

Research paper: (Un)bridged and (un)balanced  
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 practicum.

The subject that is chosen for this reseach paper are (un)bridged and (un)balanced amplifiers. This topic was chosen as it appeared to be the most interesting of all the available options given by the project coach. This research paper explains how bridged and unbridged amplifiers compare to each other. It also explains how balanced and unbalanced amplifiers compare to each other.

## Abstract

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

# 1 Amplifiers

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

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

## 1.1 Bridged and unbridged amplifiers

A bridged amplifier consists of two amplifiers driving a load floating in between their outputs[1]. Fig. 1 shows a typical bridged amplifier.

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

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"  $R_{load}$ . The output power across the load is effectively doubled. Assume:

$$U_{amp} = U_{amp2} = -U_{amp1}$$

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

The circuit in Fig1. has a total gain of 4. Bridged amplifiers are often used when the power rails do not supply sufficient voltage.[2] A bridged amplifier can be built using two regular amplifiers instead of a monolithic bridge amplifier IC.

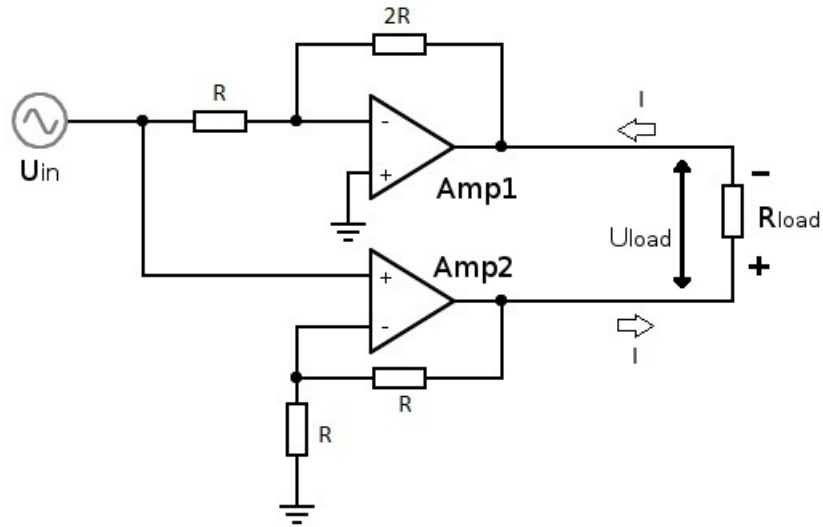


Figure 1: Bridged amplifier

An unbridged amplifier only consist of one amplifier. Therefore an unbridged amplifier doesn't have the features of a bridged amplifier (features like double voltage and double power). An example of an unbridged amplifier is given in Fig.2

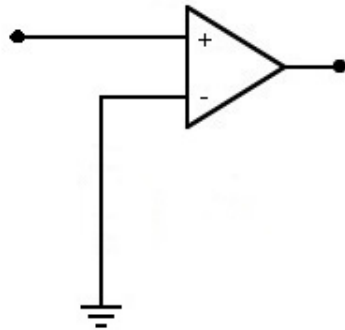


Figure 2: Unbridged amplifier

## 1.2 Balanced and unbalanced amplifiers

To reduce differential unbalance in amplifiers circuits, negative feedback can be applied.[3] This in turn stabilizes the output. These amplifiers are called balanced amplifiers or closed-loop amplifiers. This refers to the negative feedback loop like the one shown in Fig 3. With the feedback the amplifiers gain can be adjusted.

$$U_{in} = U_x$$

$$I^+ = I^- = 0A$$

$$U_x = U_{out} * \frac{R_g}{R_g + R_f}$$

$$A = \frac{U_{out}}{U_{in}} = \frac{R_g + R_f}{R_g} = 1 + \frac{R_f}{R_g}$$

The unbalanced amplifiers do not have a feedback loop and therefore the amplification is equal to the open-loop gain. This open-loop gain is typically very high. With ideal opamps the gain is infinite. Therefore an unbalanced amplifier acts as a comparator. When there is a slight change in voltage in the differential input, the output voltage will shoot up and clip at the supply voltage. Fig. 3 shows an example of a non-inverting unbalanced amplifier.

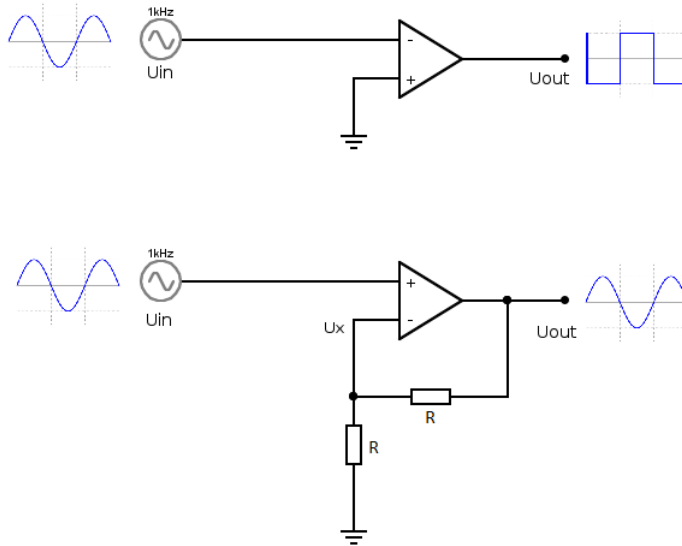


Figure 3: Balanced (bottom) and unbalanced (top) amplifier

## 2 Related work

- M. Prokin, “Boost Bridged Audio amplifier”, Faculty of Electrical Engineering, Belgrade university, Serbia, May 2001

### **3 Conclusion**

Bridged amplifiers can be used to increase power output when supply voltages are low. With balanced amplifiers the gain can be controlled by setting up a feedback loop. This stabilizes the output. Unbalanced amplifiers lack this feature and are therefore not suited for audio applications.

## 4 References

- [1] C. H. Ru. and Z.H. Wang, “High-dynamic Bridge Amplifiers with Generator for Piezoelectric Actuator”, Soochow University, Soochow, China, July 2011
- [2] J. Karki. (2008). Input impedance matching with fully differential amplifiers. [Online]. Available: <http://www.ti.com>
- [3] F.F. Offner, “Balanced Amplifier”, Offner Electronics Inc., Chicago, Illinois, March 1947
- [4] D.L. Danyuk and G.V. Pilko, Bridge amplifier with Feedforward error correction, ELECTRONICS LETTERS, May 1992