UNIT PLACEMENT & TESTING GUIDE

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Foreword

When Casambi enabled devices are paired to a Casambi network the units form a wireless mesh through which they communicate with each other. The communication is via Bluetooth Low Energy (BLE), a 2,4 GHz high frequency radio signal (RF signal).

Any high frequency RF signal is greatly affected by its surroundings. Real life achieved communication distance does not depend on the Casambi device but on the materials and obstructions around or close to the Casambi units which can reduce or block radio signals. For example, a luminaire with a metal enclosure will have a shorter communication distance than an identical looking luminaire made from plastic

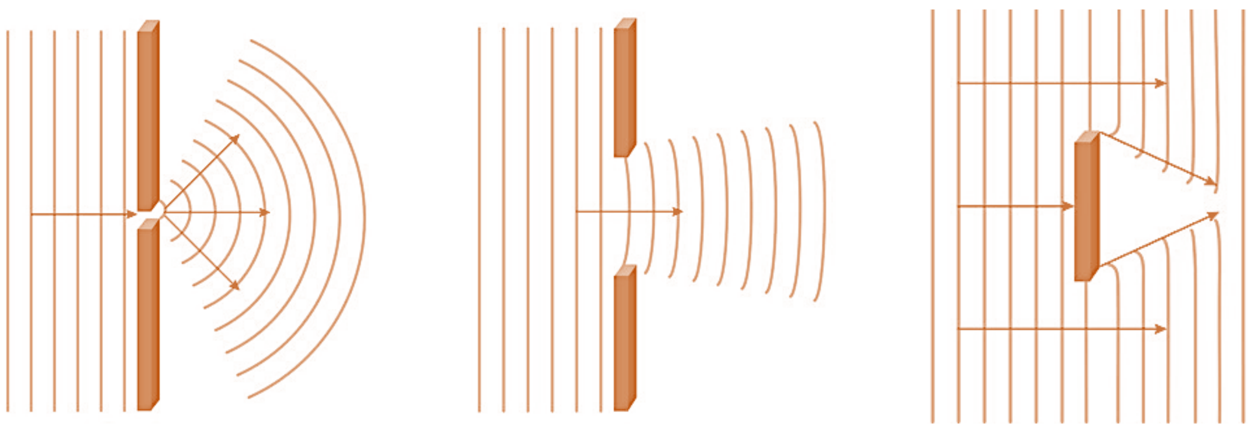
Poor placement or material selection may cause significant problems. This is why a careful planning and vigorous testing is required to achieve a good performance when integrating a Casambi unit into a final product solution.

This guide gives basic information and guidelines on how to do that successfully.

Wave basics

If (radio) waves are obstructed they are diffracted (bent), weakened or blocked. Wave diffraction will vary depending on the wavelength and size of the gap through which the signal is passing. The strength of the signal (i.e. the distance that it can travel) is also affected by material type & thickness that the wave encounters.

Maximum diffraction occurs when wavelength = gap size. In the image below, not the “blank” areas where the wave does not reach/is weakest.



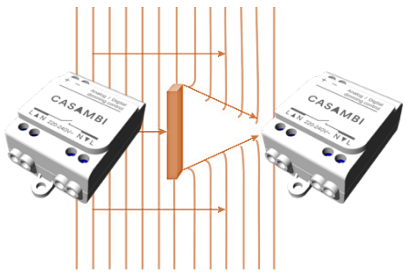
Placement considerations

Each Casambi product has an internal antenna. The surroundings of the antenna affect how good the performance (i.e. communication distance), will be. All metal, including non-magnetic metals such as aluminum, close to the antenna will have a negative effect. The antenna should as far away from any metal as possible. If some metallic structure has to be placed close to the antenna, there will have to be large openings near the antenna.

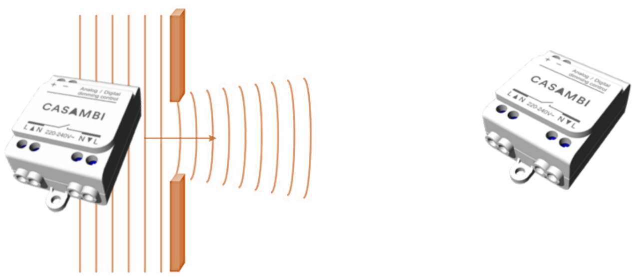
When multiple Casambi devices are placed on a final installation then obstructions on the site, and the materials from which they are made, can also affect performance. Placing units in direct line of sight provides the best communication possibilities. Small barriers may also only have a minor affect. The physical distance between Casambi devices is also important since the signal strength will reduce the further the devices are from each other.

Line of sight

Small barriers



Distance



Design guidance

For Casambi CBU components

1. Think of the enclosure into which you are installing the Casambi unit as a lampshade. The Casambi device can be considered as the light bulb.
    a. How well would the light exit the enclosure?
    b. In what direction would the light go?
2. All metal, including aluminum and other non-magnetic metals, are harmful for RF signals. Place the Casambi unit as far away from any metal as possible.
3. Do not place Casambi unit inside a closed metal enclosure. It will efficiently block all RF radiation.
4. If the Casambi unit has to be placed close to metal or in a closed metal enclosure, make any opening to the enclosure as large and as close to the Casambi device as possible. If needed, openings can be covered with plastic.
5. If large openings are undesirable, then it may be preferable to only cut a small rectangular slot in the enclosure. This should be at a specific length of 62.5mm This will ensure that the radio signal resonates as well as possible. The width of the slot is not as critical.

For Casambi CBM integration

When designing a product in which the CBM will be integrated it is necessary to consider many more factors, not only the size, shape and material of the final product enclosure. The entire design of the electronic circuitry surrounding the CBM is also of critical importance to the final performance.

The product's surrounding electronics and structures have a severe impact on the radiation pattern of the final product. The signal range can be good in one direction, but not in another. Design therefore requires a deep knowledge in RF technology as well as state-of-the-art measuring devices.

Once the product's enclosure, other components and structure have been decided, it is possible for designers to optimize the RF performance by electrically matching the antenna to the surroundings. This can be done in a specialized RF laboratory. Correct matching of the antenna can result in a huge impact on the performance of the product. During the antenna matching process, it is also possible to measure the radiation pattern of the product in different orientations. This gives the product designer a good understanding on which direction the RF signal is strongest and which weakest. Design improvements can be made based on this information.

Testing

It is extremely important to make various tests in each step of the whole design and prototyping process. No product should be put into production without sufficient testing having been carried out. If such cases occur then it will be the end user who may be first to notice the poor performance, and by then it will prove extremely costly to redesign the product.

The importance of testing cannot be emphasized enough. There can never be too much.

It is not enough to just test the range between a mobile phone and the product. This is because a mobile phone may have a stronger signal that the actual product and so may communicate further.

Testing must always be done between two identical products, and it's advisable to also test at different angles and directions depending on how the final product may be intended to be installed. This is because the RF signal is heavily influenced by the surrounding structures and the radiation pattern varies in different direction. For example, a linear luminaire may have a different communication range between luminaires depending on whether they are installed in a side-by-side or end-to-end configuration.

The testing should be done wherever practical at every step of the product design process, even before the first prototype is being built. When the basic structure of the product is decided, a mock-up model should be fabricated. This can be a very simple structure which shares the same material and basic form of the intended product. The desired Casambi unit is placed into its intended position and tested there. The final product itself does not even have to be operational at this stage. Instead the Casambi unit can be powered directly. This kind of test gives a preliminary idea of the RF signal performance in the intended product design.

If the range seems promising, an actual product prototype can be made which is tested again more thoroughly. This gives a good foundation for the actual production version.

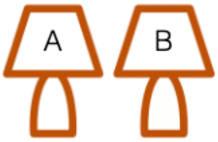
Simple range test procedure

The following testing procedure should be done in every step of the product design process. It is not possible to overtest when it comes to RF signals. To test the range between two units, follow the steps below:

1. Prepare two identical test samples (e.g. Unit A and Unit B).
2. In the Casambi app create a test network and pair these two units to it.
3. Turn the power off from both units.
4. Switch power on to Unit A and wait until you can control the device from the Casambi app. Your mobile device is now communicating with Unit A.
5. Switch power on to unit B and wait until you can control the device from the Casambi app. Unit B is not connected directly your mobile device, but is being controlled via the signal coming from Unit A.
6. Without moving Unit A or your mobile device, move Unit B further away from Unit A.
7. Control he units continuously, for example by repeatedly tapping “All lamps” icon in Casambi app to turn the devices on and off.
8. Your mobile phone will stay connected to Unit A for the whole time, but at some distance Unit B will appear offline in the app and will not be controllable. This gives an indication of the limit of communication distance in that specific configuration.
9. It is recommended to test multiple times and also turn the final products in different angles and directions and repeat the testing.
10. It is also advisable to test in different surroundings, such as corridors or large halls.

Simple range test procedure diagram

1.



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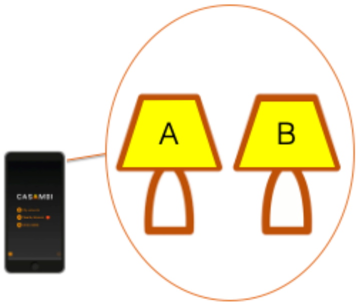

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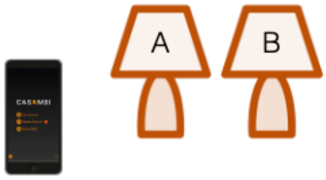

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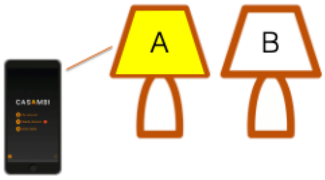

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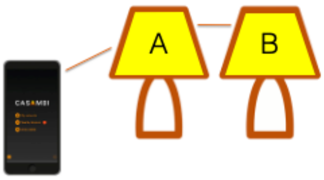

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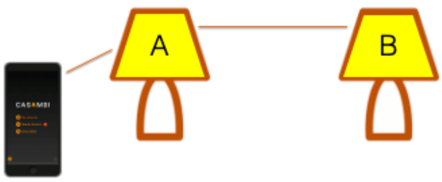

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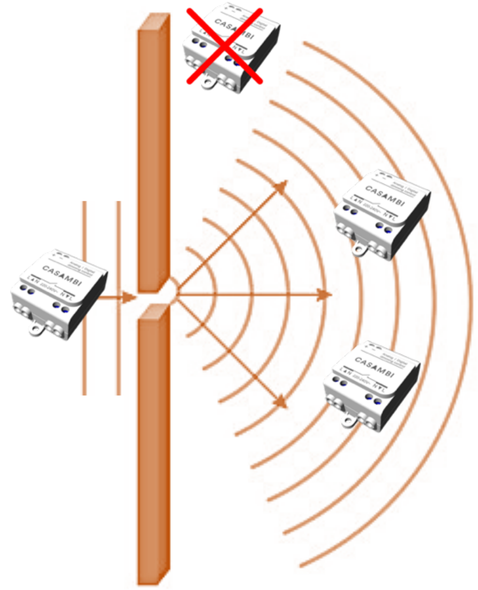
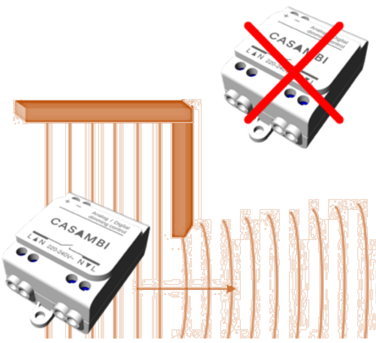
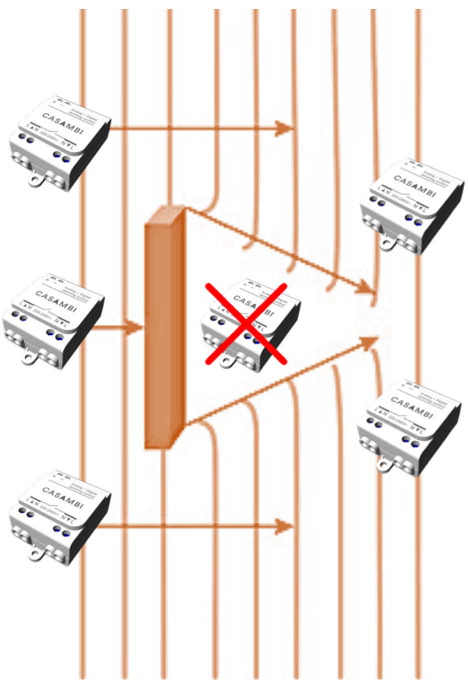
Communication issue examples

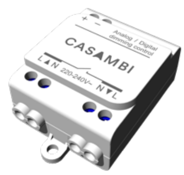
Obstructions and materials may cause communication problems even when it appears that Casambi devices are within range of each other.







Too much distance between devices



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