Measurement and control of line impedance

Inspection and maintenance of a loudspeaker line installation.

Review: 2

Support Handbook

1 INTRODUCTION

The impedance of a speaker is the resistance it presents as a function of frequency. It is therefore a magnitude that should be taken into account when carrying out a sound installation.

2 HOW TO MAKE THE MEASUREMENT

The measurement of the impedance of a line of speakers allows us to know directly the state of your installation. To do this, just follow these steps:

1. Disconnect the speaker line from the amplifier. Leave it free of voltage.
2. With an impedance meter or LCR meter (do not use a multimeter or ohmmeter).
3. Set the measurement to 1 kHz.
4. Take the following values (see *Diagram 1: Impedance Measurements*):
   (a) Impedance between positive pole and negative pole Line impedance.
   (b) Impedance between positive pole and ground. Shunt on positive pole.
   (c) Impedance between negative pole and ground. Derivation in negative pole.

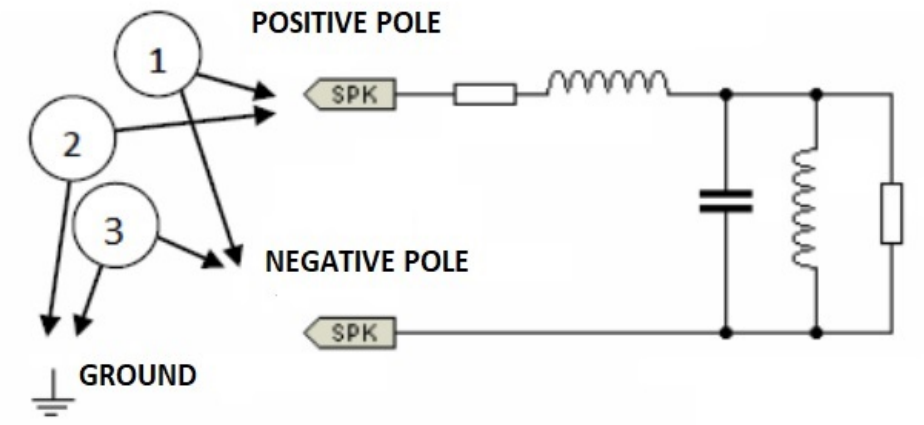


Diagram 1: Impedance Measurements

Range of values obtained:

Line impedance. Z ≈Nominal impedance (see *3.1 Real impedance vs theoretical*)

Derivation values : The ideal theoretical value is that Z = ∞, but in reality it is normal that the meter gives a lower result due to coupling effects, so the real values are:

- **20 kΩ or more:** No grounding
- **Between 10 kΩ and 20 kΩ:** Slight shunt, it is recommended to check the line. The speaker line can be connected.
- **Between 6 kΩ and 10 kΩ:** High shunt. Check the line periodically, it can vary quickly. You can connect the speaker line.
- **Less than 6 kΩ:** Bypass too high, do not connect the line. There may be a contact between the line and another metal structure in the building. When working with voltage values of up to 100V there is an electrical risk to people.

LCR METER

The essential feature of the CSF meter is its ability to measure with alternating current. The most commonly used frequency value is 1kHz because it is within the voice band. It is recommended that it is also capable of measuring other frequencies such as 120Hz or 15Khz to obtain a more accurate measurement of the speaker line.

Some brands and models on the market are:

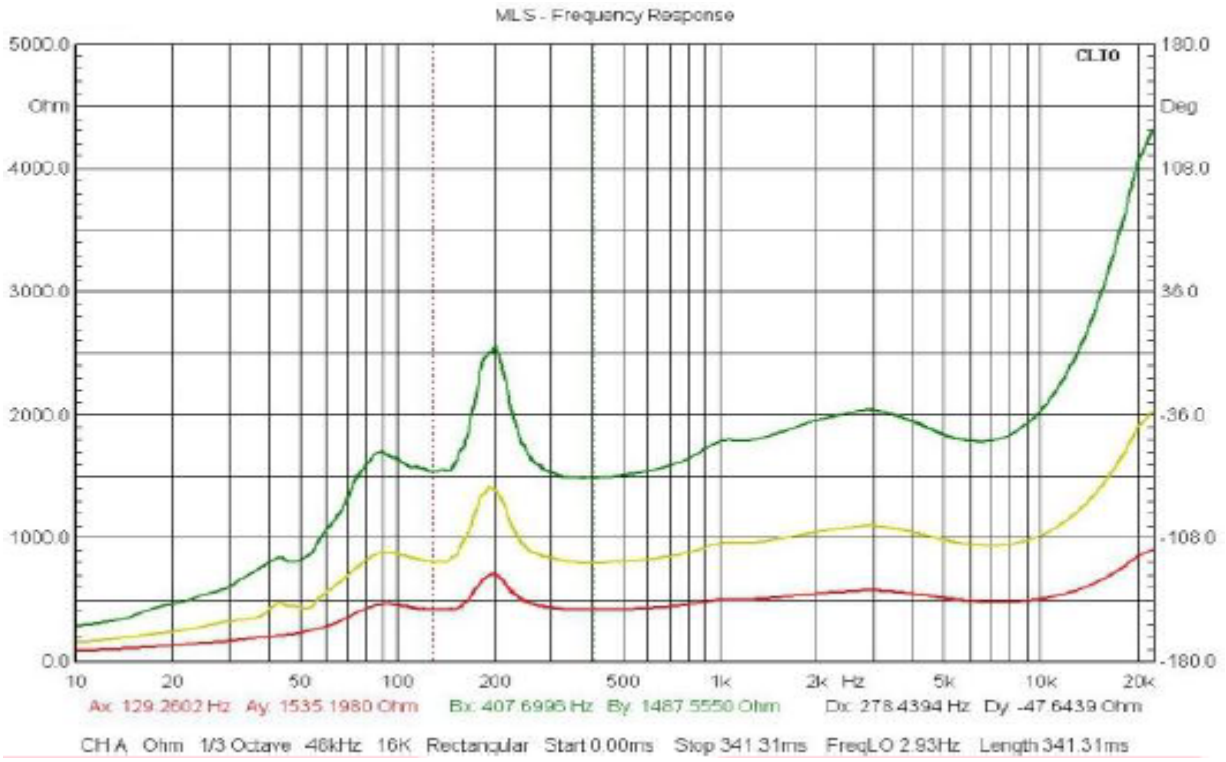
- PROMAX: MZ-505C. Measures at 120Hz and 1Khz.
- KEYSIGHT: U1731C LCR Meter. Measures at 100Hz/120Hz/1kHz.
- NTI: Audio MR Pro Minirator. Measures from 10 Hz to 20 kHz.

3 COMPLEX IMPEDANCE OF THE SPEAKER LINE. LCR MEASUREMENT COMPONENTS

Impedance is the apparent resistance of a circuit to an alternating electrical current. It is equivalent to resistance when the current is direct. It is usually referred to as the letter Z and is represented by the following equation: $Z = R + jX$

Where R is the real or resistance part and X is the reactive or imaginary part of the impedance. Within the imaginary part there are two types of reactances: inductive, due to the existence of inductors, and capacitive, due to the existence of capacitors. Real components such as speakers and wiring have an impedance that is composed of all these factors. In *Diagram 1: Impedance Measurements*

The impedance of a speaker line should be measured taking into account the CSF component, as power amplifiers operate on AC current in the audio frequency range (20Hz-20KHz).



Graph 1: Impedance of a speaker VS frequency. Measured in 5, 10 and 15W configuration

As shown in Figure 1, the value of the impedance in a speaker (or speaker line), varies considerably depending on the frequency. In order to compare them, **the measurements are normalized to 1kHz.**

NOTE: multimeter measurements:

The resistance value getting by a multimeter corresponds only to the real part of the impedance when the frequency is 0 Hz (i.e. for a continuous or DC signal), which is not indicative of actual loudspeaker performance. The graph shows that this value would be much lower than the speaker's nominal value; this will depend on the speaker's construction and the opposite effect may also occur.

3.1 Real impedance vs theoretical

It is mandatory to comply with the permited values to avoid problems in the amplifier channels and to ensure that there are no short circuits, open circuits or grounding in the speaker line.

Impedance between poles: the value should be approximately the theoretical one, which can be calculated by adding the powers of the installed speakers and applying the formula:

Example: expected value of a line composed of 20 speakers of 10 W for 100 V line. These power and voltage values are specified on the speaker itself.

The theoretical impedance of each speaker will be: $Z = \frac{V^2}{P} = \frac{(100^2)}{(10)} = 1000\,\Omega$

The entire line will give this theoretical value: $Z = \frac{V^2}{P} = \frac{(100^2)}{(20\,x\,10)} = 50\,\Omega$

The line impedance measurement (between positive and negative pole) should give a value close to 50 Ω but depending on the speaker's curve and the measurement frequency it may give values between 40 and 100. The important thing is to know that a value of half or three times the expected value could mean a problem in the line.