# DALI Summit, Session 1: DALI-2 certification and specifications

Scott Wade, DiiA Technical & Certification Manager – DiiA Ronald Tol, DiiA Technical & Certification Work Group Chair – Signify

25th September 2019, DALI Summit, Bregenz, Austria





**Summit 2019** 

### Agenda

DALI-2: The global standard for smart, digital lighting control (S.Wade)

Expanding DALI-2 certification for complete system coverage (R.Tol)

New DiiA specifications and collaborations (S.Wade)





### **DALI-2: The global standard for smart, digital lighting control**



- 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, DALI-2 and D4i trademarks owned by O Digital Interference







- 190+ members world-wide
- Membership allows DALI trademark use:
  - 600+ DALI-2 certified products
  - **1000+ DALI version-1** registered products
- Membership types:
  - Regular
  - Associate

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Interface Alliance

• **Community registration** – for luminaire makers





#### Digital Illumination Interface Alliance **Membership benefits**

	ASSOCIATE MEMBER	REGULAR MEMBER	(note 2)
Access to DiiA test sequences	Х	Х	
Certification of DALI-2 products, use of DALI-2 logo on certified products	х	Х	
Use of logos (DALI-2, DALI version-1) on luminaires containing DALI devices from DiiA members	х	Х	X
Use of DALI version-1 logo on products other than luminaires	х	Х	
Use of DiiA logo and DALI version-1 logo for marketing materials	Х	х	X
Access to members-only website	Х	Х	
Participation in General Assembly meetings	Х	Х	
Receive membership communication	Х	Х	Х
Access to draft deliverables (test sequences, specifications)		Х	
Approval of final deliverables		Х	
Participation and voting in working groups. Contribute to DiiA roadmap and development of test specifications.		Х	
Participation in interoperability events (Plugfests)		Х	
Eligible for Board of Directors membership		X	W

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**Membership benefits:** 

### **Member companies**

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### First DiiA Members' Plugfest Vienna 4-5 September



- Number of **companies**: 19 registered, 18 attended (10 regular member companies)
- Number of **people**: 37 registered, 36 attended (not including DiiA Scott & Neil)
- Feedback:
  - All attendees were very positive about the Plugfest, particularly the first-timers who were impressed by the cooperation between members to develop DALI. All appreciated the structured testing and learning opportunities afforded and gained confidence in their products. Most found minor issues, and areas for improvement.





### **DALI – Key facts & benefits (1)**

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







### DALI – Key facts & benefits (2)

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



• Cabling benefits

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- Standard 2-core cable (1.5mm<sup>2</sup>)
- Polarity-free & free wiring topology
- DALI power and data on same pair of wires







### 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** 
  - There are now more than 600 DALI-2 certified products, and more than 1000 DALI version-1 registered products.
- The drivers and control devices 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.





### **Basic types of devices (1)**

Currently, the standard describes three basic types of devices:





Control devices



• Bus power supplies









### **Basic types of devices (2)**

Control gear



- These are normally directly connected to the lamp, providing it with power
- Example: LED driver





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### **Basic types of devices (3)**

- **Control devices** (two basic types)
  - **Application controllers** (make decisions and send commands to the control gear)
  - **Input devices** (provide information to the system)
    - 301 Push-buttons
    - 302 Absolute inputs (switches, sliders)
    - 303 Occupancy sensors
    - 304 Light sensors
    - Tests and certification for these started on 20<sup>th</sup> May.







### **Basic types of devices (4)**

• Bus power supplies



- Provide typically 16 V, up to 250 mA to power the bus.
- Often built into an application controller or control gear
- Devices such as sensors and push-buttons can be powered from the bus







# Expanding DALI-2 certification for complete system coverage

Ronald Tol, DiiA Technical & Certification Work Group Chair – Signify







- The original "DALI" standard was for fluorescent control gear only.
- Later, additional lamp types and functionality were added for the control gear.
- Version 2 of IEC 62386 was released a few years ago, adding control devices for the first time.
- Since then, new parts have been added for input devices, and features for all control devices.
- The following page shows the various parts that make up IEC 62386





### **Product requirements are given in IEC 62386**

#### Many parts defined:

- Example, LED driver
  - Parts 101, 102
  - Part 207
- Example, LED driver with colour control:
  - Parts 101, 102
  - Parts 207 (optional), 209

	IEC 62386 sta	ndard	Purchase standards via the <u>IEC website</u> More details on IEC 62386: <u>DiiA website</u>
	Red text = Parts aligned with DALI-2 Part 1	1: General requirements – System cor	mponents
	Part 102: General requirements – Control gear	Part 104: General requirements – Wirele and alternative wired systems	ss Part 103: General requirements – Control devices
h	Parts 2xx: Particular requirements for control gear	Part 105: General requirements – Firmware update (In progress)	Parts 3xx: Particular requirements for control / input devices
	Published:         Part 201: Fluorescent lamps         Part 202: Self-contained emergency lighting         Part 203: Discharge lamps (excluding fluorescent l         Part 204: Low voltage halogen lamps         Part 205: Supply voltage controller for incandescent         Part 206: Conversion from digital signal into DC voltage         Part 207: LED modules         Part 208: Switching function         Part 209: Colour control	Published: Part 216: Load referencing Part 217: Thermal gear protection Part 218: Dimming curve selection Part 220: Centrally-supplied DC emergency op lamps Part 221: Load shedding Part 222: Thermal lamp protection Part 224: Integrated light source	eration Published: Part 301: Push buttons Part 302: Absolute input devices Part 303: Occupancy sensors Part 304: Light sensors Part 332: Input control devices - Feedback Part 333: Manual configuration In progress: Part 305: Colour sensor
		DiiA creates DALI-2 Test Specifications based individual Parts of IEC 62386, enabling DALI-2 ce	on these ertification. Updated: June 2019

#### For latest information, see:

www.dali2.org/dali/standards.html





### 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





### **Control gear**

**Part 102** gives the general requirements for all control gear

- Specifications include:
  - Directly changing the light level to a %
  - Scenes
  - Fading (fade time or fade rate)
  - Querying output level, lamp failure and other information
  - Memory banks
  - Addressing: short addresses, groups and broadcasting
  - Power on/start-up
  - Lamp/control gear failures



#### 101 – General requirements – System (V1 & V2)

104 – Wireless System (in progress)

105 – Firmware update (in progress)

102 – Control gear (V1 & V2)

103 – Control devices (V2)

#### Specific parts

207 LED (\/2	in 208 Switching	209 Colour	in progress ( <b>con</b>	trol gear function	s):
progress)	m200 Switching	Control	222 Thermal		224
204 LV Haloge	en 205 Incandescent	206 Conversion to DC	lamp information		Integrated Light source
	Dimmer	(0/1-10 V)		220 Central emergency	221 Load shedding
201	202 Self-	203 HID			
Fluorescent (V1 & V2)	contained Emergency (V2 in progress)		216 Load referencing	217 Thermal gear information	218 Dimming curve selection



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### **Control gear – LED drivers**

- LED drivers are the most popular type of control gear
  - **Part 207** gives the specific requirements, including:
    - Detection and reporting of various lamp fault conditions.
    - Detection and reporting of various control gear fault conditions.
    - Dimming curve selection:
    - Fast fade times.

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- Integration of a power supply and/or lamp.
- Possibility of AC/DC supply.
- Output control method: PWM, AM, current controlled, high current pulse (no further definitions)







### **Control gear – Colour control**

- Colour control can be provided from control gear that has two or more lamps
  - **Part 209** gives the specific requirements, including:
    - Support for up to 6 channels or "primaries"
    - Several colour types are defined:
      - **T**<sub>c</sub> colour temperature control ("tuneable white")
      - **RGBWAF** a simple method of selecting a colour
      - **xy chromaticity** allowing precise selection of colour
    - In addition, part 209 allows **calibration** of the attached "primaries".
    - Fading from one colour to another is supported.
  - Tests for the T<sub>c</sub> colour type are under development now.









### **Control gear – Emergency lighting**

- **Self-contained emergency control gear** is used with a battery and lamp in a luminaire, providing light when the mains supply fails
- **Part 202** gives the specific requirements, including:
  - Support for **maintained** and **non-maintained** emergency lighting
  - Support for switched and dimmed control
  - Automated testing:
    - **Function tests**: check the lamp, driver/inverter, battery and charging circuit
    - Duration tests: check the operation of the lamp from the battery, for the full rated duration
    - Tests can be triggered automatically, or on reception of a command
  - Query commands for: •
    - Features
    - Test results
    - Battery charge level
    - Failures







### **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: <u>www.dali2.org/products</u>





### **Control devices – Input devices overview**

#### • 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 (301, 302)

- Input device 301: Push-buttons
  - Various events can be sent:
    - 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
  - Sends a "position" event



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### Control devices – Input devices (303, 304)



- 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





#### **Example – Out-of-box system operation**

- **Products are wired together**, and work in a similar way to 0-10V systems, without needing any programming.
- 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 systems.
- The following example demonstrates this:





### **Example – Out-of-box system operation**



- Control gear
- Application controller

Note:

- A bus power supply is required, either separate or integrated with an existing device.
- More than one application controller is allowed.

#### 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%.





#### **Example - Commissioned (programmed) 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 programing tools.
- Main programming steps are:
  - Assign addresses
  - Group the devices
  - Set-up scenes, fade-times and other parameters as required.
- The following example demonstrates this:





### **Example - Commissioned (programmed) system**



- Control gear
- Input devices
- Application controller

Note:

- A bus power supply is required, either separate or integrated with an existing device.
- More than one application controller is allowed.

#### Example of operation:

- Movement triggers the sensor
- The occupancy sensor automatically transmits a notification:
   <address 2><instance 3> INPUT NOTIFICATION (0x009) [Movement detected]
- The 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]
- Lights in group 7 fade to the pre-programmed levels in scene 5.



### 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







### **Trademark use**

- Trademark use differs for DALI version-1 and DALI-2
- DALI trademarks



- **Successful test results must be obtained**, either by self-testing using the official testplatform and test-sequences, or by using an accredited test-house
- **Registration** became mandatory for all DALI version-1 products from 1<sup>st</sup> June 2018.
- New registrations of LED drivers ends on 31<sup>st</sup> December 2019.
- Test results must be sent to the Certification Manager, if requested.
- **DiiA members** may then use the DALI logo or "**DALI**" word trademark on their compliant products and product literature.
- Registered products are automatically added to the product database: <u>www.dali2.org/products</u>





### **Trademark use**

DALI-2 trademark 



- Successful test results must be obtained, either by self-testing using the official test-platform and test-sequences, or by using an accredited test-house
- Product information and test result registration/certification file are then submitted to the certification tool through your DiiA account.
- Product information and results are verified.
- **Further test results** must be sent to the Certification Manager, if requested.
- Once certification is granted, one certification credit is consumed from the member company's account.
- **DiiA members** may then use the DALI-2 logo or "**DALI-2**" word trademark on their compliant products and product literature.
- Certified products are automatically added to the **product database**: www.dali2.org/products





### **DALI-2 Certification**

- -12
- 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 the product



- 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.

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### **Product database (public)**

- Lists all DALI-2 certified products, as well as DALI version-1 registered products
- Used for two main purposes:

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- 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.
  - This means Trademark use is not permitted.

#### **Product database:**

http://www.dali2.org/products





## **New DiiA specifications and collaborations**

Scott Wade, DiiA Technical & Certification Manager – DiiA







### **New DiiA Specifications**

- DiiA has developed several new specifications
  - For use in smart luminaires, and products attached to smart luminaires
- Specifications (<u>www.dali2.org/specifications/download.html</u>):
  - 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 part 150 AUX Power Supply
  - DiiA part 351 Luminaire mounted control devices (under development)
- Collaborations with:

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• IEC TC34/WG11, Zhaga and ANSI C137.





### D4i specifications for intra-luminaire DALI (outdoor luminaires)







### Zhaga – D4i







### **Applications**

- A primary application for these new specifications is outdoor lighting, such as streetlights:
  - Each streetlight is a small 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.
- Some reasons that DALI was chosen:
  - Industry standard
  - Specifically for lighting control
  - Direct connection to control gear
  - Standardised dimming curve
  - Bi-directional communication





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- DiiA part 250 Integrated Bus Power supply:
  - For control gear
  - Includes:
    - Integrated DALI bus power supply:
      - Suitable for powering sensors or communication modules in a luminaire
    - Memory bank:
      - Current ratings can be read
      - PSU can be enabled or disabled allowing use in systems with multiple bus PSUs
  - For D4i certification, part 250 must be included, with the bus power supply enabled by default.





- DiiA part 251 Memory bank 1 extension:
  - For control gear
  - Memory bank describes luminaire information, including:
    - Supply power and voltage ratings
    - Light output, including CCT/CRI ratings
    - Light distribution type
    - Luminaire colour

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face Alliance

• Text luminaire identification/descriptions



- DiiA part 252 Energy reporting:
  - For control gear
  - Includes:
    - Active energy and power
    - Apparent energy and power (optional)
    - Load side energy and power (optional)





- DiiA part 253 Diagnostics & Maintenance:
  - For control gear
  - Includes:
    - Failure conditions
      - Various control gear failure conditions
      - Various lamp failure conditions
    - Counters for each failure type
    - Control gear information:
      - Operating time, start counter, supply voltage and frequency, power factor, temperature and output current.
    - Light source information:
      - Operating voltage, current, temperature, light source start counter, light source on time





### **New DiiA Specifications – Part 150 AUX**

- DiiA specification AUX power supply:
  - Can be integrated in control gear
  - 24V PSU, 3W average power, 6W pulse capability
  - Intended to supply external sensor or communication modules
    - For example, Zhaga book 18 socket used on outdoor luminaires/street lights
  - Designed to supply outdoor wireless communications transceivers that require high power pulses during transmission





### New DiiA Specifications – Part 351 Luminaire mounted control devices

- Not yet published by DiiA
- Describes two main requirements for luminaire mounted control devices:
  - Power consumption requirements.
    - Can be AUX powered or bus-powered, within specified limits.
    - Polarity sensitivity exception permitted.
  - Two types of sensors: type A and type B
    - **Type A**: Application controller takes control. Up to 2W from AUX.
    - **Type B**: Contains arbitration logic so its application controller relinquishes control when another application controller is present. Up to 1W from AUX, or 46mA bus-powered.
  - These requirements allow a maximum of **one type A** and **one type B** device to be used without requiring further configuration.
  - Type C being added for indoor use-cases.





### **New DiiA Specifications – next steps**

- Development of test sequences
  - Allowing DiiA members to self-test or use an accredited test-house
  - The existing ProbitLab2 test system will be used where possible (25x parts)

- Extension of the DALI-2 certification process
  - New tests will make it possible for control gear with the new 25x and AUX PSU parts to be included in the DiiA certification program for DALI-2.
  - Requirements are being developed for luminaire mounted control devices (part 351).
- D4i certification
  - If certified control gear, certified control devices or luminaires meet the D4i requirements, then use of the new D4i Trademark logo is allowed in accordance with the *Trademark Guidelines for Members*.
  - Trademark requirements are being updated to include the requirements for D4i.





### **Specifications from IEC and DiiA – Parts in progress**

The IEC 62386 Working Group (WG11) is working on several new parts, as well as updates to existing parts:

- 1xx
  - **104** Wireless and alternative wired system: published in May 2019.
  - **105** Firmware transfer: publication expected in 2020.
- 2xx
  - 202 Self-contained emergency control gear: update in progress.
  - **220** Centrally controlled emergency operation: published in January 2019.
- 3xx
  - **305** Colour sensor: draft started in 2019
- Upcoming DiiA specifications:
  - **351** Luminaire mounted control devices
  - **306** General purpose sensor





### **Test sequence & certification updates**

- Latest test release, 20<sup>th</sup> May 2019:
  - 301-304 input device tests.
  - Fixes and improvement for parts 101-103, including better support for multiple logical units.
- Currently in progress:
  - 150/AUX power supply, 250-253 (D4i specifications for control gear). Beta testing in progress. Release expected end of October.
  - 209 (DT8 test for colour type T<sub>c</sub>). Beta testing in progress. Release expected end of 2019.
  - 208 (relay switching), 351 (Luminaire mounted control devices). Test specifications being completed.
  - 202 (self-contained emergency). Test specification update in progress.
- Next-on tests:
  - 205 (incandescent dimmer), 206 (1-10V converter)





### **Further information** – **DiiA website:**

• 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

- D4i: <u>https://www.dali2.org/d4i/</u>
- Contact us:

info@digitalilluminationinterface.org







# www.dali2.org