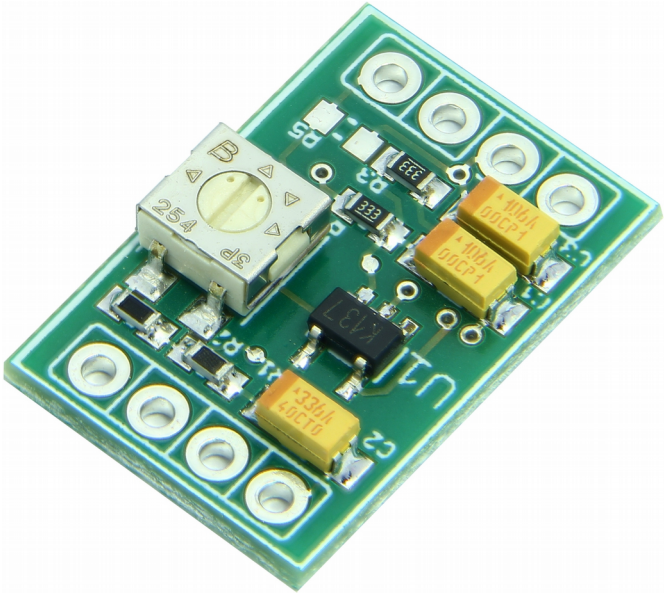
RTA-500

Adjustable-Gain AC Coupled
Inverting Amplifier
Preliminary

ROBOTHINGS

Features

- Single Supply Operation
- Input Voltage Extends Below Ground
- Output Swing to Ground
- Adjustable Gain Ratio
- Vibration Resistant



Applications

- AC Coupled Amplifier/Attenuator
- Vibration Sensors Signal Conditioning
- Microphone Signal Preamplifier
- DAC Signal Conditioning
- ADC Separation

Description

The RTA-500 is the first single supply adjustable amplifier module designed for conditioning bipolar signals before a unipolar ADC stage. It was designed to separate an input signal from the ADC and to adjust its value to maximize the ADC dynamic range usage.

The input signal is separated via a capacitor from the Op Amp input stage. The device works in a negative feedback loop thus the output signal is inverted in comparison to the input signal.

The RTA-500 can work as the signal amplifier or as the attenuator. The gain is set by the potentiometer.

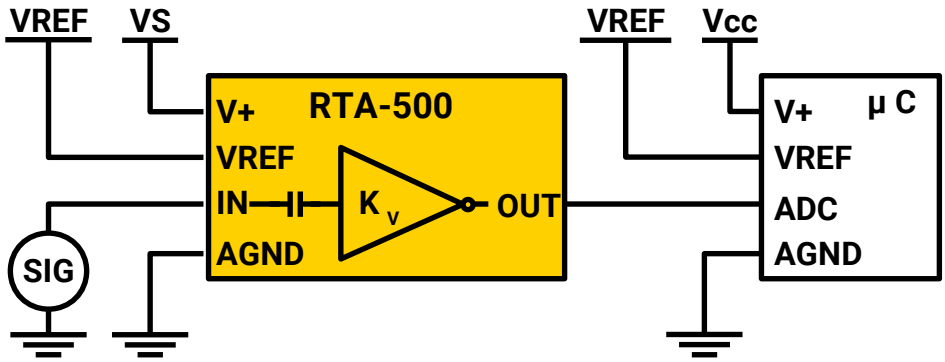
The output signal swings over half of the reference voltage from even 4mV below the supply voltage to the GND.

This device is vibration resistant and does not contain any piezoelectric materials thus it can be used in a harsh environment.

Typical application

Single supply AC coupled preamplifier

VS	3.3V
VREF	3V
VIN	±1.5V
K_V	2V/V
VOUT	0-3V



Absolute Maximum Ratings

Supply Voltage V_S.....6 V
Ground Voltage GND.....0 V
Input Voltage.....Depends on Gain
Reference Voltage V_{REF}.....GND to V_S
Input DC Voltage.....-10V to ½V_{REF}
Operating Temperature Range.....0 to 80 °C
Storage Temperature Range.....-65 to 150 °C

Operating Conditions

Symbol	Parameter	Value	Unit
V_s	Supply Voltage	2.7 to 5.5	V
T_{ENV}	Environment Temperature	0 to 85	°C

Electrical Characteristics T_{ENV}=25°C, unless otherwise noted.

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
V_{IR}	Input AC Voltage V_S=+5V, V_{GND}=0V, V_{REF}=5V, K_U=1	-7.8		7.8	V
	Input AC Voltage V_S=+5V, V_{GND}=0V, V_{REF}=5V, K_U=10	-3		3	
	Input AC Voltage V_S=+5V, V_{GND}=0V, V_{REF}=5V, K_U=0.1	-51		51	
V_{IR}	Input AC Voltage V_S=+3V, V_{GND}=0V, V_{REF}=3V, K_U=1	-7.8		10	V
	Input AC Voltage V_S=+3V, V_{GND}=0V, V_{REF}=3V, K_U=10	-4.3		5	
	Input AC Voltage V_S=+3V, V_{GND}=0V, V_{REF}=3V, K_U=0.1	-43		51	
V_{OH}	Output Swing High V_S=+5V, R_L=6kΩ	4.936	4.996		V

Symbol	Parameter	Value			Unit
		Min.	Typ.	Max.	
	Output Swing High V_S=+3V, R_L=6kΩ		2.938		
V_{OL}	Output Swing Low V_S=+5V, R_L=6kΩ,		4	15	mV
	Output Swing Low V_S=+3V, R_L=6kΩ,			36	
K_V	Maximum Gain Product		12		V/V
	Minimum Gain Product		0.1		
B_{3dB}	Bandwidth K_V=0.25V/V	1-200k			Hz
	Bandwidth K_V=1V/V	1-200k			
	Bandwidth K_V=10V/V	1-70k			
I_S	Supply Current V_S=+5V, V_{REF}=5V, V_{IN}=0, R_L=6kΩ		1.3		mA
I_S	Supply Current V_S=+3V, V_{REF}=3V, V_{IN}=0, R_L=6kΩ		1.1		mA
I_{OUT}	Output Current V_S=+5V, V_{REF}=5V		128		mA
Z_I	Input Impedance	20.8	21	21.2	kΩ
Z_{REF}	Reference Voltage Input Impedance	93.1	94	94.9	kΩ

Typical Performance Characteristics

Fig. 1 Gain, Phase vs Frequency, K_U=0.1V/V, R_L=6kΩ, C_L=10pF

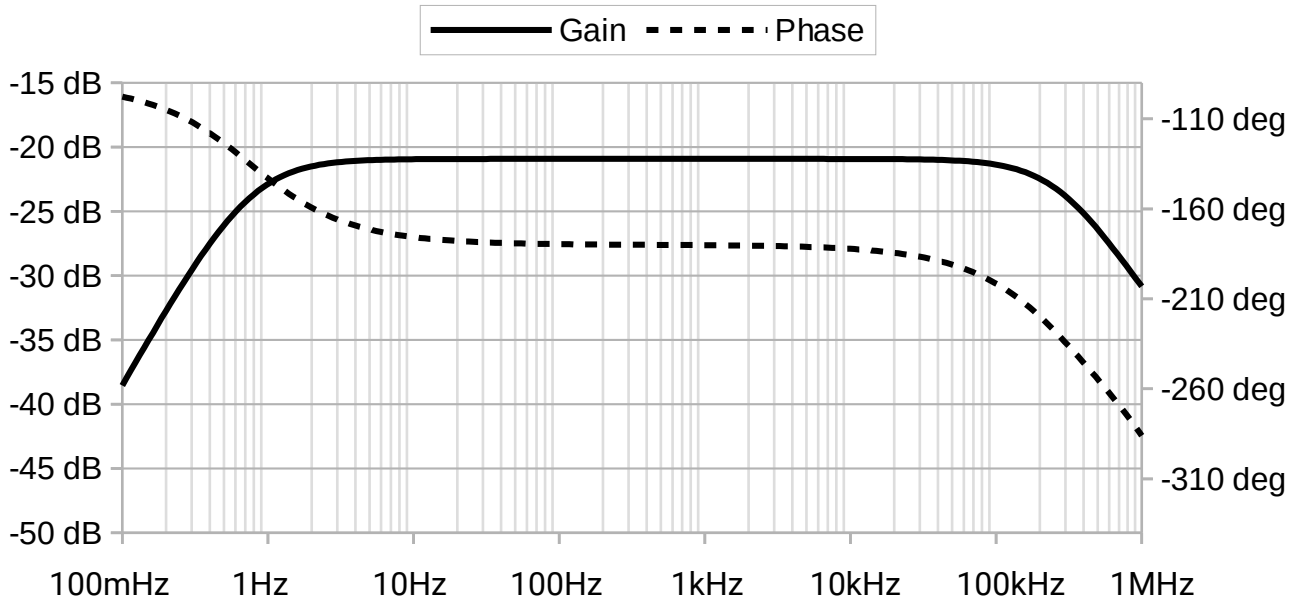
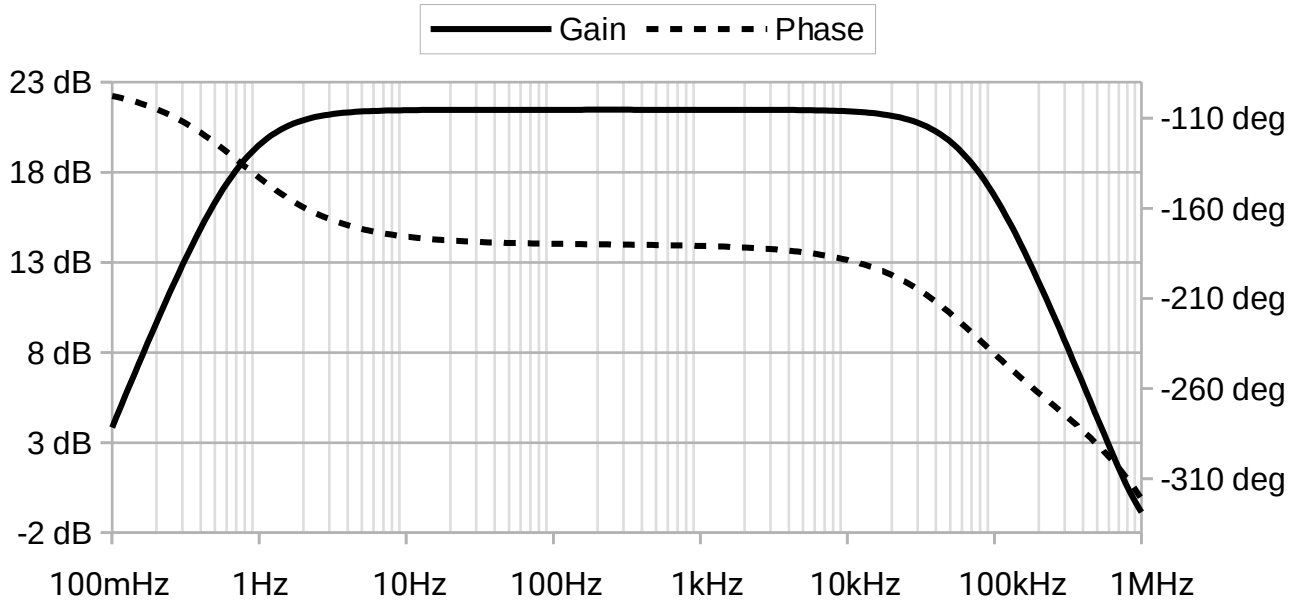
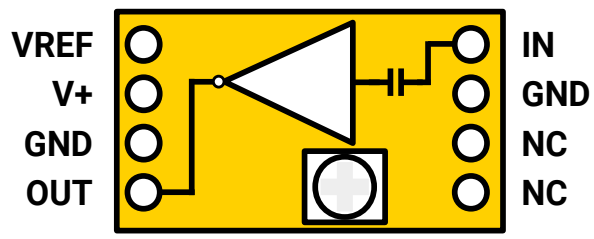


Fig. 2 Gain, Phase vs Frequency, K_U=10V/V, R_L=6kΩ, C_L=10pF



Package order information



Order Number	Shipping Form
RTA-500	Plastic Bag

Application Information

The RTA-500 is specified for a single supply operation i.e. a 5V or 3.3V DC supply. The input range includes negative voltage and the output swings within millivolts of ground.

Setting up

To setup the module in an application change the gain to the minimum (turn the potentiometer clockwise).

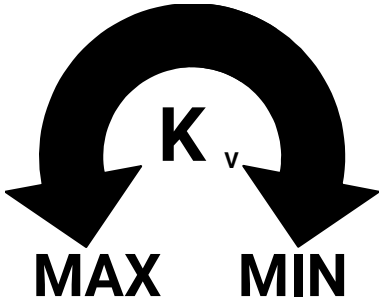


Fig. 3 Potentiometer rotation change the gain according to the rule
– clockwise: minimum gain
– anticlockwise: maximum gain

Connect the supply voltage and reference voltage to the RTA-500. Connect the output to the filter or directly to the ADC. If the module and the ADC are powered from different supplies connect the GND. Connect the input signal to the IN port and increase the gain until the output signal value covers the full ADC range.

Be sure that the input signal will never exceed the value of the test signal.

Input signal

The bipolar input of the RTA-500 allows to connect the signal of the negative voltage value.

The maximum amplitude value of the input signal depends on the voltage gain K_V (*see Electrical Characteristics*).

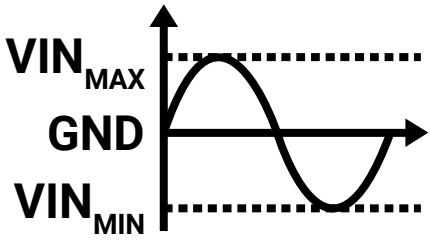


Fig. 4 Input signal may change below the RTA-500 negative supply voltage

Output signal

The output signal phase is 180 degree shifted from the input signal in general. Phase vs Frequency characteristics describe the signal phase shift in the function of the gain.

The output bias is equal to half of the reference voltage.

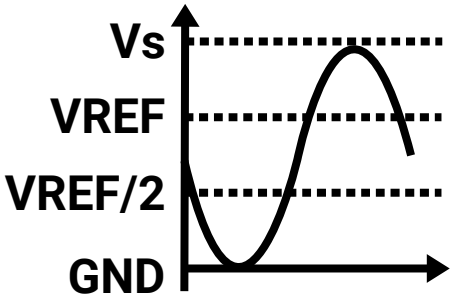


Fig. 5 Output voltage swing is constrained only by the RTA-500 voltage supply and the GND

The output voltage is constrained by the RTA-500 supply voltage. If the gain is set to high the output signal will saturate a few milivolts below supply voltage value. If necessary, consider using Schottky diodes to protect input of the next stage i.e the ADC.

Reference Voltage

The RTA-500 input reference voltage is internally divided in order to obtain bias output. The bias value is half of the reference voltage value.

If the ADC reference voltage or any other stable source is unavailable, it is possible to connect the RTA-500 supply voltage or any voltage source. Precautions must be taken to avoid damage to the ADC due to the exceeded ADC reference voltage by the RTA-500 output signal.

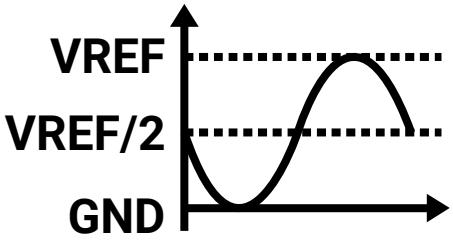


Fig. 6 Output signal is biased with half of the reference voltage

Amplifier Circuit

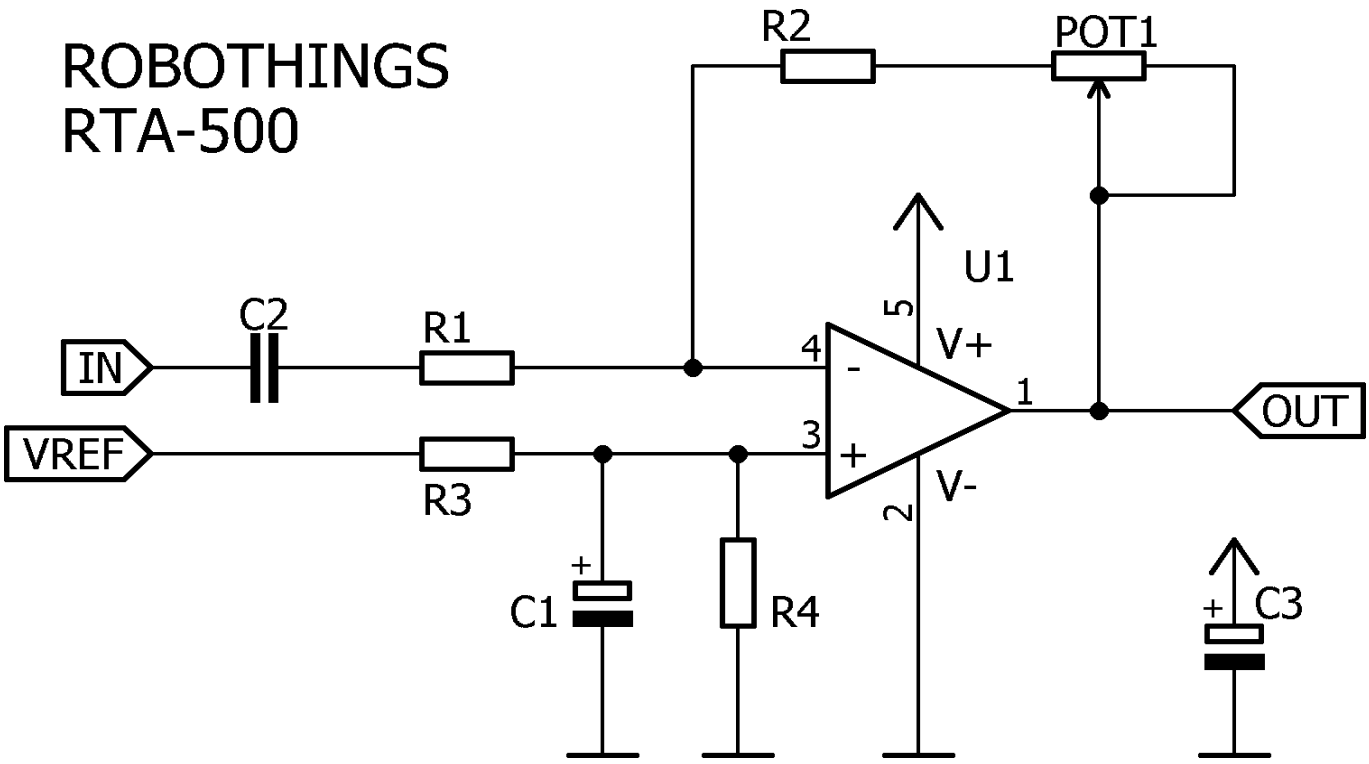


Fig. 7 RTA-500 circuit diagram

Typical Application

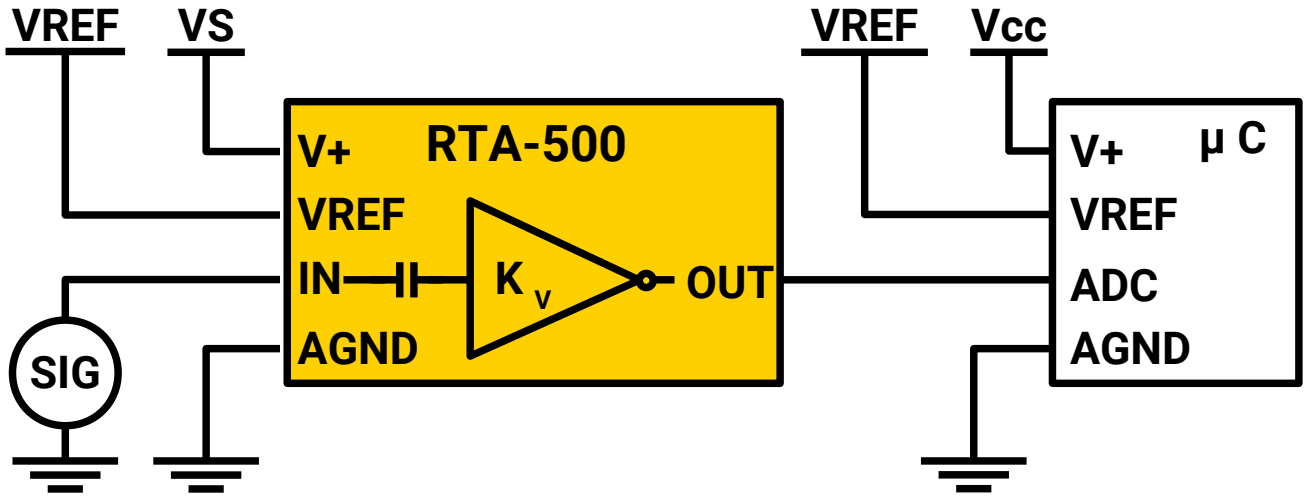


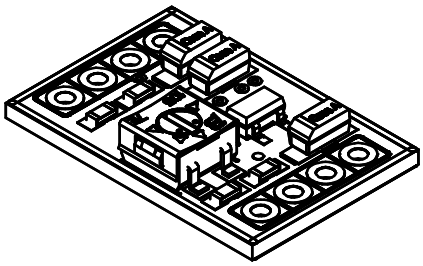
Fig. 8 RTA-500 typical application with the ADC embedded in the microcontroller

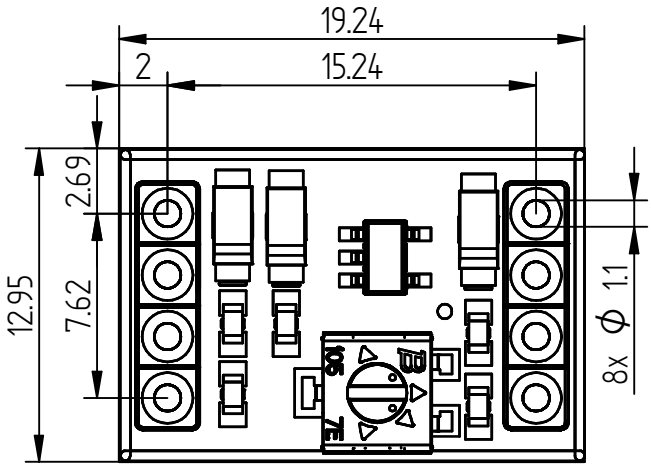
The RTA-500 amplifier can be connected to the embedded or standalone single supply ADC. In Figure 8, a typical application is presented.

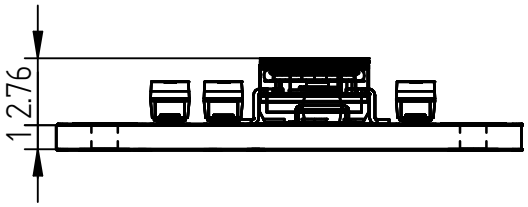
VS	RTA-500 Supply Voltage		3V	3V	5V	3V
VREF	Reference Voltage		3V	2.5V	2.5V	5V
Vcc	ADC Supply Voltage		3V	3V	3V	5V
VOUT	Output Voltage Range	Min.	0.015V	0.015V	0.015V	0.015V
		Max.	2.938V	2.938V	**4.996V**[1]	4.996V
	Output Voltage, no signal	IN=GND	1.5V	1.25V	1.25V	2.5V
BW	Output Signal Bandwidth	K_U=0.25	200kHz			
		K_U=1	200kHz			
		K_U=10	70kHz			

1 Care must be taken. The RTA-500 output signal can exceed the ADC voltage supply. Consider using the ADC input overvoltage protection circuit.

Module Package Description







RTA-500 Drawing	
Units	Milimeters
Tolerance	+/- 0.05 [mm]

IMPORTANT NOTICE

Electronic components for scientific and research purposes; not constituting a separate device without the additional components necessary for its proper operation.

Development modules are used for evaluation purposes, and the equipment they are used in are not exempted from safety tests or certification.

The user declares that he or she has the skills and qualifications to operate the Development Module safely.

The user is responsible for the proper use of the Development Module.

The information contained in the Development Module documentation is not covered by any warranties.

The information contained in the Development Module documentation may be changed without prior notice.

The Development Modules should not be used in any medical or life saving equipment or for any military purposes.

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