**ActiveAhead** wireless, self-learning, continuously adaptive, out-of-the-box lighting control solution

ActiveAhead is a continuously adaptive wireless lighting control solution. It offers enhanced comfort and convenience together with energy savings, thanks to its patented self-learning algorithm. Wirelessly networked ActiveAhead devices use the smart algorithm to learn how the space is used. The luminaire operations are adjusted accordingly to offer the user an unobtrusive experience.

Once installed the ActiveAhead devices will establish a mesh network based on wireless Bluetooth low energy technology. Luminaires exchange information between themselves over the mesh network. They use the data they receive together with the data they sense to understand how the space is used. This makes it possible for the system to learn to predict where light is next needed in a smart way depending on the actual space usage.

In addition to the energy savings and comfort offered by the smart lighting, the ActiveAhead solution offers savings provided by simpler installation with no control wiring or need for a central controller. Typically, ActiveAhead solution provides good lighting experience in a space with no need for on-site adjustments. However, customization such as adjustments of light levels, timeout values, grouping and wall panel configuration are possible by using the ActiveAhead mobile application.

The ActiveAhead solution is well suited for offices with open office spaces, corridors, social areas and small to medium sized meeting rooms with basic lighting control needs. In addition, ActiveAhead solution’s ability to learn space usage offers many benefits in applications such as stairways, corridors and parking garages. Lighting refurbishment projects in which it is not possible to add control cabling are well suited to be implemented using ActiveAhead.

# General

## Introduction

1. ActiveAhead is an advanced lighting control system, which shall combine sensor technology with an algorithm that shall learn from space usage to provide appropriate lighting conditions in commercial buildings.
2. The solution shall provide enhanced lighting comfort and increased energy efficiency (compared to simple switch solutions) while autonomously operating (“fit and forget”), being simple to install (“plug and play”) and commissioning free (“out of the box”).
3. It shall be an easy specifiable, scalable and modular system, allowing new luminaires to be added to the network without any additional programming.
4. Installation shall be simple: the technology shall be integrated into the luminaire; thus, no rewiring shall be necessary, it shall be a genuine plug and play solution. The easy installation and avoidance of additional wiring shall reduce time and cost for contractors, and shall make it ideal for refurbishment where adding additional controls wiring is not preferred.
5. The solution shall support standard DALI luminaires. A Control Unit DALI device shall act as a DALI bridge connecting the DALI luminaires to the wireless mesh network. It shall be possible to connect one to four DALI luminaires to one Control Unit DALI device. The device shall reside either inside or outside a DALI luminaire.
6. ActiveAhead patented algorithm shall learn the space usage through sensors integrated into luminaires, detecting both presence and ambient light. It then shall use this information to predict where people will be going to provide the appropriate lighting conditions. The algorithm shall be constantly and continuously learning, able to adapt instantly to changing conditions and always keep the lighting at the ideal designed level. The learnt parameters shall be saved to endure possible power outages. For example, if a person is walking down a corridor towards a frequently used room, ActiveAhead shall begin to raise the light levels in the entrance area of that room ahead of potential entry so that they shall not enter a dark space, while keeping the corridor well-lit in case the person shall continue to walk in that direction.
7. From the moment they shall be installed, luminaires with integrated ActiveAhead shall wirelessly connect to each other building a Bluetooth low energy based mesh network. This shall enable them to communicate with each other automatically, dimming or raising light levels as per the space usage. Solution intelligence shall reside in the wireless networking capable Control Unit. Each device in the mesh network shall act as a node for received data.
8. ActiveAhead shall provide good lighting experience in a space with no need for on-site adjustments. However, customisation such as adjustment of light levels, timeout values, groupings and wall panel configuration are possible by using the ActiveAhead mobile application.
9. The ActiveAhead solution shall be designed for data driven future in mind and new features are planned for future releases.

## Overview

1. The ActiveAhead solution shall be formed of ActiveAhead enabled luminaires.
2. The ActiveAhead enabled luminaire shall be formed of the ActiveAhead Control Unit, ActiveAhead compatible LED driver and the multi-functional ActiveAhead compatible sensor or alternatively of the ActiveAhead Control Unit DALI, DALI LED driver and the multi-functional ActiveAhead compatible sensor.
3. In case of the ActiveAhead Control Unit, all components shall be wired in series allowing for single power supply from the LED driver.
4. The installation of the luminaire shall not require connecting any other cables besides the mains power to the luminaire. No commissioning shall be needed either.
5. Standard DALI luminaire shall be converted to ActiveAhead enabled luminaire by using specific control unit (ActiveAhead Control Unit DALI) and the multi-functional ActiveAhead compatible sensor.
6. In case of DALI luminaire, the ActiveAhead Control Unit DALI and the multi-functional ActiveAhead compatible sensor can also be installed outside the body of the luminaire.
7. It shall be possible to use the ActiveAhead Control Unit DALI together with the ActiveAhead compatible sensor as a separate sensor node without a DALI luminaire.
8. The luminaires in a network shall communicate with each other using the CSRmesh (Bluetooth low energy mesh) technology, which also shall provide safe and secure transmission of the messages. The luminaires shall not communicate with other building service systems.
9. The solution shall be intended to be operated as an autonomous operating luminaire system with no need for wall switches. However, the luminaires shall be possible to be locally controlled by ActiveAhead wireless control panels in areas like meeting rooms. Also it shall be possible to switch off luminaires by disconnecting the mains power to them. When reconnected the solution shall continue normal operation, including continuous learning.
10. Temporary power outages shall not impair the operation of luminaire, the operation shall continue normally after the mains power returns.
11. No other sensors than the ones that can be connected straight to the wireless networking capable Control Unit shall be used in the solution.
12. The solution parameters shall be configurable using a mobile application. It shall allow parameter changes as well as grouping of luminaires.
13. The solution shall allow creation of groups and manage them. One Control Unit shall support up to three groups and additionally up to three corridor hold.
14. The luminaire shall be resettable, if the environment shall change or that shall be otherwise desired. The resetting shall be possible to one individual luminaire, group or the whole network. After the reset the luminaire shall forget its previously learned parameters and shall start the continuous learning from zero.

# Functional description

## Continuous learning

1. After the initial connection of the mains power, the luminaire shall start to gather information instantly from the multi-functional sensor as well as from the other ActiveAhead luminaires in the network. The data shall be processed and used to control the luminaire light levels and timeouts.
2. The solution shall continue to gather information and learn from it as long as it shall be connected to the mains power. Consequently, the solution shall adapt to the changes in the environment.
3. The solution shall save and remember the learnt parameters and information about the closest luminaires.

## intelligence

1. The pre-programmed self-learning algorithm shall reside in the wireless networking capable Control Unit, which shall analyse the data it receives and shall instruct the LED driver accordingly.
2. To operate correctly, the multi-functional sensor shall be connected to the wireless networking capable Control Unit and the wireless networking capable Control Unit to the LED driver at all times after the installation within the luminaire.

## Mobile application

1. A mobile application shall be available for optional fine-tuning of the solution parameters. Normal operation shall not be reliant on configuration by the mobile application or any other commissioning software.
2. The application shall be available for approved mobile devices (iPhone 4s / iPad 3rd gen / Android 4.4 onwards and Android 6.0 onwards with NFC for wall panel configuration) equipped with Bluetooth low energy It shall be possible to configure the parameters of a single luminaire or a group of luminaires or a network or luminaires over a Bluetooth connection with the mobile application. The configurations shall be possible once the mobile device shall be connected with one of the luminaires in the network. Connection to the luminaire shall be possible once the Bluetooth signal strength is strong enough to establish the connection.
3. Security shall be essential in the smart building environment, and ActiveAhead shall have a comprehensive set of security protocols to keep the system safe and operating effectively. Three layers of security shall protect the control system: the connection of a mobile phone to a luminaire for optional customization shall happen through the point-to-point Bluetooth connection only possible nearby the luminaire, Bluetooth low energy mesh shall be encrypted as well as the output of the algorithm.
4. The operation of the App is described within the app and visually for parameter changes. Those parameters are described in the after following chapters of the specification.

## Occupancy Control

1. Energy saving and enhanced user comfort shall be provided by the use of intelligent occupancy control. The occupancy control shall consist of presence and absence detection both in the luminaire’s own range of sight as well as that of the other ActiveAhead luminaires in the network. The occupancy control behavior shall be adjusted automatically by the solution software, according to the results of the continuous learning.
2. The solution shall have different states in which a luminaire may be. Moving from one state to another shall happen by fading in an unobtrusive manner. Each state shall have default parameters for light level.
3. Presence detection:
The integrated sensor shall initiate the light output automatically when presence shall be detected within the luminaire’s range of sight. The light output shall be also initiated when selected other luminaires in the network shall detect presence. Each luminaire in the network shall continuously learn which are the selected luminaires it should follow. Group members shall react to the presence detection in any group member’s range of sight.
4. Dimming down for energy saving:
The sensor integrated in the luminaire shall initiate the automatic reduction in illumination of the area after a timeout period of non-occupancy (absence). A luminaire shall dim the light output to the defined level during a set fade time.
5. The light levels and timeout parameters shall be modifiable manually with the mobile application if desired. It shall be also possible to set the luminaire not to switch the light off at any time, but to retain the minimum level indefinitely in case of prolonged absence. The default preset, parameter values shall be the following for the ActiveAhead solution from the Control Unit firmware version 1.5 onwards. The default parameters for the previous versions and default value background information are explained in the ActiveAhead Self-Learning Solution - System Description document available through Helvar sales and technical support.

Light levels in different states:

* + Occupied: 85 %
	+ Power save: 20 %
	+ Minimum: 0 %

Occupancy timeout: 4 min
Transition timeout: 5 min

Fade-up time: 1 s
Fade-down time: 60 s

Daylight harvesting: On
Minimum daylight harvesting dimming level: 20 %

## Resetting

1. It shall be possible to reset a single luminaire, group of luminaires or a network of luminaires by using the ActiveAhead mobile app.

## interruptions

1. The recovery from a power interruption shall be deterministic. The luminaire shall continue as if no interruption had occurred, that is maintain the parameters as they were prior to the interruption.
2. A sensor failure in a luminaire shall mean that the wireless networking capable Control Unit shall no longer detect presence. Such a luminaire shall continue to follow the other luminaires in the network for a period of time and act according to the learnt parameters.
3. In case of a wireless networking capable Control Unit failure, the luminaire shall turn the light output to 100 percent. In case the failure shall be limited to the radio transmitter, the luminaire shall continue as if no interruption had occurred while the other luminaires in the network shall not be able to receive messages from the luminaire in question. In case the failure shall be limited to the radio receiver, the luminaire shall continue operating as a standalone luminaire while still sending out messages to the other luminaires in the network.
4. In case of a LED driver failure, the luminaire shall be off.
5. In case one of the luminaires in the network fail, the other luminaires in the network shall continue working without interruptions. A possibility shall exist that the failed luminaire shall create a disconnect in the mesh network; thus, dividing the network in to multiple networks. In such a case, the networks shall each operate independently.

## eMERGENCY LIGHTING

1. ActiveAhead 1.0 shall operate within regular luminaire use cases, i.e. it excludes luminaires that also functions as emergency lighting (i.e. luminaires that have mains to battery switch-over and need to move to highest light level overriding any sensor input data).

## Distance and Height of luminaires installed

1. In order to achieve highest comfort and/or energy consumption savings, it shall be recommended to position neighbouring luminaires not further apart than 5 meters from each other.
2. In order to achieve highest comfort and/or energy consumption savings, it shall be recommended to position the luminaires at ceilings not higher than 3 meters.

## CONNECTIVITY OF LUMINAIRES INSTALLED

1. Control Units shall use 2.4 GHz Bluetooth low energy (BLE) wireless communication. Signals shall be transmitted and received by the built-in chip antenna located inside the wireless Control Unit.
2. Designing luminaires and environments which shall enable good connectivity between wireless Control Units and mobile application to connect to wireless Control Units shall be advised in the ActiveAhead documentation such as Guidelines for ActiveAhead Luminaire Design and ActiveAhead Self-Learning Solution - System Description document available through Helvar sales and technical support.

# Product description

## Solution software

1. The solution software shall reside partially in the wireless networking capable Control Unit with pre-programmed algorithms as well as partially in the ActiveAhead compatible LED driver.
2. The software shall enable the luminaire to implement defined functions such as:
	* Automatic continuous learning based on the received data
	* Automatic operation of the luminaire based on learnt parameters
	* Gathering usage data such as burning hours
	* Resetting the luminaire
	* Possibility to receive and store configuration parameters from the mobile application
	* Communication with the other nodes in the mesh network

## Mobile application

1. The application is available for approved mobile devices (iPhone 4s / iPad 3rd gen / Android 4.4 onwards) equipped with Bluetooth low energy. A list of tested phones/devices shall be provided on the App stores where the app shall be possible to be download.
2. The mobile application shall have the following features
	* Light levels adjustments
	* Timeouts and fade times adjustment
	* Control daylight harvesting
* Preset parameters
* Predefined eco and comfort modes
* Add, edit and remove presets
	+ Grouping
* Create a new group
* Add to a group
* Remove from a group
* Delete group
* Group member light level
* Corridor hold
* Remove corridor hold from a device
	+ Factory reset
	+ Security
	+ Wall panel configuration (requires an Android version 6.0 onwards device with NFC support)
* Absence detection setting
1. In order to connect the mobile device with the luminaire, the mobile device shall be within Bluetooth range of the luminaire. The distance shall depend; for example, on the material used in ceiling and luminaire as well as the position and direction of the wireless networking capable Control Unit within the luminaire.
2. Designing luminaires and environments which shall enable good connectivity between wireless luminaires shall be guided in documentation such as Guidelines for ActiveAhead luminaire design and ActiveAhead System description.
3. The integrated multi-functional sensor shall provide luminance measurement and occupancy sensing. The two sensor elements shall be separated to ensure no interaction and to give defined performance. The sensor shall be suitable for installing inside the luminaire in a recessed way with mounting features available on the sensor housing. The sensor shall have at least IP30 rated housing. For outdoor applications there shall be sensor variant with IP65 rating.
4. Occupancy detector shall use PIR technology.
5. The sensor shall be powered from the wireless networking capable Control Unit. The sensor shall be connected straight to the wireless networking capable Control Unit with a four-way, 2 mm keyed connector. No other sensors than the ones that can be connected straight to the wireless networking capable Control Unit shall be used with the solution.
6. The sensor shall comply with EN 55015, EN 61547 and EN 61347-2-11 standards and RoHS directive.
7. The dimensions of the multi-functional sensor are 32.4 mm x 15.5 mm x 14.5 mm. The flexible cable connecting the multi-functional sensor to the wireless networking capable Control Unit shall be 80 cm. Special cable length variants shall be available on request.
8. There shall exist mounting accessories for mounting the multi-functional sensor into the luminaire or into the ceiling.
9. The dimensions of the IP65 rated version multi-functional sensor are 75 mm x 60 mm x 37 mm. The IP65 rated sensor shall only be possible to be batten mounted into the luminaire.

## Wireless networking capable control unit

1. The wireless networking capable Control Unit shall have the needed software pre-programmed for the luminaire to be able to operate in an automatic way. The wireless networking capable Control Unit shall store the configuration data and parameters in a non-volatile memory.
2. The wireless networking capable Control Unit shall have the possibility to connect and power the sensor from the wireless networking capable Control Unit itself.
3. The wireless networking capable Control Unit shall be able to command the LED driver on the desired light levels.
4. The wireless networking capable Control Unit shall have the capability of connecting to the pre-programmed CSRmesh network using Bluetooth low energy. The wireless networking capable Control Unit shall be able to send, receive and relay messages within the mesh network.
5. The wireless networking capable Control Unit shall be able to connect with a mobile device over Bluetooth and receive parameters from the mobile application.
6. The dimensions of the wireless networking capable Control Unit (ActiveAhead Control Unit) are 53.50 mm x 25.50 mm x 17.20 mm.
7. ActiveAhead Control Unit shall be able to control one ActiveAhead compatible LED driver equipped luminaire.
8. The dimensions of the wireless networking capable Control Unit, which can command standard DALI drivers (ActiveAhead Control Unit DALI) are 184.0 mm x 40.0 mm x 25.2 mm. ActiveAhead Control Unit DALI shall be able to control maximum 4 DALI luminaires.

## ActiveAhead Compatible LED driver

1. The LED driver shall be able to take commands from the connected wireless networking capable Control Unit.
2. The LED driver shall have the possibility to connect and power the wireless networking capable Control Unit from the driver itself.
3. The LED driver shall be able to drive the luminaire LED module or modules in the intended way, with the capability of dimming the light output between 1 % and 100%. Accordingly, the light levels and dimming ranges shall be possible to set manually with the mobile application between these levels.

## Cable

1. A flexible cable shall connect the wireless networking capable Control Unit to the LED driver.
2. Two different cable lengths shall be available: 15 cm and 30 cm. Cable thickness shall be 3.8 mm.

## WIRELESS PANEL

1. In spaces such as offices with meeting rooms a method to enable manual control of the lights shall be provided by bringing ActiveAhead wireless control panels as part of the solution. The setup of the wireless control panel scenes shall require the use of the ActiveAhead mobile app in mobile device able to handle the NFC communication.
2. The wireless panel shall be easy to install, self- powered and need no mains power nor battery.
3. The wireless panel shall communicate with wireless Control Units using Bluetooth Low Energy technology.

# Glossary

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| **Absence detection** **BLE**  | *Where lights that have been turned on via a user interface or some other means, are automatically turned off once an area has been vacated* *Bluetooth Low Energy standard for wireless communication of devices* |
| **CSRmesh**  | *Low power wireless technology for enabling Bluetooth low energy devices to create a mesh network* |
| **Illuminance**  | *The density of the luminous flux incident on a surface* |
| **LED**  | ***L****ight* ***E****mitting* ***D****iode* |
| **Luminaire**  | *A light fixture containing one or more light sources* |
| **Occupancy sensors**  | *A device for detecting the presence of a person or people within in a space* |
| **Presence detection**  | *Where a sensor is used to turn lights on when presence is detected within the sensor coverage area, and off again once the area is vacated* |
|  |  |
| **RoHS** | *European directive relating to the* ***R****estriction of* ***H****azardous* ***S****ubstances* |
| **Sensors**  | *Devices for detecting presence or light level etc.* |