DALI-2:
The global standard for smart, digital, lighting control in the IoT era

Scott Wade – Technical & Certification Manager – DiiA
Ronald Tol – Director Standardization – Signify/T&C WG Chair, DiiA
Michael S. O’Boyle, LC – Technical Policy Manager – Signify/ANSI
Kevin Fitzmaurice, LC – Principal Engineer, Lighting and Smart Services – Georgia Power

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Agenda

• DALI & DiiA overview, key facts & benefits, comparison with 0-10V (Scott Wade, DiiA)
• Q&A
• New DiiA specifications – smart luminaires (Ronald Tol, Signify/DiiA)
• An End User’s Perspective to Using DALI for Outdoor Lighting (Kevin Fitzmaurice, Georgia Power)
• Q & A
DALI & DiiA

Digital Addressable Lighting Interface

- World-wide standard for lighting control communications
- Technically managed in the open standard IEC 62386
- Driven by Digital Illumination Interface Alliance (DiiA)
- Ensures interoperability through testing, certification and registration with trademark use
- Control, configuration & querying of devices over a 2-wire bus
- Individual, group & broadcast addressing to any DALI device
- DALI and DALI-2 trademarks owned by Digital Illumination Interface Alliance
Membership (May 2019)

- 170+ members world-wide

- Membership allows DALI trademark use:
  - 435 DALI-2 certified products
  - 1048 DALI version-1 registered products

- Membership types:
  - Regular
  - Associate
  - Community registration – for luminaire makers
## Membership benefits

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<th>Membership benefits</th>
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<td>Access to DiiA test sequences</td>
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<td>Participation and voting in working groups. Contribute to DiiA roadmap and development of test specifications.</td>
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[www.dali2.org/membership/benefits.html](http://www.dali2.org/membership/benefits.html)

DiiA booth: 5921
Hall F
Member companies

For the latest list of members: www.dali2.org
DALI – key facts & benefits

• **Technical limits**
  • max. 64+64 addresses per DALI subnet
  • max. 300 m cabling (between furthest-apart devices)
  • max. 250 mA bus power supply

• **Digital benefits**
  • Robust communication
  • Addressing: individual (64+64), groups (16/32) and broadcast (all)
  • Flexible: Simple operation “out-of-box”, or changes can be made via software
  • Two-way communication (feedback)

• **Cabling benefits**
  • Standard 2-core cable (1.5 mm²)
  • Polarity-free & free wiring topology
  • DALI power and data on same pair of wires
Currently, the standard describes **three basic types** of devices:

- **Control gear**
  - These are normally directly connected to the lamp, providing it with power

- **Control devices** (two basic types – see following slides)
  - Application controllers
  - Input devices

- **Bus power supplies**
  - Provide typically 16 V, up to 250 mA to power the bus.

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**Download the DALI Quick Start Guide:**

[www.dali2.org/downloads](http://www.dali2.org/downloads)
• Control devices (IEC 62386-103) are new to the DALI-2 standard. There are two types:

• **Application controllers**
  • The “brains” of the system.
  • Use information from any source, make decisions and can send commands to the control gear.

• **Input devices**
  • Fairly simple devices that provide information to the system.
  • Examples include push-buttons, sliders, occupancy sensors, and light sensors.
Control devices – Application controllers

- Can be very simple devices, or could be complex gateways interfacing with other systems

- Single-masters: Only one can be used on the DALI bus
  - Often these only support control gear, but may also be able to poll input devices.

- Multi-masters: Follow the rules for shared use of the DALI bus
  - Often they support both the polled and event driven methods of obtaining information from input devices.
  - The DiiA product database describes the supported features: www.dali2.org/products
Control devices – input devices

- **Currently four types:**
  - 301 Push-buttons
  - 302 Absolute input devices (switches, sliders)
  - 303 Occupancy sensors
  - 304 Light sensors

- Up to 32 of these “instances” can be in the same product (using one address)
  - An example is a sensor consisting of an occupancy sensor (303) and a light sensor (304):

- Operation can be event driven, or polled, or periodic transmission.

- Optional “feedback” feature can be used to control LED indicators on each instance, for example on push-buttons.
Control devices – input devices

• Input device 301: Push-buttons
  • Events can be sent on:
    ▪ Press
    ▪ Release
    ▪ Short press
    ▪ Long press
    ▪ Double press
    ▪ Button stuck

• Input device 302: Absolute input devices
  • Simple on/off switches, or multi-position switches
  • Digital inputs
  • Analog inputs
  • Slider or rotary controls
Control devices – input devices

- **Input device 303: Occupancy sensors**
  - Movement or presence type sensors catered for.
  - Events can be triggered on state change to: occupied, vacant, movement, no movement.

- **Input device 304: Light sensors**
  - Measures illuminance level
  - Programmable hysteresis to minimise bus traffic
  - Optional periodic events reporting the illuminance level
System example – Out-of-box system operation

• **Products are wired together**, and work in a similar way to 0-10V systems, without needing any programing.

• Often called a “**broadcast**” system because commands are simply broadcast to all devices.

• Addresses, scenes, groups and other **configuration is not required**.

• Bus wiring can be used to divide the operation into groups of lights, in the same way as with 0-10V.

• There are still advantages over 0-10V:
  • multiple controls can be used; controls can co-operate; push-button feedback LEDs; controls can be powered from the bus; programing can be done later if required…

• The following example demonstrates this:
System example – Out-of-box system operation

Example of operation:

- Movement triggers the sensor
- Sensor may automatically broadcast several commands:
  - DTR0 (2) [Data transfer register = 2]
  - SET FADE TIME (DTR0) [Set fade time to 1s]
  - DAPC (254) [Go to 100%]
- All lights react together by going to 100%.
System example - Commissioned (programed) system

- **Products are wired together on the same DALI bus** (no need to divide the bus wiring).

- A tool is used to set-up the system.
  - Laptops, tablets, phones, IR handsets, LCD touch-panels or even wall-mounted push-buttons are examples of programming tools.

- Main commissioning (programming) steps are:
  - Assign **addresses**
  - **Group** the devices
  - Set-up scenes, fade-times and other parameters as required.

- The following example demonstrates this:
System example - Commissioned (programed) system

Example of operation:

- Movement triggers an occupancy sensor
- The occupancy sensor automatically transmits a notification:
  `<address 2><instance 3> INPUT NOTIFICATION (0x009) [Movement detected]`
- Application controller receives this, and decides to recall scene 5 in the group 7 lights:
  `<group 7> GO TO SCENE 5 [Change level according to scene 5]`
- All lights in group 7 fade to the pre-programed levels in scene 5.

Note:
- Systems can contain more than one application controller.
- A bus power supply is required, either separate or integrated with an existing device.
Comparison with 0-10V (1-10V)

- **Wiring**
  - 0-10V: uses a **2-wire connection**, with thicker cables required for longer runs, to avoid voltage drop affecting the light output. Daisy-chain, star, tree and combinations allowed.
  - DALI: also use a **2-wire bus**, but polarity insensitive. Daisy-chain, star, tree and combinations allowed.

- **Bus power**
  - 0-10V: Drivers provide between 10µA and 2mA.
  - DALI: Up to 250mA allowed on DALI bus. Drivers consume 2mA max. Devices can be bus-powered.

- **Signal**
  - 0-10V: The voltage represents the light output, although the dimming curve is not standardised. (ANSI C137.1)

- **Other**
  - 0-10V: some manufacturers of control gear provide a non-standardised way to indicate a lamp has failed: the current sourcing in the control gear is turned off. Can be useful with a single driver.
  - DALI: **Configuration** can be changed in the control gear, for example fade time, groups and scenes. Information can also be **queried**, for example output level, lamp failure, emergency test status.
  - DALI: **Individual** devices *or groups* can be addressed/configured/controlled/queried.
  - DALI: Multiple points of control are allowed.
Common misconceptions

• DALI is a **European standard**.
  • **No!** IEC 62386 is a world-wide standard. DiiA member companies operate throughout most regions.

• DALI **devices are more expensive**.
  • Sometimes true, but the situation reversed in Europe as the DALI volume increased above the 1-10V volumes.

• DALI is **difficult** to program (e.g. laptops needed, 2-man job, difficult to replace faulty products).
  • Out-of-box operation, with no programing, gives at least the level of operation obtained from 0-10V.
  • Programing, if required, varies between manufacturers.

• Products are **not available**
  • The choice is increasing. Additionally, some companies may already have implemented DALI in their products without stating they use DALI communications.

• The drivers and controls need to be on **separate buses**
  • No – they are designed to allow connection to the same DALI bus. Look for the DALI-2 logo on the products.

• DALI is **expensive to install**
  • No – it is likely to be lower cost than 0-10V installations due to requiring less wiring
  • This makes the installation simpler and offers more robust communication.
Major changes from DALI version-1 to DALI-2

• Improved interoperability!
  • Control gear:
    ▪ Clearer specifications: timing, fading, power-on and start-up
    ▪ New: extended fade times (0.1s to 16min), bus-powered, Continuous Up/Down commands
  • Control devices:
    ▪ New to the DALI-2 standard (DALI version-1 is only control gear)
  • Bus power supplies:
    ▪ Clearer specifications
    ▪ Tests added
    ▪ Can be DALI-2 certified
• Increased testing
• DALI-2 certification!

See a comparison and download the technical note on the DiiA website: www.dali2.org/dali/comparison.html
Testing

• Products can be tested by the member company, or sent to an accredited test-house:
  • For **self-testing**, the following are required:
    ▪ ProbitLab2 test platform
    ▪ Official test-sequence software (downloaded from DiiA account)
    ▪ Oscilloscope, voltage/current/resistance meter
    ▪ Light meter (for testing of control gear and some control devices)
  • **Accredited test-houses** are listed on the website: [www.dali2.org/testing/test-houses.html](http://www.dali2.org/testing/test-houses.html)

• **Products that can be tested:**
  • Control gear of various types, with LED drivers being the most popular.
  • Control devices: application controllers, and the recently added input devices.
  • Bus power supplies (and integrated bus power supplies)
DALI-2 Certification

• **Test the product**
  • Self-tested using the approved tester and the official test sequence software.
  • Alternatively: use a DiiA accredited test-house.

• **Submit product information and test results**
  • This is done through the member’s DiiA website account.

• **Verification by DiiA**
  • Test results and product information is checked.

• **Trademark use:**
  • The DALI-2 trademark may be applied to the product and product literature.
  • The product is automatically included in the public database.
Product database (public)

- Lists all DALI-2 certified products, as well as DALI version-1 registered products

- Used for two main purposes:
  - Check if a product that shows the DALI-2 (or DALI) Trademark is really certified (or registered)
  - Find and select suitable products for an installation.

- If a product isn’t listed, it isn’t certified.

Product database:
http://www.dali2.org/products
IEC 62386 Parts

- Many existing IEC 62386 parts for:
  - Control gear
  - Control devices
  - Bus power supplies

- Several IEC parts are in progress

For latest information, see: www.dali2.org/dali/standards.html
Further information

• See the DiiA website:
  http://www.dali2.org/downloads/

• Download the **DALI Quick Start Guide**:  
  http://www.dali2.org/downloads/

• Product database:  
  http://www.dali2.org/products

• Membership benefits:  
  http://www.dali2.org/membership/benefits.html

• Contact us:  
  info@digitalilluminationinterface.org
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New DiiA Specifications

• DiiA has developed several new specifications
  • For use in smart luminaires, and products attached to smart luminaires

• Specifications (www.dali2.org/specifications/download.html):
  • DiiA part 250 – Integrated Bus Power supply
  • DiiA part 251 – Memory Bank 1 Extension (Luminaire Data)
  • DiiA part 252 – Energy Reporting
  • DiiA part 253 – Diagnostics and Maintenance
  • DiiA AUX – Auxiliary Power Supply
  • DiiA part 351 – Luminaire mounted control devices (under development)

• Collaborations with:
  • IEC TC34/WG11 on IEC62386, Zhaga and ANSI C137
  • It is expected these 5 new specifications will be included in IEC 62386
D4i specifications for intra-luminaire DALI

- **AUX power supply spec.**
- **DALI Part 250** (integrated bus power supply)
- **DALI Parts 251-3** (operational & diagnostic data)

**DALI-2 LED driver with integrated bus power supply and data**

* Auxiliary (AUX) power supply can be in a driver, or implemented in a separate product.
A primary application for these new specifications is outdoor lighting, such as streetlights

- Each streetlight can be a single DALI system
- A sensor or wireless communications module is often connected to the DALI bus
- DiiA-Zhaga collaboration is standardising:
  - the connector/receptacles (Zhaga book 18),
  - the use of DALI for communications, and
  - the bus and auxiliary power supplies.
- Through participation in ANSI C137.4:
  - Power supplies, asset management
  - Reference to ‘NEMA’ socket

Some reasons that DALI was chosen:
- Industry standard
- Specifically for lighting control
- Direct connection to control gear
- Standardised dimming curve
- Bi-directional communication
Integrated bus power supply and AUX power supply

- **DiiA Part 250 – Integrated DALI bus power supply:**
  - Provides at least 50mA on the DALI bus
  - Useful to power sensors or other control devices
- **Memory bank 201:**
  - Allows the **guaranteed** and **maximum** currents to be read
  - Allows the bus power supply to be enabled/disabled
- **AUX power supply**
  - 24V DC auxiliary power supply
  - Can be used by sensors or communication modules attached to the luminaire
  - 3W average power
  - 6W peak power
    - Supports city-wide wireless communications requiring high peak transmission power
DiiA part 251 – Memory bank 1 extension

- Memory bank 1 includes luminaire information such as:
  - GTIN
  - date of manufacture
  - nominal input power
  - power at minimum dimming level
  - supply voltage range
  - nominal light output
  - CRI
  - CCT
  - light distribution type
  - luminaire colour
  - luminaire description
- Useful for asset management applications
DiiA part 252 – Energy Reporting

- Memory bank 202:
  - **Active** energy and power

- Memory bank 203 (optional):
  - **Apparent** energy and power

- Memory bank 204 (optional):
  - **Load-side** energy and power
DiiA part 253 – Diagnostics and Maintenance

• Memory bank 205 – Control gear diagnostic and maintenance information:
  • Operating time, start counter, external supply voltage, external supply frequency, power factor, overall failure condition, overall failure counter, external supply under-voltage & counter, external supply over-voltage & counter, output power limitation & counter, thermal derating & counter, thermal shutdown & counter, temperature, output current %.

• Memory bank 206 – Light source diagnostics and maintenance information:
  • Start counters, on-time counters, voltage, current, overall failure condition & counter, short-circuit & counter, open-circuit & counter, thermal derating & counter, thermal shutdown & counter, temperature.

• Memory bank 207 – Luminaire maintenance data:
  • Luminaire lifetime, control gear reference temperature, rated light-source starts.
DiiA part 351 – Luminaire mounted control devices

- Draft specification nearing completion
- Allows two types of control devices: Type A and B
  - Maximum of one type-A and one type-B control device can be connected.

- Examples
  - Type A: an outdoor luminaire controller with city-wide wireless communications
  - Type B: a light or occupancy sensor
New trademarks

- New wordmark (‘D4i’) and new logo:

- Used on drivers, control devices and luminaires to indicate **D4i certification**

- **D4i Certification of drivers:**
  - Parts 207 and 250-253 implemented. Part 250 bus power supply default state: “enabled”.

- **D4i Certification of control devices:**
  - Part 351 implemented

- **D4i use on luminaires:**
  - All drivers are certified for D4i.
  - Only include control devices meeting the DALI-2 and D4i requirements.
  - At most one type A and one type B control device as per Part 351.
Streetlight with sockets for nodes

Sensor and/or communication node with Zhaga or NEMA connector

Zhaga or NEMA Socket

Intra-luminaire DALI bus

AUX supply

D4i driver

LEDs

Sensor node
Benefits

• **Easy to add or upgrade sensors and/or communication nodes:**
  • Enables future-proof luminaires that can keep pace with rapid developments in digital networking and sensing technology.

• **Intra-luminaire DALI-2 bus:**
  • Enables bi-directional interaction between sensors and/or communication nodes and LED drivers using the well-established and standardized DALI protocol.

• **D4i drivers are smart:**
  • Able to report operational and diagnostic data to an external network, and can provide inventory-related information about the luminaires.

• **IoT connectivity:**
  • With a suitable wireless communication node, the luminaire is able to interact with an external lighting-control network, and to participate in the IoT.
Co-operation with Zhaga

• Zhaga-D4i certification: A joint program from Zhaga and DiiA
  • Certification for interoperable luminaires and sensors and/or communication nodes

• Based on complementary specifications from Zhaga and DiiA
  • Zhaga Book 18 plus D4i specifications from DiiA

• Product certification enables use of D4i on outdoor luminaires, sensors and communication nodes.
  • Logo indicates multi-vendor product interoperability

• Initial focus on outdoor lighting
  • Indoor solutions will also be developed
Zhaga – D4i

Zhaga-D4i node (sensor and/or wireless communication node)

Zhaga receptacle

Intra-luminaire DALI bus

Sensor node

D4i driver

Zhaga-D4i luminaire (outdoor)
Scope of Zhaga–D4i certification

1 Zhaga-D4i Node = D4i certified sensor and/or communication node with a Zhaga Book 18 plug
2 Zhaga-D4i Luminaire = has a powered Zhaga Book 18 socket and contains a D4i driver