CABLE INSTALLATION GUIDE FOR CENTRALISED BATTERY SYSTEMS

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1 INTRODUCTION

In the context of the safety and functionality of emergency lighting in buildings, correct wiring in centralised battery systems is of crucial importance. This precaution ensures reliable system operation in critical situations. The following are the main points that justify the need for a meticulous approach to this task:

1. Safety in Emergency Situations:

- Emergency lighting systems are essential to ensure people's safety in the event of a power outage.
- A system failure due to incorrect installation may hinder safe evacuation and endanger human lives.

2. Compliance with Regulations and Standards:

- Cabling must be installed to comply with the regulations and standards established for safety systems and emergency lighting.
- This ensures that the system operates within safe parameters and complies with local and national regulations.

3. Minimising risks and errors:

- Careful installation reduces the likelihood of mistakes and faults during system operation.
- Each connection and cable must be thoroughly inspected to prevent short circuits, overloads, and other potential problems.

4. Use of Qualified Staff

- It is strongly recommended that these tasks be assigned to qualified technical staff.

- Appropriate experience and training ensure that the correct procedures are followed, and the risks associated with improper installation are minimised.

5. Maintaining system integrity:

- The quality and reliability of the emergency lighting system are largely dependent on precise, careful installation of related wiring and components.

In short, the correct installation of cables in a centralised emergency lighting battery system is a critical task whose importance must not be overlooked. This work must be conducted meticulously and with diligence to guarantee the safety and functionality of the system at all times.

2 CABLING

Fire resistant cable must be used to ensure the system maintains its structural and functional integrity in case of fire. This means the cable is manufactured with special materials and coatings that enable it to withstand high temperatures and flames without spreading fire or losing its electrical or data transmission properties. In short, using fire-resistant cable helps prevent the spread of the fire and maintain continuity of power or signal in emergency conditions.

2.1 Regulations and standards applicable to fire resistant cables

The applicable regulations and standards applicable to the use of fire-resistant cables in emergency lighting systems may vary by region and jurisdiction. However, some of the most common regulations and standards are:

- ***UNE EN 50200:2016*** This European standard specifies the testing methods and requirements for fire-resistant cables used in fire safety systems, including emergency lighting.
- ***IEC 60331:*** This international standard establishes the test procedures for insulated electrical cables and cables when subjected to fire conditions for a specified period.
- ***Low Voltage Electrotechnical Regulation (REBT):*** In Spain, the REBT sets the technical and safety requirements for low voltage electrical installations, which may include emergency lighting and thus the use of fire-resistant cables. In France, the equivalent of the REBT is the "*Règlement de Sécurité pour les Établissements Recevant du Public*", more commonly known as the "*Règlement de Sécurité incendie*" (Fire Safety Regulations). In Germany, the regulation that applies to electrical installations is the "*Verordnung Uber elektrische Anlagen und*

Betriebsmittel" (Regulation on Electrical Installations and Equipment), abbreviated as VDE. In the UK, electrical installations are regulated by the Institute of Engineering and Technology Wiring Regulations, commonly known as the IEE Wiring Regulations or BS 7671. In Italy, electrical installations are governed by the "*Norme CEI 64-8*" (CEI standards 64-8). These are just a few of the regulations equivalent to the BTW in different European countries. It is important to note that although the names and specifics of these regulations may vary, they all share the goal of ensuring the safety and reliability of electrical installations.

2.2 Benefits and

The use of fire-resistant cables has significant benefits beyond preventing the spread of fire. These cables increase safety by providing a safer environment during emergencies, while reducing the risk of damage to equipment by maintaining its structural integrity. In short, in addition to complying with fire regulations, these cables actively protect people and assets in critical situations.

2.3 Recommendations

- ***Low Smoke Zero Halogen (LSOH) cables:*** These cables are manufactured using materials that produce low emissions of smoke and toxic gases in case of fire. They are suitable for areas where safety and rapid evacuation are a priority.

- ***Cross linked polyethylene (XLPE) cables:*** These cables are known for their heat resistance and ability to maintain structural integrity during fires. They are ideal for use where high fire resistance and long service life are required.

- ***Silicone coated cable:*** Silicone coated cables are flexible and heat resistant, making them suitable for environments with extreme or fluctuating temperatures. They are a popular choice for emergency lighting systems in places such as factories, warehouses, and commercial buildings.

- ***Metal armoured cable:*** These cables are protected by a metal armour that provides greater mechanical strength and protection against physical damage, as well as superior fire resistance. They are suitable for industrial and outdoor environments where conditions can be adverse.

3 INSTALLING CABLES

The cables that connect the components of a centralised emergency lighting system are an important part of the system in themselves, and it is essential that they are not subject to interference. There are two main sources of interference:

- ***Improper handling***, possible disconnection or other manual interference with the cable while working on cables from other systems.
- ***Electrical interference or crosstalk*** due to the proximity of other cables carrying currents or signals. This interference can cause an electrical signal transmitted over a cable to be induced or coupled into an adjacent cable, which may cause distortions to the original signal and affect system performance. Crosstalk can occur in electrical wiring systems, such as network cables, power cables and signal cables, particularly when they run parallel or are too close together. Electromagnetic interference can arise due to the ability of electric and magnetic fields to influence each other, especially when cables are not properly shielded or insulated. The effects of crosstalk can include a decrease in the quality of the transmitted signal, data errors in communication systems, power loss in electrical power transmission systems and even malfunction of sensitive electronic equipment.

To reduce this interference, the utmost care must be taken when handling the cables to minimise failures due to accidental disconnection of lines. To minimise this effect, it is good practice to identify the cables by colour or to label them.

To reduce crosstalk problems, you must keep your cables separate from the cables in other systems. You can separate them by one or more of the following procedures:

- ***Installation in*** ducts or channels reserved for emergency lighting cables.
- ***Separation from*** other cables by means of a mechanically resistant, rigid, and continuous partition made of a material that meets the requirements of Classes A1, A2 or B of Standard UNE EN 13501-1.
- ***Mounting the installation at a minimum distance*** of **20 cm** from cables in other systems, particularly power cables.
- ***Using electrically shielded cables.***

Distribution boxes are allowed in the system; however, it is crucial to pay special attention to the type of connector used to make electrical connections. It is essential that high-quality connectors are used that are able to withstand high currents (5A), while minimising voltage drop. Connectors must meet safety standards and be designed to manage the specific demands of the electrical system to ensure the optimal, safe performance of all electrical connections.

4 INSTALLATION TOPOLOGIES

Our system allows multiple types of electrical connections, such as:

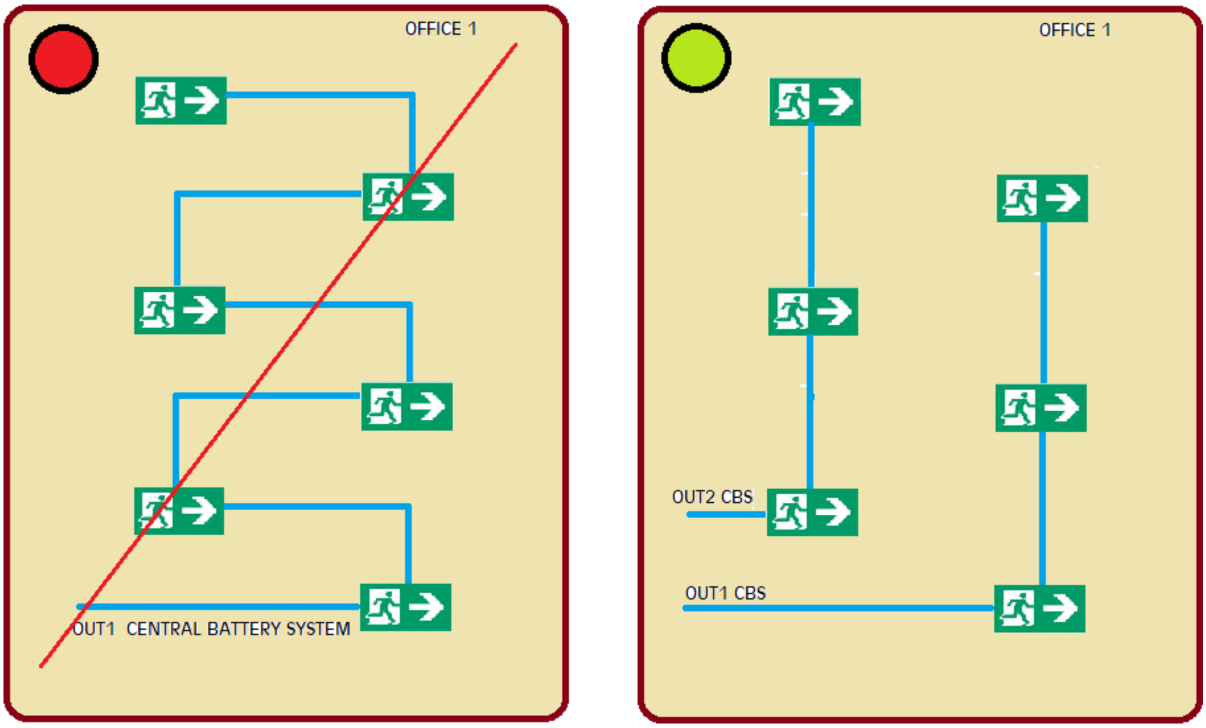
1. ***Inline connection (or inline splicing):*** This is the most basic form of electrical connection, where components are connected in a straight line. This means that the flow of electrical current passes through each component in sequence.
2. ***Fishbone (or star-type) splicing:*** In this configuration, a central point (commonly a line) is connected to each of the components in a pattern similar to a fish bone.
3. ***Parallel connection:*** In this type of connection, all the components are connected to each other in parallel, which means that each component follows its own path from the power supply.
4. ***Star connection:*** Similar to the fish bone, but with a central point.
5. ***Mesh connection:*** In this type of connection, all the components are connected, forming a network of cross-connections.

This is NOT permitted in our system.

1. **Ring connection (or loop) between two or more outputs**: **It is not possible to join several outputs in a loop, or from the same C24i, or from several.**

4.1 Recommendation

In our system, the same cable cannot be used to power more than 85W of points or, alternatively, according to local regulations (in Spain 12 lights) or, if there are several points for emergency lighting on the premises, these must be distributed, at least, between two different cables, even if there are fewer than the limit in the local regulation.



5 CALCULATING DISTANCES BETWEEN CABLES

It is essential to verify the specifications of the cabling to be used before making the calculations since the sections can have different formats. Here are some common denominations:

1. ***Nominal cross-section cables (mm²)*** *:* This is a common designation in many countries, where cables are identified by their cross-sectional area in square millimetres (mm²).
2. ***AWG or American Wire Gauge cables*** In the United States and other countries that use the AWG system, cables are referred to by an AWG number indicating their thickness. For example, an AWG 10 cable is thicker than an AWG 14 cable.
3. ***- Brand name:*** In addition to technical designations, cables may also have brand names indicating their specific use, such as "power cord", "control cable", "low voltage cable", etc. These names are usually accompanied by the cross section of the cable to indicate its current capacity.

In addition, cable resistance can be affected by factors such as the type of cable (rigid or flexible) and the material used. Therefore, it is important to consider these variables to make accurate calculations and ensure a safe and efficient electrical installation.

To determine the maximum length, we can use in a centralised battery feeding system, you must consider several factors. Firstly, you must consider the maximum permissible voltage drop, as an excessive drop can negatively affect system performance. In addition, you need the voltage to be powered, which will allow you to calculate the current that will flow through the cable. Finally, you must consider cable resistance, as this will affect the conductor's ability to transport current efficiently and minimise the voltage drop.

The first crucial step in this process is to determine the maximum permitted voltage drop. In our case, we have established that this voltage drop should not exceed **2.5** volts This value is quite restrictive. You could allow up to 3v if using a continuous cable (without cuts or splices), but also additional parameters of voltage drop due to possible connectors that can be found on the line. These connectors introduce an additional resistance into the circuit, which can affect the total voltage drop along the line. You also adjust this value (2.5V), to provide for any possible errors in the calculation of the resistance of the cable due to the temperature, since the calculation is made for 20ºC. This value is a reference point for calculating the maximum cable length in our centralised battery feeding system.

The next step is to determine the maximum power that will be supplied by the cable. This will provide the information needed to calculate the maximum current that will flow through the cable and, therefore, help you to properly size the cable to ensure an efficient, safe power supply in the centralised battery power system. For our example, we will use 80W as the total load of an output. With this value and knowing that our system is 24v, we will calculate the maximum current I=P/V , which in this case would be 80W/24v=3.33A.

Finally, you must determine the maximum resistance of the cable, which will ensure that the voltage drop is within the established limit. You will do this with Ohm's law, expressed by the formula R=V/I, where **R** is the resistance of the cable, **V** is the maximum permitted voltage drop (2.5V in our case), e **I** is the maximum current that will flow through the cable. Using the example above 3.33A, we will have a cable resistance of R=2.5V / 3.33A = 0.75 Ohm.

Once you have the maximum resistance of the cable, depending on the section used and the material of the conductor, you can determine the maximum length that you can use.

To calculate this, you will use the formula to calculate the resistance of a cable and replace the length. It is important that you remember that the distance is calculated for the use of the total load at the end of the line.

$$R = \frac{P * L}{A} \qquad A = \frac{R * A}{P}$$

Where:

- R It is the electrical resistance of the cable (in ohms, Ω).
- ρ is the resistivity of the cable material (in ohms per metre, Ω·m). For copper at room temperature, resistivity is commonly 1.68×10^{-8} Ω·m.
- L is the length of the cable (in metres, m).
- A is the transverse area of the cable (in square metres, m^2). If the cable is round, you can use the formula of the area of a circle ($A = \pi \cdot R^2$), where r is the radius of the cable.

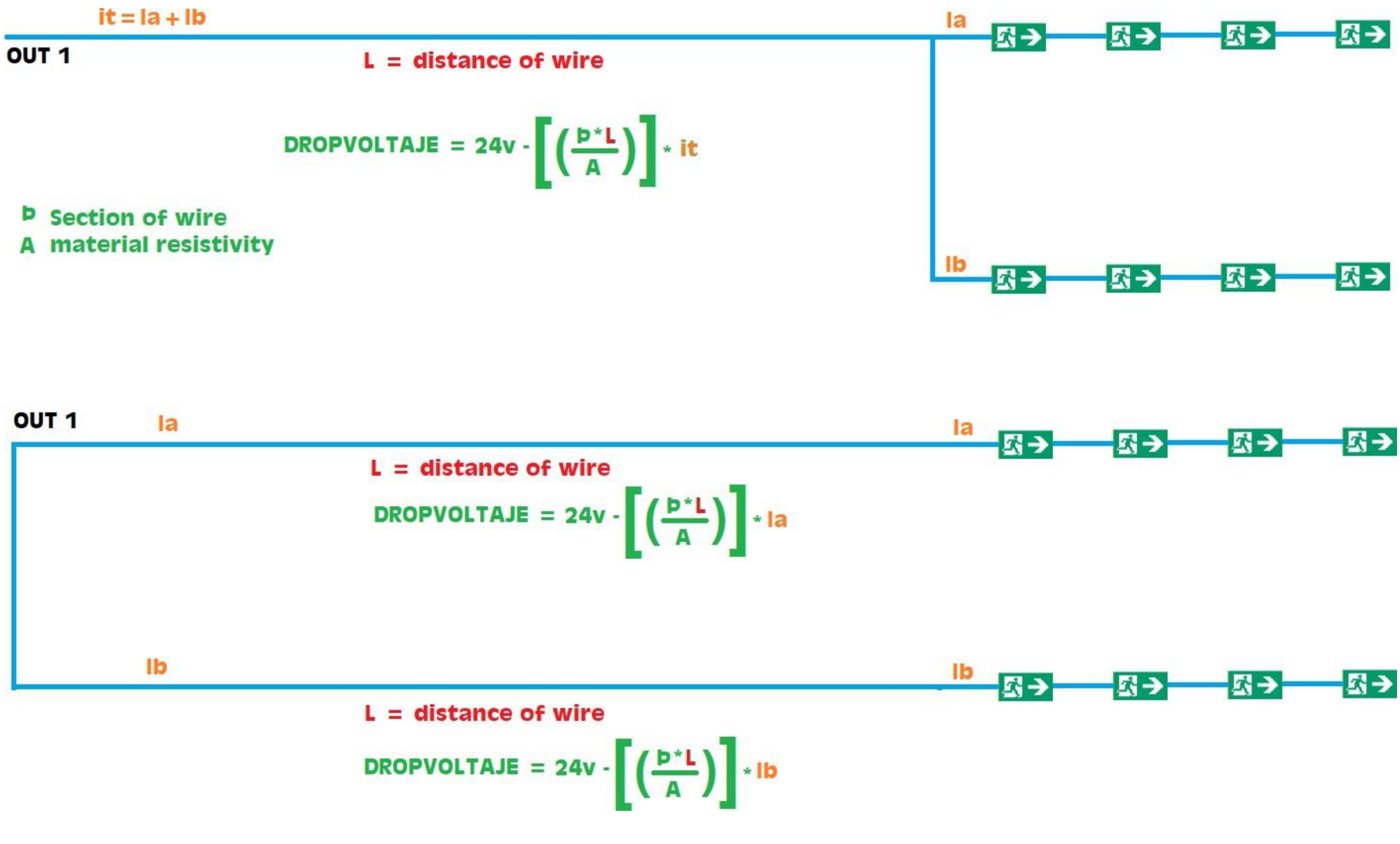
Following the above example and using a $2.5 mm^2$, conductor, you can determine that the maximum length that can be used for one 3.33A current and a maximum voltage drop of 2.5V, is

$$L = \frac{0.75 * 2.5 \times 10^{-6}}{1.68 \times 10^{-8}} \quad 111.6 \text{ m}$$

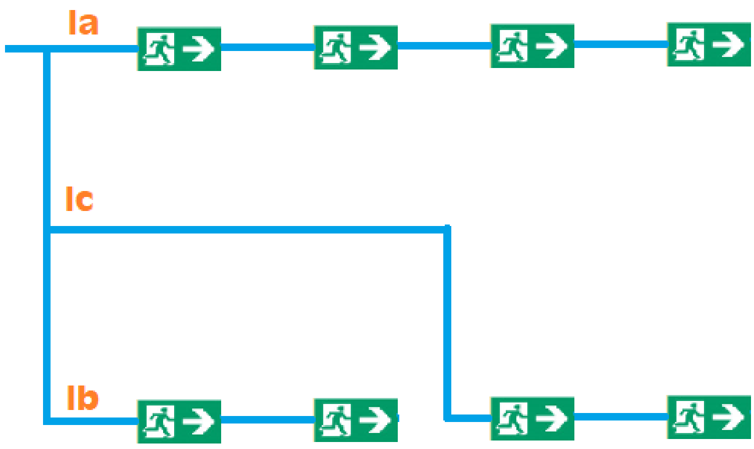
This result should be divided by 2 since the system needs 2 conductors (+) and (–).

5.1 Techniques for increasing the distance from the cable

As discussed above, to ensure that the voltage is maintained within the necessary limits along the length of the cable, it is essential to consider two basic factors: the cross-section of the cable and the current that runs through it. These parameters are critical to ensure efficient transmission of electrical energy. Therefore, in a facility with a fixed wiring section, you can adjust the electrical loads to minimise the current flowing through the conductor. This allows you to increase the length of the cable while keeping voltage drop within acceptable limits. Using this strategy, you can optimise the electrical installation design to ensure efficient, reliable system performance, even over extended distances.



In case of occasional faults in voltage drop, it is also possible to apply the previous technique at a smaller scale and distance.



6 CABLE CHECKING PROCEDURE

Before connecting the cables to the centralised battery system, you must check they are in good condition with no anomalies. The following aspects must be checked:

1. ***Short circuit:*** Use a multimeter to check that line A does not have a resistance close to 0. In this case, a short circuit failure is highly likely. Until the issue is identified, the entire line must be inspected.
2. ***Online tension:*** Use the multimeter to check that the voltage in the disconnected line is 0, both in AC and DC. If voltage values are observed, the line is connected to another system.
3. ***Inline Neutrals:*** Use the multimeter to measure the voltage between the DC power line and the ground. If the DC line is connected to the AC line neutral, you may see 0V or a low voltage, as the AC line neutral is usually grounded.
4. ***Checking for voltage drops:*** If points 1.2 and 3 are correct, the line can be connected to one of the outputs, and a luminaire register will be made to then light up the entire line. Once the process is complete, disconnect the output line from the C24i, and connect the line to an external 24v DC supply, to measure the voltage at the most distant points from the line. You should not read a voltage lower than the external source voltage of 2.5v. If the voltage is lower, you must check the cable to identify the locations of the losses due to voltage drop.

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