MKT1132 ELEKTRİK DEVRE TEMELLERİ DÖNEM PROJESİ

PROJE NO:2

Microchip AN682– Using Single Supply Operational Amplifiers in Embedded Systems

**Voltage Follower Amplifier**

**A diagram of a capacitor

AI-generated content may be incorrect.**In this figure we have a Voltage Follower Amplifier (Buffer Amplifier) using a MCP601 op-amp. Our output, which is at node 6, is connected directly to the inverting input at node 2, and its signal is applied to the non-inverting input at node 3. We also have a bypass capacitor (1 µF) connected between VDD at node 7 and ground at node 4, which stabilizes power and prevents oscillations that are not needed. This circuit is mainly used for impedance matching, capacitor load driving, and unity gain linear amplification. As the operating principle of this circuit we have a unity gain configuration VOUT=VIN. The non-inverting input receives the signals, and then the op-amp adjusts it to match the inverting and non-inverting input. Also output is directly fed back to the inverting input. The operation of our op-amp is closed-loop, which tracks the input voltage exactly.



In this circuit we have a MCP601 Op-Amp because it is used for single supply operations, low power, and high input impedance (up to 10^13Ω) CMOS input stage. These features make it suitable for buffering with no loading of previous stages. We also have a Bypass Capacitor (1 µF), which stabilizes our power supply. It is used when we have high-frequency or sensitive analog signals. This capacitor is designed to prevent oscillations and improve transient response. The voltage gain is , meaning no amplification because the purpose is signal buffering, not amplification. High input impedance (10^13Ω) makes a minimal current draw from the source, which is useful in sensor circuits and audio buffers, while low output impedance (<10Ω) allows the op-amp to drive heavy or capacitive loads with almost no voltage drop.

A diagram of a circuit

AI-generated content may be incorrect.This figure's circuit contains two op-amps (both MCP601). First, we have a precision amplifier with a non-inverting configuration and a resistive gain network of R1 and R2. Second, there is a voltage follower (buffer amplifier)connected after the precision amplifier. The main purpose of these connections is to maintain accuracy in small-signal amplifications (100 μV) and isolate the load with the help of the buffer to prevent heating or loading effects on the precision op-amp. The bypass capacitor is used for supply decoupling. All of this allows it to do hight accuracy amplification of very small input signals. The operating principle for the first op-amp (Precision Amplifier) is non-inverting configuration , it amplifies very small signals with high precision. Second op-amp (Buffer) is a voltage follower(unity-gain) ,which drives the load while preserving the amplified signal integrity from the previous op-amp. Buffer also prevents loading and self-heating issues that would affect accuracy.



Again, here, we have an MCP601 used in both precision and buffering stages. It is CMOS-based, which allows it to provide high input impedance and low offset voltage. We have resistor R1 connected to the inverting input(-) of the op-amp at node1 and the ground from the other end, and R2 connected to the inverting input of the MCP601 at node1 and its output at node2. Together, they define the gain of the precision amplifier. We also have a Bypass Capacitor (1 µF) stabilizing power supply to prevent unwanted oscillations. The gain of the precision amplifier is , which provides controlled voltage gain to amplify the input. It is needed for measuring very small signals (100 µV). The output of buffer is . As you can see, the buffer does not change this voltage, but it isolates the load. Input impedance is very high in MCP601, making it ideal for signal sourcing, and the output impedance of buffer is low, ensuring effective load driving. All the above is for impedance matching.

**A diagram of a circuit

AI-generated content may be incorrect.Gaining Analog Signal**

This circuit is a non-inverting amplifier, meaning the input is amplified without phase inversion. It operates in single supply mode, making it practical in systems lacking negative voltage. The R1 and R2 create a resistive feedback network connecting the output back to the inverting input, and in the end the the bypass capacitor supplies decoupling. The main operational principle uses negative feedback through R1 and R2 to stabilize the gain. The op-amp internally adjusts the voltage at both inputs to make them equal, this ensures linear amplification. The signal remains in-phase, meaning no polarity change occurs from input to output.



This circuit contains two resistors, R1 connected from the inverting input in node1 to ground, and R2 connected from the op-amp output in node 2 to the inverting input at node1. R1 is used to determine the gain with R2, and R2 is used as a part of the gain-setting divider. Again, we have as MCP601which performs signal amplification with a high impedance input and a low output one. The bypass capacitor here decouples supply noise to prevent unwanted oscillations. The voltage gain formula is which is derived using voltage and op-amp feedback theory, which forces the op-amp to make . In here, we make sure that gain is always greater than or equal to 1. This ensures that no phase shift is happening and amplifies .

A diagram of a circuit

AI-generated content may be incorrect.This figure represents an inverting amplifier with bias. Like all the above circuits, we use a single supply op-amp, MCP601. The input signal is applied through R1 to the inverting input of the op-amp at node1. At the same time, R2 provides feedback from the output to the inverting input at nodes1 and 2. To prevent the output from going below the ground, which is very important in single supply applications, the non-inverting input is biased to a fixed DC voltage . Again, our boy capacitor is used to stabilize the op-amp supply voltage. The operating principle of this circuit is that its op-amp inverts and amplifies the input signals. A bias voltage It is applied to the non-inverting input to shift the signal into the op-amp output range. In here, we have negative feedback, and due to this, the op-amp forces creating a virtual ground. The op-amp adjusts the voltage difference between its two inputs to nearly 0.



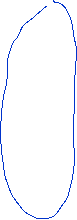
R2 resistor is connected to the inverting input of the amplifier and to its output at nodes1 and 2, R1 is connected to the inverting input of amplifier from one end, but from the other end it is connected to the input signal determining the gain with R2. We also have which is a DC bias applied to the non-inverting input. It centers the output swing within the single-supply range. We also have MCP601, which is a low-power op-amp used for single-supply use. As usual, the bypass capacitor stabilizes the power supply and filters high-frequency noises. The full output voltage formula here is: . The first term gives the amplified and inverted version of the input signal, providing a negative sign because the op-amp is in an inverting configuration, so it's entering the inverting input, making it negative, so the output is going to be 180 degrees out of phase. The second term adds a DC offset to keep the output above ground. By applying a superposition of one, the op-amp output is influenced by both the signal applied to the inverting input and the DC bias applied to the non-inverting input. Typically, the average output voltage should be designed to be Equal to.

**Single Supply Circuits and Supply Splitters**



A diagram of a circuit

AI-generated content may be incorrect. This circuit is called a supply splitter or level shifter. It is used in single supply systems to generate a mid-supply reference voltage. It also creates a stable DC voltage () which is often needed in inverting op-amp stages or analog-to-digital converters () that needs a reference centered between the ground and . In single supply systems, signals cannot swing below ground level, but in this circuit, we have a shift of the reference point to allow AC-coupling or bipolar-like behavior. In operating principles, we have DC behavior, which follows the voltage divider rule. Resistors R3 and R4 form a voltage divider generating an intermediate voltage. This DC voltage is applied to the non-inverting input of the op-amp. We also have an AC behavior following the capacitive theory. The capacitor C1 smooths the reference voltage, acting as a charged reservoir, reducing AC impedance at the reference node, while C2 provides bypass filtering.



We have a MCP601 op-amp, which has the same rule as previous examples, and it has been explained already. We have R3 and R4 as a voltage divider setting a DC reference level, and also C1 as a reference capacitor and C2 as a bypass capacitor, which were explained in detail in the previous paragraph. R1 and R2 are isolation resistors that prevent instability with capacitive loads. The formula used for calculating the output voltage is:. In here, R3 and R4 determine the proportional reference voltage. If R3=R4, we have which is ideal for mid-supply reference, like 2.5V for a 5V supply. This results in an accurate and noise-isolated reference voltage.

**The Difference Amplifier**

A diagram of a circuit

AI-generated content may be incorrect. in here, we have the