EK022 – Electret Amplifier

Kit description:

EK022 is an amplifier for electret microphones. A microphone is included in the kit and is mounted directly on the circuit board. The kit contains all the components needed to power the microphone and amplify the signal to a level suitable for use with a microcontroller or audio equipment. If capacitor C5 is installed, the output will be AC-coupled and suitable for use with mixers, amplifiers, or other audio equipment. For use with a microcontroller or other electronics with standard logic levels, the two connections should instead be bridged with a component lead. In this case, the output will be DC-coupled and swing between 0V and V+, centered around half of the supply voltage. The gain is set to 100x but can be adjusted by replacing the feedback resistor in the amplifier (R3). The gain can be calculated using the formula G = R2/R3 (1kΩ/100kΩ = 100x gain). The included microphone has a sensitivity of -50dBu, which translates to 3.16mV/Pa. To provide a usable signal, it needs significant amplification! The TLC271 operational amplifier used in the kit supports a wide voltage range and can be powered with voltages from 3V up to 12V.

* Supply voltage:	3 - 12 VDC
* Current consumption:	2.2mA (@ 12V)
* Dimensions:	38 x 25mm
* Mounting holes:	c-c 33 x 20mm, ø2.5mm

Assembly guide:

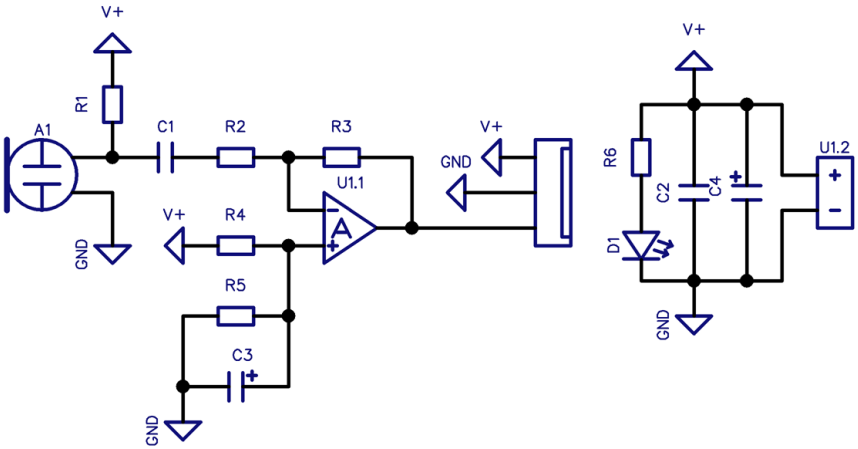
Before you begin mounting components, make sure the board is free from damage and scratches. Make sure all the components are included and are of correct value. Compare with the component list!

Begin mounting the lowest components and work your way up to the largest. IC sockets, resistors, ceramic capacitors and diodes go first. Electrolytic capacitors, connectors and potentiometers go last. Some components are polarized and must be mounted in the right way. Please observe the markings on the board!

Component list:

RefDes	Value	Qty.	Part.no.	
A1	Microphone	1	40290007	
C1	1 uF	1	41017671	
C2	100 nF	1	41003038	
C3, C4, C5	10 uF	3	41017674	
C6 (not included)	470 pF	0	41011989	
D1	LED 3mm	1	40307000	
P3	Header	1	41001167	
R1, R4, R5, R6, R7	10 kohm	5	40811410	
R2	1 kohm	1	40811310	
R3	100 kohm	1	40811410	
U1	TLC271	1	40350271	+ 40410008

Schematic:



Circuit description:

How an Electret Microphone Works
The first stage of the circuit is the electret microphone A1. Electret microphones are sometimes called condenser microphones because they function similarly to a capacitor. They consist of two plates, one fixed and one movable. The movable plate is the diaphragm that captures sound waves and together with the other plate, generates a small voltage. This signal is extremely weak and high impedance, requiring buffering before further processing. Therefore, the microphone includes a built-in amplifier, powered through a resistor (R1) connected to the supply voltage.

The audio signal at the point where R1, C1, and the microphone's positive terminal meet now has a DC offset, as the power voltage and the audio signal are combined. The capacitor C1 ensures that only the AC (audio) signal passes through, preventing the operational amplifier (op-amp) from amplifying unwanted DC voltage.

Amplification of the Signal
After C1, the signal is sent to the inverting input of the operational amplifier (U1). The gain is determined by resistors R2 and R3 according to the formula: Vout = R2 / R3. For example, if R2 = 100 kΩ and R3 = 1 kΩ, the gain is 100x, meaning the signal is amplified 100 times, making it strong enough for use with audio equipment.

Reference Voltage and Stabilization
Since an op-amp requires a reference voltage to properly handle audio signals, R4 and R5 form a voltage divider, setting the reference voltage to half of the supply voltage. This allows the signal to swing both positively and negatively relative to the reference voltage. When no sound is present, the audio signal will match the reference voltage.

To reduce noise and ripple in the reference voltage, capacitor C3 is used for stabilization. Capacitor C6, connected between the op-amp's output and its inverting input, helps maintain amplifier stability and filters out high frequencies beyond the audible range.

Signal Adaptation
For use with audio equipment, the signal should not swing between 0V and V+, but instead be centered around 0V. C5 and R7 form a high-pass filter that removes DC offset, which is important to prevent clicking noises and to protect audio equipment.

If the amplifier is instead used with a microcontroller or ADC (Analog-to-Digital Converter), C5 can be bypassed with a wire, and R7 can be omitted. This retains the DC offset, allowing the signal to swing between 0V and V+.

Power Supply and Indicators
To ensure a stable supply voltage, C2 and C4 help filter out noise from the power source. D1 and R6 form an LED indicator with a current-limiting resistor, which lights up when the amplifier is powered on.