# Bridged, Unbridged, Balanced and Unbalanced Amplifiers
# PRO-Q2

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## Preface

One of the assignment for the project PRO-Q2 is to write a reseach paper. Each group, consisting of two members, has to choose a subject related to the Electrical Engineering course. Although this assignment is more research wise and not practical, it is important to be able to do research on various subjects. Even in a university of applied science, which is well known for practice.

The subject that is chosen for this reseach paper are bridged, unbridged, balanced and unbalanced amplifiers. This topic was chosen as it appeared to be the most interesting of all the available options given by the project coach.

## I. Amplifiers

***Abstract*—Amplifiers are applied in many electroncal devices. These are for example laptops, mobile phones, microwaves and many more. Examples of amplifiers are bridged, unbridged, balanced and unbalanced amplifiers.**

There are different types of amplifiers. The following amplifiers are explained in details:

- Bridged amplifiers
- Unbridged amplifiers
- Balanced amplifiers
- Unbalanced amplifier

### A. Bridged and Unbridged Amplifiers

A bridged amplifier consists of two amplifiers driving a load floating in between their outputs[1]. Fig1 shows a general shape of a bridged amplifier and Fig2 shows an example of a bridged amplifier. Bridged amplifiers are often used when the power rails do not supply sufficient voltage[2] and in single supply applications[3]. A bridged amplifier is typically used in an output stage.

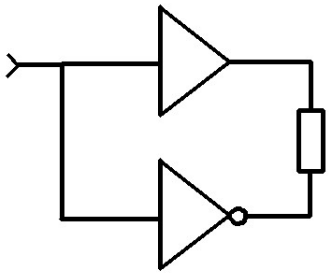

Figure 1. General shape of a bridged amplifier

*1) Example of a Bridged Amplifier:* A bridged amplifier can be built using two regular amplifiers instead of a monolithic bridge amplifier IC. This makes it possible to construct a bridged amplifier with cheap off the shelf parts as opposed to using expensive bridged amplifier IC's. This is demonstrated in Fig2.

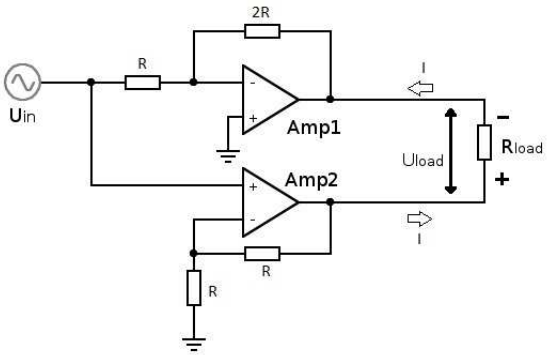


Figure 2. An example of a bridged amplifier

The second amplifier's output is in anti-phase with the first one, thus doubling the voltage across the shared

load. The current however remains the same since both amplifiers "see" Rload. The output power across the load is effectively doubled. Assume:

$$I_{load} = \frac{U_{amp1} - U_{amp2}}{2R_{load}} \tag{1}$$

$$U_{amp} = U_{amp2} = -U_{amp1} \tag{2}$$

$$U_{load} = I_{load} * 2R_{load} = \frac{2U_{amp}}{2R_{load}} * 2R_{load} = 2U_{amp} \tag{3}$$

The gain of both amps is equal to 2, but amp1 inverts the signal.

$$Gain_{Amp1} = -\frac{2 \cdot R}{R} = -2 \tag{4}$$

$$Gain_{Amp2} = \frac{R + R}{R} = 2 \tag{5}$$

The output of Amp1 is connected to the negative terminal of $R_{load}$ and therefore the circuit in Fig2 has a total gain of 4.

$$Gain_{Total} = 2 + 2 = 4 \tag{6}$$

*2) Unbridged Amplifiers:* An unbridged amplifier only consist of one amplifier. Its output signal is single-ended as opposed to differential and therefore an unbridged amplifier requires a higher supply voltage and output voltage than a bridged amplifier to yield the same result. An example of an unbridged non-inverting amplifier is given in Fig3.

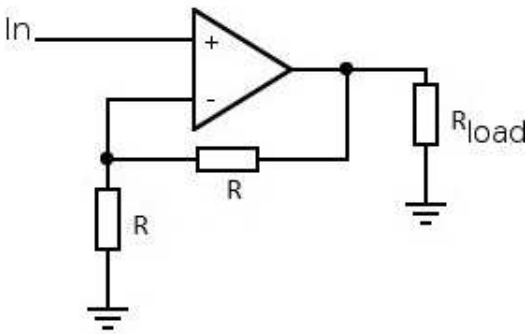


Figure 3. Unbridged amplifier

*3) Benefits of Bridged Amplifiers:* The two main benefits of using bridged amplifiers over unbridged, as stated before, are: double output power and lower supply voltage requirements. There are some more notable benefits to using bridged amplifiers such as power supply noise rejection. Any noise introduced by the supply will be cancelled out because the noise is common to the outputs driving the floating load.

*4) Applications of bridged amplifiers:* Bridged amplifiers are commonly used in hi-fi, professional audio equipment, battery powered speaker amplifiers and car audio. In battery powered speakers and car audio systems there is a limited supply voltage, so in this case the bridged amplifier is used to double the output voltage. In hi-fi and professional audio equipment supply voltage is usually not an issue, so here bridged amplifiers are used to drive speakers at high power. The outcome may seem similar, but the bridged amplifiers in these applications are used for different reasons.

### *B. Balanced and Unbalanced Amplifiers*

A balanced amplifier consists of either one or more amplifiers that amplify a differential signal. The difference between the two input voltages is amplified. High-end audio equipment uses balanced interconnects, which means the signaling is differential. Balanced amplifiers are typically used in the input stage of a device.

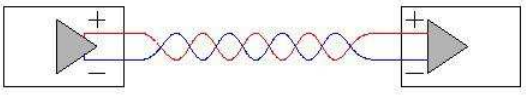


Figure 4. A basic balanced amplifier

*1) Example of a balanced amplifier:* A balanced amplifier can be constructed using a single opamp as seen in Fig5. The differential signal is fed into the opamp's inverting and non-inverting inputs. The opamp then amplifies the difference in voltage between the inputs. In order for balance to be achieved, $R_1$ must be equal to $R_3$ and $R_2$ must be equal to $R_4$.

The gain with $In_-$ active is equal to:

$$Gain_{In-} = -\frac{R2}{R1} \tag{7}$$

The output voltage with $In_-$ active is equal to:

$$Vout_{In-} = Gain_{In-} \cdot In_- = -\frac{R2}{R1} \cdot In_- \tag{8}$$

The gain with $In_+$ active is equal to:

$$Gain_{In+} = \frac{R4}{R3+R4} \cdot (1 + \frac{R2}{R1}) \quad (9)$$

The output voltage with $In_+$ active is equal to:

$$Vout_{In+} = Gain_{In+} \cdot In_+ = \frac{R4}{R3+R4} \cdot (1 + \frac{R2}{R1}) \cdot In_+ \quad (10)$$

The total output voltage is equal to:

$$Vout = -\frac{R2}{R1} \cdot In_- + \frac{R4}{R3+R4} \cdot (1 + \frac{R2}{R1}) \cdot In_+ \quad (11)$$

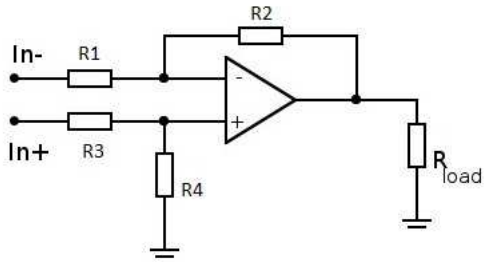


Figure 5. Example of a balanced amplifier

*2) Unbalanced amplifier:* An unbalanced amplifier is the opposite of a balanced amplifier. An unbalanced amplifier has a single-ended input which is more susceptible to common mode noise.

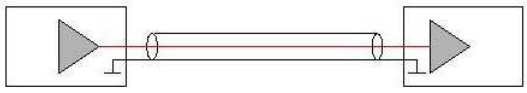

Figure 6. Single-ended unbalanced amplifier

*3) Advantages of balanced amplifiers:* Since the voltage between the inputs is amplified, any voltage common to these inputs is rejected. Common mode noise is therefore canceled out. Mains hum caused by ground loops can be eliminated, since the signal ground does not have to be connected directly to the ground of the amplifier.

*4) Applications of balanced amplifiers:* Balanced amplifiers are commonly used in professional audio equipment to reduce common mode noise introduced in long cables. It's also used to eliminate ground loops.

## II. Related work

[1] M. Prokin, "Boost Bridged Audio amplifier", Faculty of Electrical Engineering, Belgrade university, Serbia, May 2001

## III. Conclusion

Bridged amplifiers can be used to increase power output when supply voltages are low. Balanced amplifier can be used in professional audio equipment to reduce common mode noise introduced in long cables and eliminate ground loops.

## IV. References

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[6] Douglas Self, "Small Signal Audio Design", Elsevier Ltd.,Oxford, UK