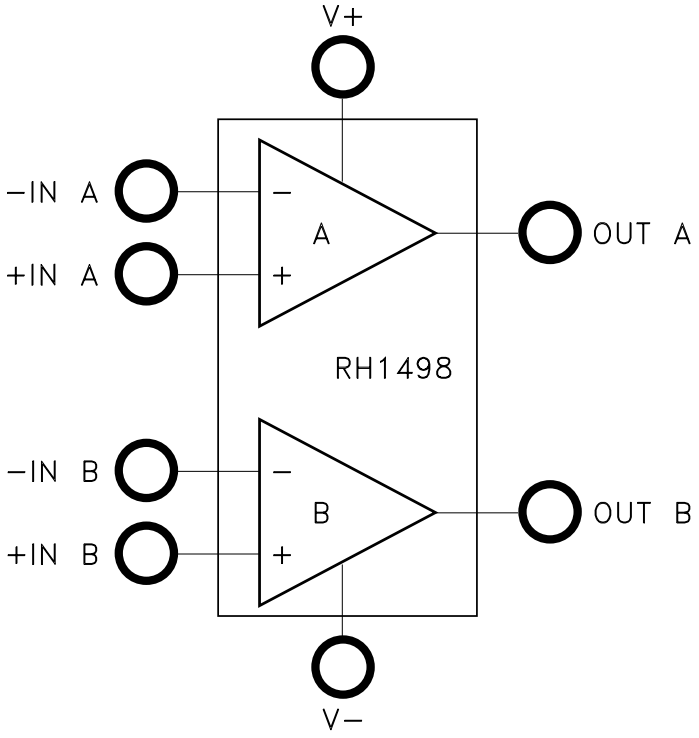
The MSK198RHL is a radiation hardened dual operational amplifier for use in space and severe military applications. This device offers rail-to-rail input and output, 10MHz gain-bandwidth product and 6V/uS slew rate. With a wide supply range of 4.5V to ±15V and drive current to 30mA, these op amps remain stable while driving capacitve loads up to 10,000pF. The MSK198RHL is an ideal solution when multiple robust precision amplifiers are required and board space is at a premium. The hermetically sealed MSK198RHL is offered in a leadless ceramic chip carrier package for surface mount applications.

PIN-OUT INFORMATION

1	OUT A
2	NC
3	-IN A
4	NC
5	+IN A
6	NC
7	V-
8	CASE/LID
9	+IN B
10	NC
11	-IN B
12	NC
13	OUT B
14	NC
15	V+
16	NC

CASE; LID = PIN 8

EQUIVALENT SCHEMATIC



TYPICAL APPLICATIONS

- Battery Powered Precision Instrumentation
- Driving A - to - D Converters
- Rail - to - Rail Buffer Amplifiers
- Low Voltage Signal Processing
- Active Filters

ABSOLUTE MAXIMUM RATINGS ⑩

Total Supply Voltage (V+ to V-)..... 36V
Input Current..... ±10mA
Output Short - Circuit Duration..... Indefinite

T_{ST} Storage Temperature Range..... -65°C to +150°C
T_{LD} Lead Temperature Range
(10 Seconds)..... 300°C
T_J Junction Temperature..... 150°C
T_C Case Operating Temperature Range
MSK198K/H RHL..... -55°C to +125°C
MSK198RHL..... -40°C to +85°C
ESD Rating..... 2

ELECTRICAL SPECIFICATIONS

Parameter	Test Conditions ⑪ ①		Group A Subgroup	MSK198H/K RHL Min.	MSK198H/K RHL Typ.	MSK198H/K RHL Max.	MSK198RHL Min.	MSK198RHL Typ.	MSK198RHL Max.	Units
Input Offset Voltage			1	-800	-	800	-800	-	800	µV
			2, 3	-1100	-	1100	-	-	-	µV
		Post Radiation	1	-950	-	950	-950	-	950	µV
Input Bias Current			1	-715	-	715	-715	-	715	nA
			2, 3	-1200	-	1200	-	-	-	nA
		Post Radiation	1	-915	-	915	-915	-	915	nA
Input Offset Current			1	0	-	70	0	-	70	nA
			2, 3	0	-	300	-	-	-	nA
		Post Radiation	1	0	-	100	0	-	100	nA
Large Signal Voltage Gain	V_{OUT} = -14.5V TO 14.5V, R_L = 10K		4	1000	-	-	1000	-	-	V/mV
			5, 6	60	-	-	-	-	-	V/mV
		Post Radiation	4	500	-	-	500	-	-	V/mV
Common Mode Rejection Ratio ⑤	V_{CM} = -14.5V TO 14.5V		1, 2, 3	70	-	-	70	-	-	dB
CMMR Match ② ⑤	V_{CM} = -14.5V TO 14.5V		1, 2, 3	70	-	-	70	-	-	dB
Power Supply Rejection Ratio	V_S = ±2.25V TO ±16V		1, 2, 3	88	-	-	88	-	-	dB
PSRR Match ②	V_S = ±2.25V TO ±16V		1, 2, 3	82	-	-	82	-	-	dB
Output Voltage Swing (Low) ④ (V_{OUT} - V -)	No Load		1, 2, 3	-	-	75	-	-	75	mV
		Post Radiation	1	-	-	60	-	-	60	mV
	I_{SINK} = 1mA		1, 2, 3	-	-	150	-	-	150	mV
		Post Radiation	1	-	-	100	-	-	100	mV
	I_{SINK} = 5mA		1, 2, 3	-	-	500	-	-	500	mV
		Post Radiation	1	-	-	500	-	-	500	mV
Output Voltage Swing (High) ④ (V+ - V_{OUT})	No Load		1, 2, 3	-	-	25	-	-	25	mV
		Post Radiation	1	-	-	20	-	-	20	mV
	I_{SINK} = 1mA		1, 2, 3	-	-	250	-	-	250	mV
		Post Radiation	1	-	-	150	-	-	150	mV
	I_{SINK} = 5mA		1, 2, 3	-	-	800	-	-	800	mV
		Post Radiation	1	-	-	800	-	-	800	mV
Short - Circuit Current			1	±15	-	-	±15	-	-	mA
			2, 3	±7.5	-	-	-	-	-	mA
		Post Radiation	1	±10	-	-	±10	-	-	mA
Supply Current			1	-	-	5.0	-	-	5.0	mA
			2, 3	-	-	6.0	-	-	-	mA
Slew Rate	A_V = -1, R_L = 2K, V_{OUT} = ±10V		4	3.5	-	-	3.5	-	-	V/µS
	Measure at V_{OUT} = ±5v	Post Radiation	4	2.0	-	-	2.0	-	-	V/µS
Input Voltage Range ⑤			1	-15	-	15	-15	-	15	V
Input Noise Voltage ⑤	0.1Hz to 10Hz		-	-	400	-	-	400	-	nVp-p
Input Noise Voltage Density ⑤	f = 1kHz		-	-	12	-	-	12	-	nV/√Hz
Input Noise Current Density ⑤	f = 1kHz		-	-	0.3	-	-	0.3	-	pA/√Hz
Gain - Bandwidth Product ⑤	f = 100kHz		4	6.8	-	-	6.8	-	-	MHz
Thermal Resistance ⑤	Junction to Case @ 125°C		-	-	13.6	16	-	13.6	16.5	°C/W

ELECTRICAL SPECIFICATIONS CONT'D

NOTES:

① Unless otherwise specified; V_S = ±15V, V_{CM} = V_{OUT} = 0V

② Matching parameters are the difference between amplifiers A and B.

③ Input Offset Voltage Match and Input Bias Current Match are not specified for post radiation.

④ Output Voltage swings are measured between the output and power supply rails.

⑤ Guaranteed by design but not tested. Typical parameters are representative of actual device performance but are for reference only. Not applicable to post irradiation performance.

⑥ Industrial grade devices shall be tested to subgroup 1 and 4 unless otherwise specified.

⑦ Military grade devices shall be 100% tested to subgroups 1,2,3 and 4.

⑧ Subgroups 5 and 6 testing available upon request.

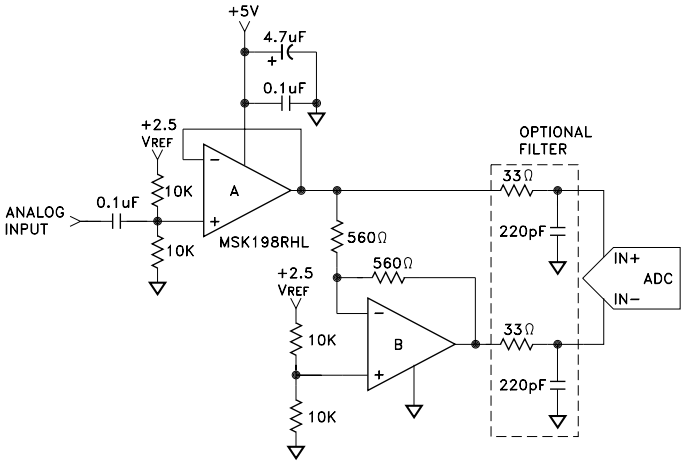
⑨ Subgroup 1, 4 TA = TC = +25°C
Subgroup 2, 5 TA = TC = +125°C
Subgroup 3, 6 TA = TC = -55°C

⑩ Continuous operation at or above absolute maximum ratings may adversely effect the device performance and/or life cycle.

⑪ Pre and Post irradiation limits at 25°C, to 100K TID, are identical unless otherwise specified. Post irradiation performance is guaranteed by design with a 2X radiation design margin.

SINGLE TO DIFFERENTIAL ADC DRIVER

The circuit shown in Figure 1 utilizes the MSK198RHL to buffer and convert a single analog signal into an ADC with differential inputs. Some ADC's require an op amp to provide the appropriate gain and offset to match the signal to the input range of the ADC. An ADC may generate transient currents at their input due to the internal conversion circuit, and these currents need to be isolated from the signal source. The circuit in Figure 1 will provide a low impedance drive and absorb these currents. The first op amp offsets the input signal 1.25V while operating in unity gain. The output of the first op amp goes into the IN+ of the ADC and the inverting input of the second op amp. The second op amp inverts the signal around the 1.25VDC level applied to its non-inverting input and the output is connected to the IN- of the ADC. Optional filtering can be added to reduce high frequency noise from the ADC inputs if required.

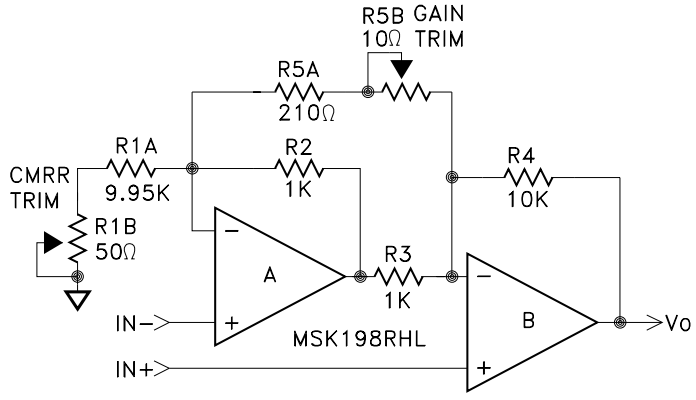


SINGLE−ENDED TO DIFFERENTIAL−INPUT ADC DRIVER
(PINOUT SHOWN FOR MSK 198RHL)

FIGURE 1

INSTRUMENTATION AMPLIFIER

A simple low cost, low power consumption instrumentation amplifier can be designed with the MSK198RHL. Figure 2 shows a design that offers sensitivity trim for offset voltage, CMRR and gain. The circuit is configured for a differential input gain of 100.



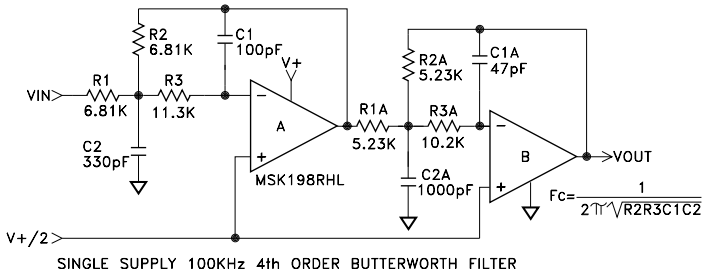
$$GAIN = \frac{R4}{R3}\left[1 + \frac{1}{2}\left(\frac{R2}{R1A+R1B} + \frac{R3}{R4}\right) + \frac{R2+R3}{R5A+R5B}\right]$$

INSTRUMENTATION AMPLIFIER

FIGURE 2

4th ORDER BUTTERWORTH FILTER

The wide bandwidth of the MSK198RHL is ideal for designing multi-order filter circuits. The circuit in Figure 3 shows a design that cascades two 2nd order filters as a 100KHz 4th order low pass filter. The design operates from a single supply. The filter offers a good compromise for low parts count and performance with minimal overshoot and ringing characteristics that a Butterworth filter offers.



SINGLE SUPPLY 100KHz 4th ORDER BUTTERWORTH FILTER

FIGURE 3

TOTAL DOSE RADIATION TEST PERFORMANCE

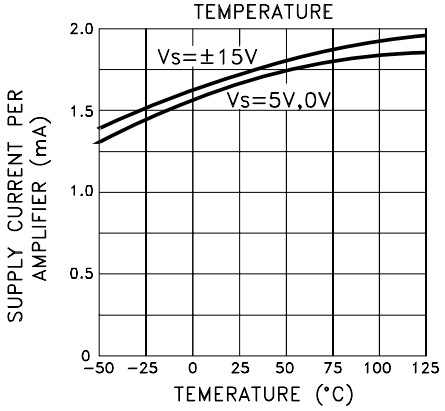
Radiation performance curves for TID testing will be generated for all radiation testing performed by MS Kennedy. These curves show performance trends throughout the TID test process and will be located in the MSK198RHL radiation test report. The complete radiation test report will be available in the RAD HARD PRODUCTS section on the MSK website.

ADDITIONAL APPLICATION INFORMATION

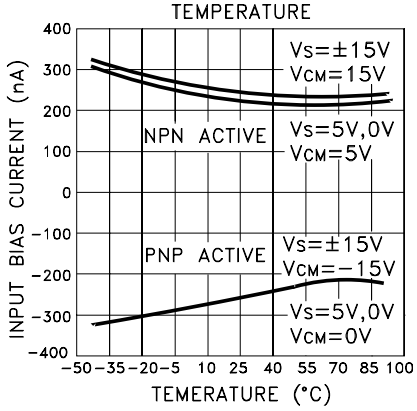
For additional applications information, please reference Linear Technology Corporation's® LT1498/1499 and RH1498 data sheets.

TYPICAL PERFORMANCE CURVES

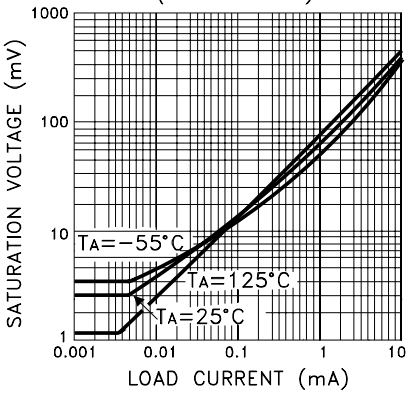
SUPPLY CURRENT vs TEMPERATURE



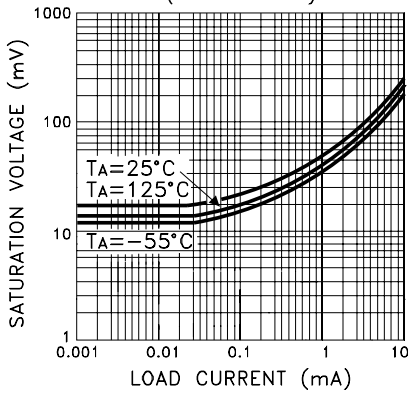
INPUT BIAS CURRENT vs TEMPERATURE



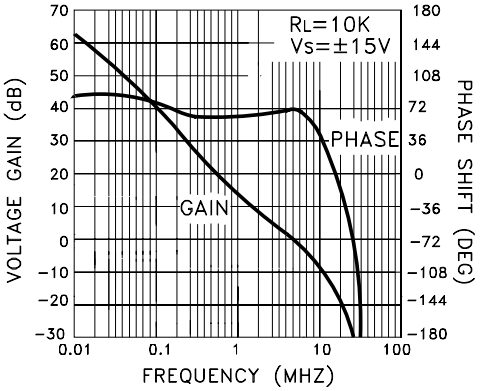
OUTPUT SATURATION VOLTAGE vs LOAD CURRENT (OUTPUT HIGH)



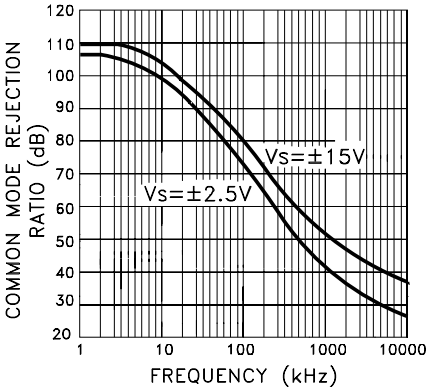
OUTPUT SATURATION VOLTAGE vs LOAD CURRENT (OUTPUT LOW)



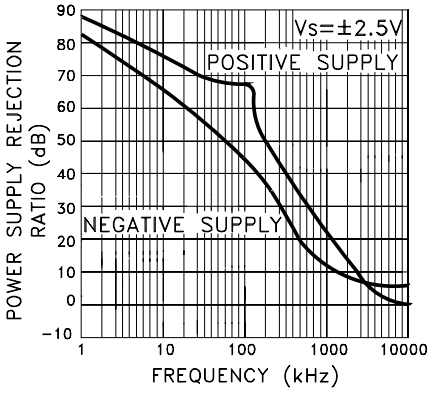
GAIN AND PHASE vs FREQUENCY



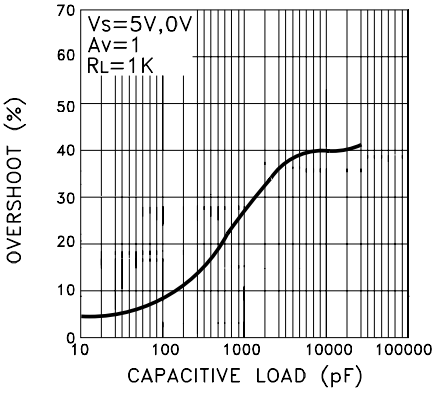
CMRR vs FREQUENCY



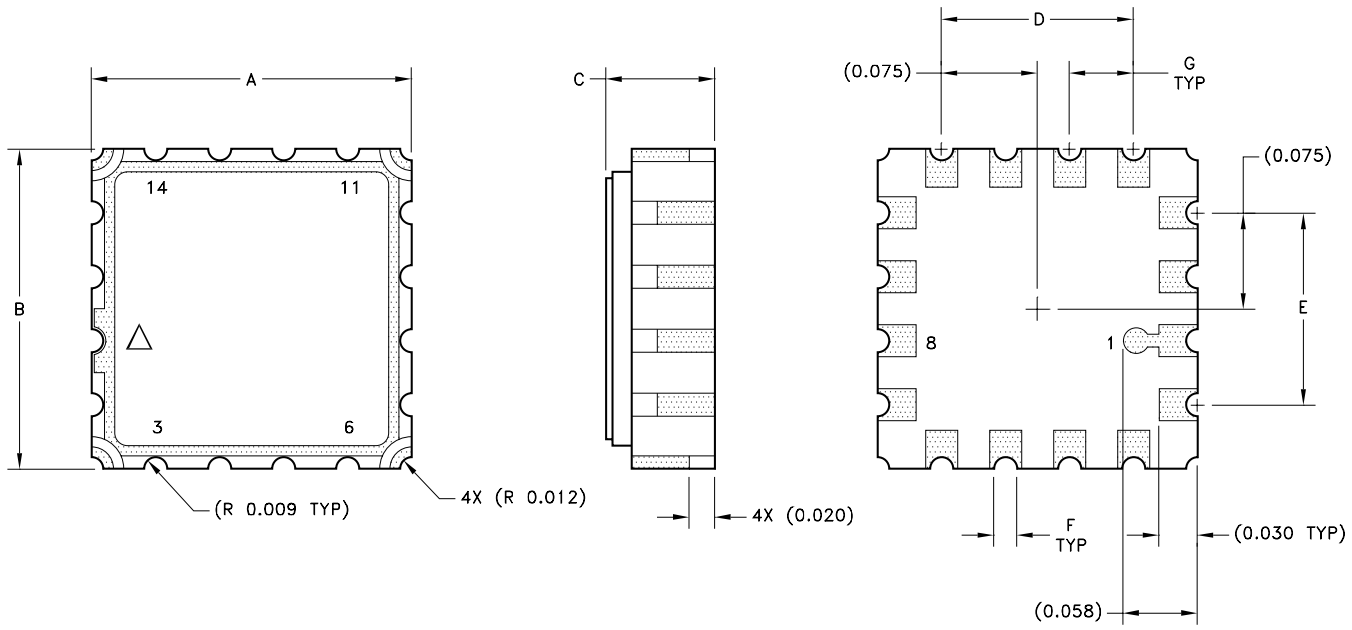
PSRR vs FREQUENCY



CAPACITIVE LOAD HANDLING



MECHANICAL SPECIFICATIONS



NOTE: PIN 8 IS CONNECTED TO PACKAGE LID.

REF	MIN	MAX
A	0.245	0.260
B	0.245	0.260
C	———	0.117
D	0.145	0.155
E	0.145	0.155
F	0.015	0.030
G	0.045	0.055

ESD TRIANGLE INDICATES PIN 1
WEIGHT=0.29 GRAMS TYPICAL

ALL DIMENSIONS ARE SPECIFIED IN INCHES

ORDERING INFORMATION

MSK198 K RH L

PACKAGE STYLE
L=LCCC PACKAGE
RADIATION HARDENED
SCREENING
BLANK= INDUSTRIAL
H=MIL-PRF-38534 CLASS H; K=MIL-PRF-38534 CLASS K
GENERAL PART NUMBER

The above example is a Class K Dual Operational Amplifier in an LCCC package.

REVISION HISTORY

REV	STATUS	DATE	DESCRIPTION
A	Released	01/15	Update format and add ESD rating.
B	Released	10/16	Add typical weight to mechanical specificatins.
C	Released	09/17	Update parameters to better correlate to manufacturer's pre and post RAD specs.