

# Organic Response

## Level 9 Darling Park Demo Site

### Organic Response Lighting Control System Inspection

LR001

Final Issue | 4 September 2012

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 224797

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# ARUP







# 1 Executive Summary

This report provides an analysis and evaluation of the Organic Response Lighting Control System as installed at Level 9 of the CBA head office at Darling Park Tower 1, Sydney. This was the original demo site to show the market the technology. Arup was commissioned to provide this analysis as independent experts in the field. The demo site involved retrofitting the Organic Response System to the existing light fittings, and overriding the existing DSI timer/photocell based control system.

The Organic Response lighting system is a new patent pending system invented, developed and manufactured in Australia by Organic Response. It is based on Distributed Intelligence, rather than centralised control. It utilises peer to peer, non-addressable wireless communications to allow “standalone” fittings to work together as a system. It consists of an array of Sensor Nodes, which each contains sensors, a microprocessor, and the ability to communicate with its immediate neighbours. This report provides a comprehensive analysis of the implications of the radical difference from existing addressable architectures.

The analysis covers a broad range of areas including:

- 1) A feature review of the novel new architecture of the system, particularly as compared with existing systems that rely on addressable networks.
- 2) A performance review of the installed system
- 3) Energy consumption. Metering was provided before the installation and continued through a ‘ghosting phase’ where the Organic Response System was operating and gathering data, but not actually controlling the lights yet, and ultimately when the Organic Response System was activated to fully control the lights.
- 4) Green Star Implications. Green Star is a Green Building rating tool commonly used in Australia to assess the energy efficiency and environmental impact of the design and construction of a base building/office fitout. The Organic Response System was assessed against each of the relevant credits available for the system
- 5) Occupancy Comfort. Motion sensor based Lighting Controls have a notorious reputation for distracting and disturbing occupants, particularly due to blind spots or insensitive motion sensors. In addition existing daylight harvesting systems are prone to oscillation and are a common source of complaints. An occupancy survey was conducted to ascertain the performance of the system from the occupants’ perspective.

The feature review of the system promised on spec to have several advantages to existing systems, primarily in the form of simplicity of specification, control system installation, commissioning and maintenance. The features of the system are presented in the report, as well as the advantages of the Distributed Intelligence architecture.



## 2 Introduction

Arup has carried out an independent review of the Organic Response Lighting Control System, focussing on the demo site installed in the head office of the Commonwealth Bank of Australia (CBA). CBA is aiming to reducing its entire carbon footprint by 20%, and Organic Response is engaged to provide their system for testing in order to reduce the lighting energy consumption.

### 2.1 System Overview

The Organic Response System utilises a technology which operates on a system vastly different from the conventional lighting control protocols such as Digital Serial Interface (DSI) and Digital Addressable Lighting Interface (DALI).

#### 2.1.1 Conventional Lighting Control Systems

Both DALI and DSI require installation of data cabling, back end hardware and extensive zoning of the luminaires. Lighting is either controlled by a pre-determined time clock, manual switches or local motion detectors which will activate a zone of luminaires that has been physically connected via cabling. The control logic of both systems is complex and the lighting within a space can only be controlled via pre-determined lighting zones due to the physical connection requirement with the installed circuiting and switching. Reconfiguration of an office layout would require re-wiring and/or reprogramming of these systems. It is generally difficult and involves after-hour installations of new cables and computer headend/software in order to retrofit these systems in an existing fitout.

#### 2.1.2 Organic Response System

The Organic Response System operates without the requirement of data cabling nor head end computers. The system is based on installing Sensor Nodes on each individual luminaire. The Sensor Nodes detect motion as well as illuminance within a space. By utilising infrared peer-to-peer communications, a wireless network is created, controlling the luminaires based on the wide, point-by-point coverage over the entire floor plate.

The motion sensors (quad element PIRs) are from Murata, a component that is incorporated into the design of the sensor nodes. The ambient light sensor (manufactured by Osram) is a separate component which is also incorporated into the Sensor Nodes, allowing detection of illuminance levels and adjustment of lighting level according to on site configuration



Figure 1 – Organic response Sensor Node

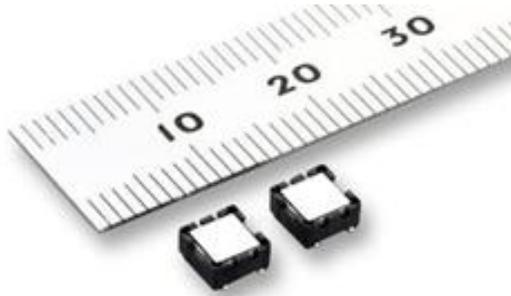


Figure 2 – Quad Core Motion Sensors (PIRs)



Figure 3 – Ambient Light Sensor

### 2.1.2.1 Motion Sensing

The motion sensors employed by the Sensor Nodes are quad-element passive infrared (PIR) sensors from Murata Manufacturing. Once a Sensor Node detects motions and presences it activates the luminaire. Utilising infrared communication, the Sensor Nodes sends signals to the adjacent Sensor Nodes. This creates a network of Sensor Nodes and activates the luminaires accordingly. The system can be configured so that a localised zone of luminaires is activated based purely on presence, instead of the conventional, pre-determined zones.

### 2.1.2.2 Light Sensing

Each Sensor Nodes is fitted with an ambient light sensor. This allows daylight harvesting and lumen maintenance operations for dimmable luminaires. Daylight harvesting reacts according to the amount of natural lighting within a space. This is typically implemented in the perimeter zone. Lumen maintenance allows automatic control of the lighting output of the luminaires, dimming them where possible to a pre-adjusted lighting level and therefore reducing energy use, preventing a space from being overlit, as well as prolonging the lamp life.

### 2.1.2.3 Configuration/Optimisation

The Organic Response System is a plug and play system. Unlike other conventional lighting control systems, the Organic Response System does not require any addressing, programming or configuration. However if desired each light fitting can be optimised via an application (app) along with an infrared transmitting attachment, designed for iPad, iPhone or iPod.

This is based on the third party app L5 Remote. By downloading the Organic Response Remote Control for the L5 Remote app, it allows pre-configuration of different “moods” for different spaces. A designer or facility manager can easily configure and reconfigure setting of individual luminaires, or a group of luminaires, based on their installed location and the function of that area. The app allows the following to be configured:

- Moods: preset lighting level correspond to the function a space
- Dimming: allows localised control of the lighting output
- Max light: setting the maximum lighting output of a luminaire. This enables lumen maintenance as outlined earlier
- Dwell time: how long a luminaire remains ON when motion is detected
- Daylight harvesting.

As there is no physical data cabling or zoning and all luminaires are controlled via infrared, the system will respond automatically to a change in layout. Should additional rooms/partitions be installed, the infrared sensors will automatically regroup without the requirement of rewiring or reconfiguring.

## Relay Configuration

To allow an easy lighting commissioning phase, the Organic Response System includes a feature called Relay Configuration. Instead of individually setting the moods, max light, dwell time and daylight dimming for each luminaire, the Relay Configuration feature allows the user of the app to utilise the setting on one “source” luminaire, and have this setting implemented for all fittings within a space where the luminaires can communicate to each other via the Organic Response System.

## New Lamp Burn-In Mode

Fluorescent lamps require a burn in time before they are dimmed to maximise their lamp life. During this period, the lamps should not be dimmed. While some lamp manufacturers allowed this as part of their lamp manufacturing process, it is always advisable to perform an additional burn in period in a new lighting installation.

The Organic Response System comes with a Burn-In mode feature. When enabled, it lasts for 50 hours. During this time, they function as normal. However the luminaires operate only at 100% or 0% - i.e. they do not dim as this can shorten the life of lamps if dimming occurs in the first 50 hours.

## 2.2 Functional Assessment Overview

Organic Sensor Nodes have been retrofit temporarily to the existing dimmable luminaires within the demo site. The intention of this report is to assess the following based on the demo site condition:

- Configurability of the sensor system
- Operation of the product and accuracy of its performance compared to its description
- The range of the motion sensors
- The sensitivity of the motion sensors

## 3 Methodology for Functional Assessment

Two methods of testing the Organic Response System have been employed:

- Physical inspection of a system demo site
- Analysis of energy usage data provided by Organic Response and verified by Arup. This is covered in Section 4 - Energy Monitoring section.

### 3.1 Demo Site

The demo site is within the Commonwealth Bank offices on Level 9 of the Darling Park Building. 46 recessed 1x35W T5 luminaires within one of the existing lighting zones have all been retrofitted with the Organic Response Sensor Node.

The existing luminaires on this floor plate are controlled via a conventional DSI system which divides the floor plate into six hardwired zones and centralised time clock control. While the existing lighting control system is functioning as intended, such that luminaires are deactivated once the system is outside of its pre-determined operation time and therefore allowing energy saving, the system neglected the presence of users within the space. By turning off the luminaires at a preset time, it disrupts the occupants of the space forcing them to activate the lights again via a manual override wall mounted switch. The current timeclock control activates all the luminaires over the full floor plate, disregarding where the occupant is located when it is outside of the preset time.

An on-site testing was carried out by Arup at 8:00pm on 8th May 2012. This report is based on the direct inspection of the prototype Sensor Nodes, retrofitted to existing luminaires installed within the test site.

The office interior is a typical Sydney commercial type with standard finishes including white ceiling tiles, standard reflectance painted walls and mid-grey carpet. The ceiling height is 2700mm.

The luminaires are primarily recessed 1x35W T5 linear fluorescent luminaires with a small quantity of 1x24W T5 fittings, all fitted with aluminium cut off louvres (indicated as Australume).

### 3.2 Motion Sensor Test Benchmark

In lieu of specific Australian Standards recommending the procedures to carry out a lighting site inspection, Arup have referred to the California 2008 building Energy Efficiency Standards: Non Residential Compliance Manual (CEC-400-2008-017-CMF-Rev1, Section 10.8). This standard proposed a step-by-step test procedure for lighting systems, including Occupancy Sensor and Manual Daylight Controls Acceptance.

Prior to the testing and inspection taking place, we ensured that the site has met the following test conditions:

- Occupancy sensors are installed properly, and located in places that avoid obstructions and minimise false signals
- All luminaires are wired and powered









- The Organic Response System was activated on the evening of 7<sup>th</sup> May 2012 without the daylight harvesting function.
- Arup attended the site on the evening of 8<sup>th</sup> May 2012 for the initial site inspection, as well as to reduce the overall illuminance by dimming the individual luminaires as detailed in Section 3.4.
- Between 3<sup>rd</sup> June and 11<sup>th</sup> July, Organic Response was gathering detailed system diagnostic information. Hence the system was not focussed on energy savings. As such the data was ignored in the energy savings calculation.
- The information of the daylight harvesting was collected between 12<sup>th</sup> July 2012 and 19<sup>th</sup> August 2012. The system was fully functional and commissioned at this stage, hence the energy savings were calculated based on this period

The following sections compare the performance of the existing lighting system against the Organic Response System (Ghosting Stage) before and after daylight harvesting was being implemented, as well as providing observation of the change in energy performance after the Organic Response System was activated.

## 5.3 Lighting Energy Usage – Ghosting Stage

### 5.3.1 Weekdays

Prior to the activation of the Organic Response System, the lighting within the test site is scheduled to be activated between 7am to 6pm, with manual override to activate all the lighting in the office afterhours where required.

At this phase of the test, the Organic Response System was set at a Ghosting phase. This collects data from the luminaire operation, while the lighting is still controlled by the existing lighting control system on site.

The data collected demonstrates that the general office lighting is typically switched ON between 6am to 7am and remains ON until approximately 8:30pm during weekdays. Typically, at around 9:30pm the luminaires are reactivated for exactly an hour, indicating the space is occupied again. This is presumably for the cleaners. All the luminaires in the test site were ON for the cleaners. The cumulative lighting energy usage during weekdays is generally 25kWhr per day.

On the 2<sup>nd</sup> May, the actual electrical meter reading indicated that luminaires in the test site were all activated at 6:10am. However the data also demonstrates that there was no movement until 6:48am. This data demonstrated that other parts of the floor were in use. However the existing lighting system was set so that it activated all luminaires in the fitout regardless of whether the zone was occupied.

As demonstrated from the ghosting information, if the motion detecting function was activated during this period, there would be a daily energy saving of 5% to 14%. This varies depending on the amount of movement during the day. Note that this estimate is based on the motion sensing function of the Organic Response System alone. The figure would be significantly higher with the other functions of the Organic Response System implemented.





## 6 Green Star Implications

Green Star environmental rating systems for buildings have been developed by the Green Building Council of Australia (GBCA). The GBCA has developed Green Star to provide industry with an objective measurement for green buildings. In assessing those elements that should be rated and to drive change in the market, the GBCA focused on areas of environmental impact that are a direct consequence of a building's briefing, design, construction and maintenance.

Green Star has built on existing systems and tools in overseas markets, including the British BREEAM (Building Research Establishment Environmental Assessment Method) system and the North American LEED (Leadership in Energy and Environmental Design) system, by establishing individual environmental measurement criteria relevant to the Australian marketplace and environmental context.

The following section provides the impact Organic Response System has on Green Star assessment, based upon:

- Green Star Office Design & Office As Built Technical Manual version 3, 2008 (Base Building)
- Green Star Office Interiors Technical Manual version 1.1, 2011 (fitout).

### 6.1 Base Building

#### 6.1.1 ENE4 Lighting Zoning

ENE4 aims “to encourage and recognise lighting design practice that offer greater flexibility for light switching, making it easier to light only occupied space.”

This point is awarded when all individual or enclosed spaces are individually switched and the size of individually switched lighting zones does not exceed 100m<sup>2</sup> for 95% of NLA. An additional point is awarded where the above point is achieved and it is demonstrated that an individually addressable lighting system is provided for 90% of the NLA.

For the 100m<sup>2</sup> lighting zone criteria, conventional lighting control systems require a carefully designed lighting zone with appropriate controls to achieve this point. The zones are preset and ignore the location of the occupant.

The mechanism of the Organic Response System is different from other conventional lighting controls. The “lighting zone” changes according to the presence of occupants and the size of the zone is dictated by the quantity of luminaires that are operated by the infrared communication. This can be simply achieved by configuring the Organic Response System so that only fittings within a limited radius are activated with occupant detection.

For the control system criteria, the objective is to allow flexibility during modification of an office layout. It has specifically shown “individually addressable lighting control system”, which to date had suggested DALI. This was due to the availability of products on the market during the time of the document in 2008. Our recommendation is that the Organic Response System,





## 7 Online Occupant Survey

This section lists the main findings from a post occupancy survey carried out after the Organic Response System had been installed and implemented for more than three months. This allows the occupants to experience the Organic Response System for sufficient time to produce more appropriate ratings.

The survey was circulated to all the occupants at the test area. The data was collected from 2<sup>nd</sup> August. The survey was opened for three weeks to allow sufficient time for the occupants to provide their responses. A total of 11 responses were received.

Refer to Appendix A for the survey results. The below sections are the summary of the findings.

### 7.1 Occupant Demography

More than 80% of the respondents have been working in the building for more than a year, while 63% work at least 30 hours per week at the test site location.

There is a fine split of both administrative staff (5) and professionals (6) in the respondent population. The age group is also split at a similar ratio between the under 30s (5) and 31 to 50 (6).

### 7.2 Occupant Responses

Eight out of eleven respondents reported that their work was interrupted when the lights were automatically turned off prior to the Organic Reponses System being installed. None of the respondents experienced any difficulty with the lighting control at their workspace recently.

Nine out of the eleven respondents believed the lighting quality enhanced their work, one believed it interfered while one did not provide a response.

Being scaled on a rating from 1 to 10, 10 being the most satisfactory score:

- The lighting level achieved a high average score of 8.64, with (6) being the lowest score recorded by one respondent, and over 50% of respondents answered with a full satisfactory score of (10).
- The lighting quality (glare/reflection/contrast) achieved a score of 8.27
- The Organic Response System, when compared to the previous lighting control installed on site, achieved an average score of 8.09

### 7.3 Summary from Responses

From the result, it indicates that the occupants are highly satisfied with the Organic Response System. There are no difficulties with the control, and with the illuminance reduction being implemented, the occupants are still satisfied with the lighting level.





# A1 Survey Data

1. How many years have you worked in this building?		<a href="#">Create Chart</a>	<a href="#">Download</a>
		Response Percent	Response Count
Less than a year		18.2%	2
<b>1-2 years</b>		<b>72.7%</b>	<b>8</b>
3-5 years		9.1%	1
More than 5 years		0.0%	0
2. In a typical week, how many hours do you spend in your workspace?		<a href="#">Create Chart</a>	<a href="#">Download</a>
		Response Percent	Response Count
10 or less		9.1%	1
11-30		27.3%	3
<b>More than 30</b>		<b>63.6%</b>	<b>7</b>
3. How would you describe the work you do?		<a href="#">Create Chart</a>	<a href="#">Download</a>
		Response Percent	Response Count
Administrative support		45.5%	5
Technical		0.0%	0
<b>Professional</b>		<b>54.5%</b>	<b>6</b>
Managerial/supervisory		0.0%	0
Other (please specify)		0.0%	0
4. What is your age?		<a href="#">Create Chart</a>	<a href="#">Download</a>
		Response Percent	Response Count
30 or under		45.5%	5
<b>31-50</b>		<b>54.5%</b>	<b>6</b>
Over 50		0.0%	0
5. Prior to the recent Organic Response lighting control system installation, did your work gets interrupted when the lights turned off afterhours?		<a href="#">Create Chart</a>	<a href="#">Download</a>
		Response Percent	Response Count
<b>Yes</b>		<b>72.7%</b>	<b>8</b>
No		27.3%	3

6. Have you experience any difficulties with controlling the lighting at your space recently?											<a href="#">Create Chart</a>	<a href="#">Download</a>
										Response Percent	Response Count	
<b>No</b>										100.0%	11	
<b>Yes (please specify)</b>										0.0%	0	
7. How satisfied are you with the amount of light in your workspace?												
Very dissatisfied (1)	2	3	4	5	6	7	8	9	Very Satisfied (10)	Rating Average	Response Count	
0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	18.2% (2)	18.2% (2)	0.0% (0)	9.1% (1)	54.5% (6)	8.64	11	
8. How satisfied are you with the visual comfort of the lighting (e.g., glare, reflections, contrast)?												
Very dissatisfied (1)	2	3	4	5	6	7	8	9	Very Satisfied (10)	Rating Average	Response Count	
0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	9.1% (1)	18.2% (2)	9.1% (1)	9.1% (1)	9.1% (1)	45.5% (5)	8.27	11	
9. Overall, does the lighting quality enhance or interfere with your ability to get your job done?											<a href="#">Create Chart</a>	<a href="#">Download</a>
										Response Percent	Response Count	
<b>Enhances</b>										90.0%	9	
<b>Interferes</b>										10.0%	1	
10. Compared to the previous lighting control, are you statisfied with the new occupancy sensors?												
Very dissatisfied (1)	2	3	4	5	6	7	8	9	Very Satisfied (10)	Rating Average	Response Count	
0.0% (0)	0.0% (0)	0.0% (0)	0.0% (0)	18.2% (2)	9.1% (1)	9.1% (1)	18.2% (2)	0.0% (0)	45.5% (5)	8.09	11	

