Speaker lines wiring for PA systems

Indications and types of wiring to be used according to regulations.

Review: 1

Support Handbook

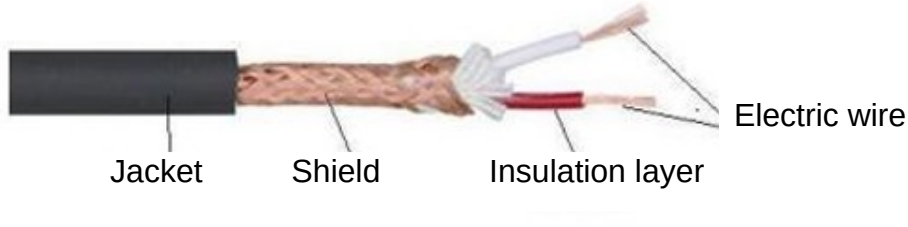
1 INTRODUCTION

Public address and voice alarm (PAVA) systems are made up of different elements, combined at the sound chain. From the input sources, the analog-digital converters, digital matrices, amplification, and electro-acoustic transducers (speakers), all play a fundamental role in maintaining the integrity and quality of the audio signal.

The purpose of this document is to serve as a guide for the choice of the most suitable cabling for public address and voice evacuation installations.

2 CABLE COMPOSITION

Picture 1: Type and composition of cable shows the typical composition of a cable: the external protector, the shield, the conductor(s) insulation and the conductor itself.



Picture 1: Type and composition of cable

The mesh (or shield) provides a mechanism to reduce electromagnetic interference in the wiring environment; due to emissions from radio frequency devices and disturbances generated by other electrical and electronic devices. It is based on the use of conductive material that surrounds the signal conductors, in such a way that it provides a low impedance path to earth for the mentioned electromagnetic interferences.

3 TYPES OF CABLE

Depending on the composition, we differentiate three types of cable in public address:

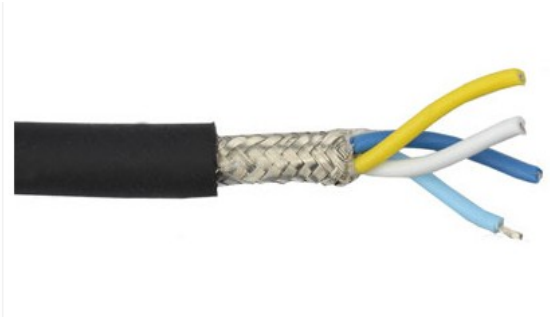
- **Twisted pair wiring:** The simplest. It has the advantage that, by interlacing the conductors, there is a certain suppression of electromagnetic interference.

Picture 2: Example twisted pair cables

- **Mesh or coaxial cable:** It has a high degree of protection against electric and magnetic fields thanks to the mesh.

Picture 3: Example coaxial wire

- **Twisted pairs of conductors with mesh (or shielded):** It has the advantages of the twisted pair of conductors, in addition to having the mesh that intercepts the electromagnetic fields. It is specially recommended for data transmission.



Picture 4: Two pairs of wires twisted with shield

From this composition, depending on the materials with which these components are made, the cable is given characteristic physical properties.

4 CHOICE OF WIRING

When choosing the most appropriate wiring for the public address system, the following parameters should be taken into account (among others):

4.1 Electrical protection regulations

As detailed in section *5*. *HIGH-IMPEDANCE LINES ,* the public address lines work with a voltage of up to 100V. This voltage cannot be considered "Very Low Voltage", as it exceeds the 50V (AC) limit. Therefore, the materials required by the Low Voltage Electrotechnical Regulations (REBT from spanish regulation) must be used in cabling and conductors, according to *Table 1: Voltage categorization according to REBT.*

	Alternating current (Effective value)	DC (Arithmetic mean value)
Very Low Voltage	$U_n \leq 50$ V	$U_n \leq 75$ V
Usual Voltage	$50 < U_n \leq 500$ V	$75 < U_n \leq 750$ V
Special Tension	$500 < U_n \leq 1000$ V	$750 < U_n \leq 1500$ V

Table 1: Voltage categorization according to REBT.

Depending on the particular case of the installation, the corresponding Complementary Technical Instructions (ITC-BT-01 to ITC-BT-52) will also be applied, as well as the UNE 20.460 Standard. In the case of public places, the ITC-BT-28 is especially relevant.

NOTE: The regulations indicated in this document are general for use in Spain. Anyway, each installation must be carried out in accordance with local, regional and national regulations. Where these are not applicable or not available, the recommendations in section *7. SYSTEM SPECIFICATIONS* can be followed.

4.2 Regulations for voice evacuation systems

The transmission of the signal at 100 V is considered as electric cable and therefore will be classified as shown in *Table 2: REBT cable classification* and *Table 3: RSCIEI cable classification* , as extracted from the REBT (stands for spanish Low Voltage Electrotechnical Regulations) and RSCIEI (stands for spanish Fire Safety Regulations in Industrial Establishments).

REBT Section	**Installation**	**Denomination**	**Minimum CPR class**
ITC-BT 20	Installation systems	No propagator of the flame	E_{ca}
ITC-BT 28	Public concurrence premises	(AS)	C_{ca} – s1b, d1, a1
ITC-BT 29	Premises with risk of fire or explosion	No propagator of the flame	C_{ca} – s1b, d1, a1

Table 2: REBT cable classification

RSCIEI	**Installation**	**Denomination**	**Minimum CPR class**
Appendix 2 Point 3.3	Located inside false ceilings or raised floors	(AS)	C_{ca} – s1b, d1, a1

Table 3: RSCIEI cable classification

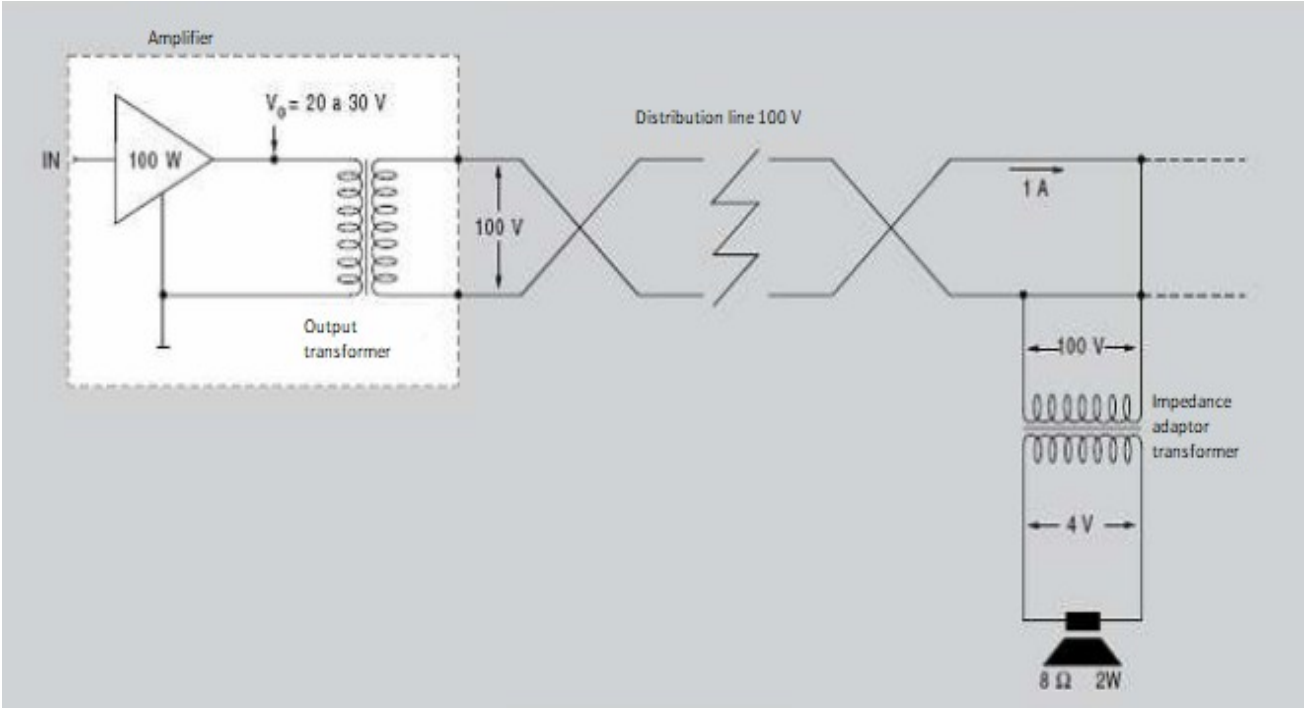
This classification is the Spanish adaptation to the EN 50575 standard. Cables with characteristics equivalent to those of the UNE 21123 standard, parts 4 or 5, or to the UNE 211002 standard (depending on the cable's rated voltage) comply with this requirement also.

Depending on the nature of the installation, to meet REBT requirements, the cables used with other specifications are:

- Flame retardant UNE-EN 60332-1
- Halogen-free UNE-EN 50267-2-1 / IEC 60754-1
- Low smoke opacity UNE-EN 50268 / IEC 61034
- Low gas corrosivity UNE-EN 50267-2-2 / IEC 60754-2

5 HIGH-IMPEDANCE LINES

One of the main parameters to be taken into account when calculating the lines is to minimize the possible signal losses, which may be generated by the distance, section and material used in the speaker lines.



Graph 1: Transport of an audio signal.

In low impedance lines, it is important to take into account the resistance of each speaker so that the assembly (series/parallel) never exceeds the nominal impedance of the amplifier.

To simplify the calculations and limit power losses, the system called "constant voltage line" or "high impedance" was developed (see *Graph 1: Transport of an audio signal.*), which consists of using an audio transformer to raise the output voltage of the amplifier to a high level (100 V), thus reducing the current to be transported through the cables. This process involves reducing this voltage again, by means of another transformer, when it reaches the speaker, to the value appropriate to the impedance and power of the speaker.

6 ELECTROMAGNETIC INTERFERENCE IN THE INSTALLATION

The choice of a shielded or unshielded cable type will depend on the electromagnetic disturbances that may be induced in the installation. Thus, if our cable ducting is our own and free from external interference, we can opt for a twisted pair. If, on the other hand, our public address system is shared with another system (for example, low voltage), the use of shielded cable is recommended.

6.1 Methods to reduce electromagnetic interference

At industrial environments, electromagnetic emissions can induce interference in the elements of the public address system and consequently damage the equipment (especially the amplification).

The following actions are proposed to reduce such interference:

1. Install cabling through separate conduits or in separate cable trays
2. If the wiring must cross a power line, it must do so, as far as possible, at a 90-degree angle maintaining the maximum possible separation.
3. To avoid loops in the wiring, it should be installed as straight as possible.
4. Using a twisted pair meshed cable to carry the audio signal minimises electromagnetic interference. If the mesh is connected to earth at one end, a path is provided for the current generated by the electromagnetic interference to flow to earth.
5. Connect one end of the screen to ground, if possible to the ground point that has the least electrical noise.
6. Minimize the length of the unshielded cables from the control room and verify that the exposed wires remain well stranded throughout their route to the connection points.

6.2 Cable laying

Cables carrying energy or signals for a PAVA System should be routed to avoid adverse effects on the system:

- Electromagnetic interference at levels that could prevent proper operation.
- Fire damage.
- Mechanical damage, including damage that could cause short circuits between VAS wires and other cables.
- Damage due to maintenance work on other systems.
- Inadequate separation or protection from other simultaneous systems.

7 SYSTEM SPECIFICATIONS

The cable types must meet the specifications of the manufacturer of the components to be connected to the VAS. Also, the characteristics of all transmission paths must be specified in the design phase and must be suitable for the specific PAVA using them:

- Current transport capacity.
- Impedance.
- Capacitance.
- Breakdown voltage.
- Insulation resistance.
- Voltage drop

Non-compliance with design requirements may result in adverse effects on the installation:

- Speaker line cables **must be at least 0,8 mm in diameter per conductor**. The greater the diameter, the lesser the effect of interference and energy losses. For more information, refer to the "Wiring Section" tools on the LDA Support website.
- The maximum voltage drop on any one line of speakers should not exceed 10% of the nominal.
- **A 10% voltage drop in a speaker circuit approaches 1 dB of sound pressure level loss.**
- It should be noted that the cumulative effect of the speaker lines and the speakers themselves should not be less than the minimum resistive load or greater than the maximum capacitive load declared by the manufacturer of the amplification equipment.
- **Long cable runs may affect frequency response and thereby compromise intelligibility**, due to their influence on line impedance.
- In case of crosstalk or electromagnetic interference affecting intelligibility, consideration should be given to increasing the physical separation of the cable from other systems or using twisted cables, shielded cables or coaxial cables.