DALI protocol

PROFESSOR: MR.AMIN FOSHATI

STUDENT: MITRA GHOLIPOOR

INTERFACE CIRCUITS DESIGN

OVERVIEW

- Why DALI Emerged
- Key Advantages of DALI
- DALI Architecture
- SIGNALLING
- FRAME
- Error Detection
- Error Handling

Why DALI Emerged

- Replaces older analog or proprietary lighting control systems (e.g., 0–10 V)
- Offers digital, addressable control for individual fixtures
- Simplifies wiring and reduces complexity
- Enhances flexibility and scalability for modern lighting solutions

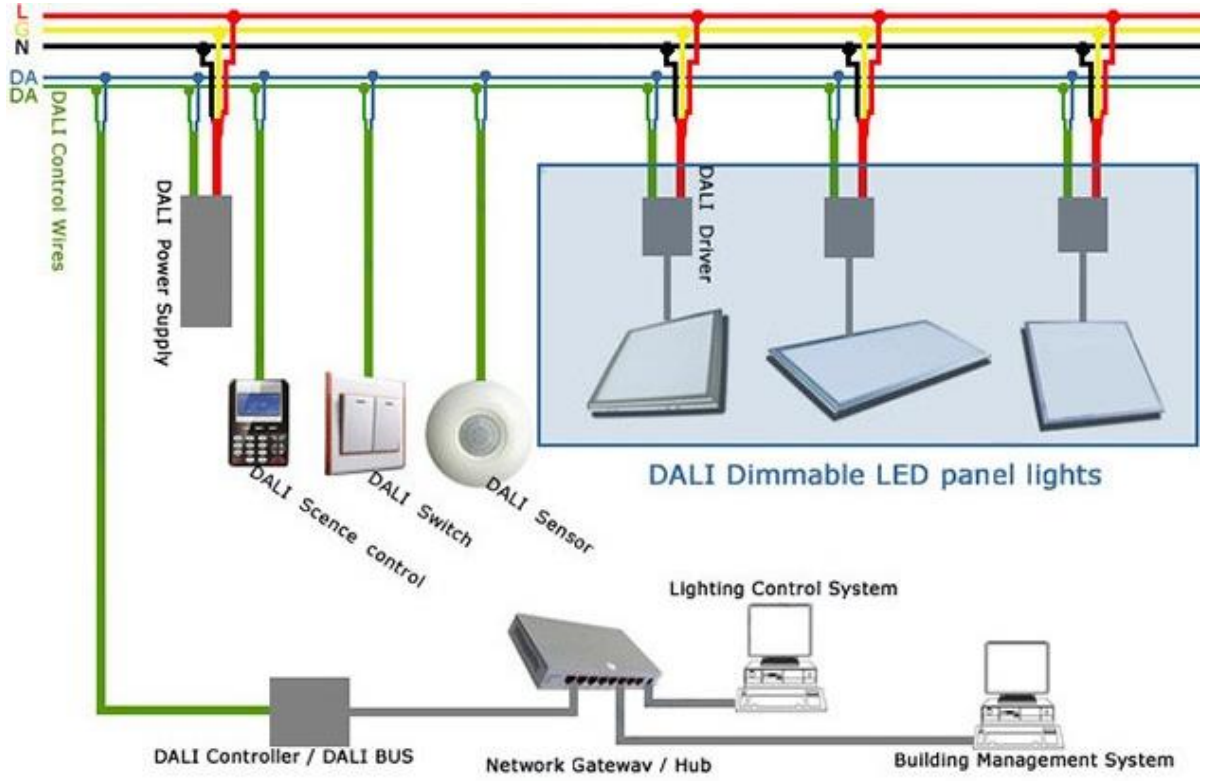
Key Advantages of DALI

- Open standard (IEC 62386) – ensures interoperability
- Digital communication and individual addressing
- Two-wire bus for data + power
- Scene, group, and fade-time control

DALI Architecture Basics

- Master (Controller) – Issues commands
- Bus – Two-wire bus (~16 V DC)
- Control Gears (Slaves) – Ballasts, LED drivers
- Control Devices – Sensors, switches, & multi-master controllers

DALI Architecture Basics

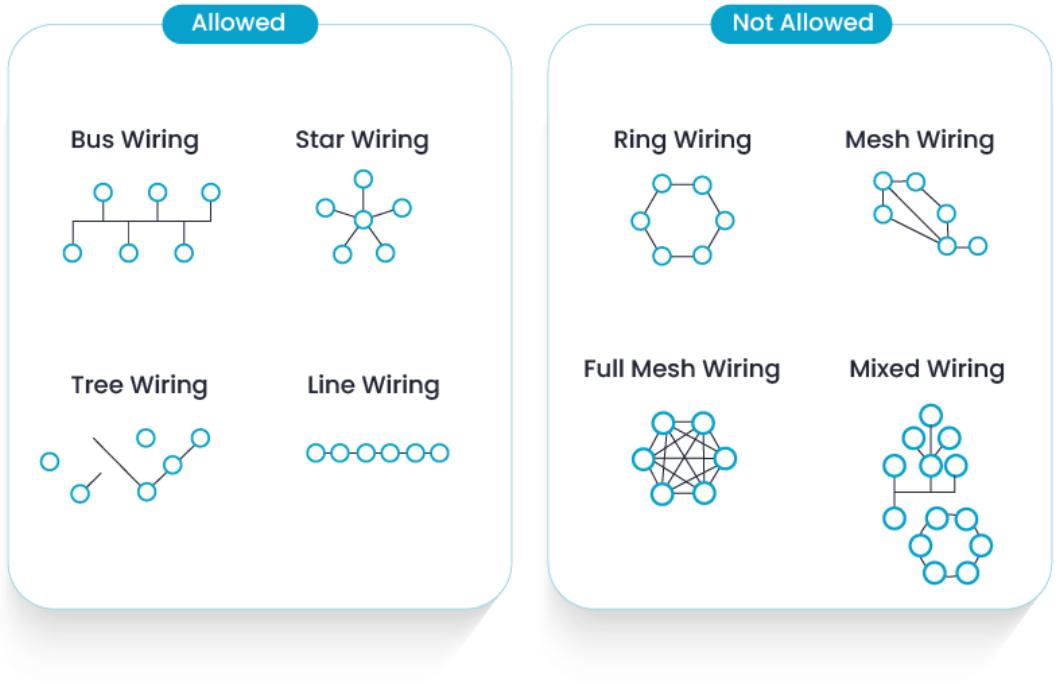


DALI Wiring Topologies

What topology is used for DALI?

• DALI will work with bus, star (hub and spoke), tree or line topologies, or any combination of these.

•It will not work with any sort of ring or mesh wiring topology



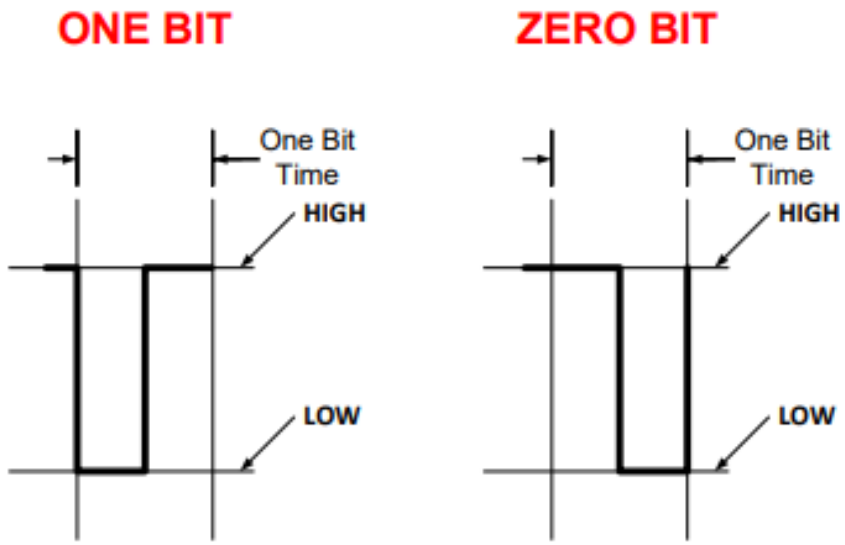
DALI Wiring Essentials

- **What is the DALI voltage?** DALI operates at 16V. However, a DALI bus is not SELV. Therefore, it must always be wired in mains-rated cable or flex.
- **Is DALI polarity sensitive?** No, it is not. The pair of wires that form the DALI bus are not polarity sensitive. Terminals on DALI devices, such as LED drivers, are typically marked DA, DA.
- **Does DALI wiring need to be shielded?** No, it does not need to be shielded. The data rate is relatively slow (1,200 baud), the bus voltage is relatively high (16V) and there is a large tolerance of voltage fluctuation. Together, these factors make the bus very robust in the presence of electrical interference, so shielding is not required.
- **What cable or flex is suitable for DALI?** DALI is most commonly wired with a multi-core cable that also carries mains power. Typical cables would be either 5-core (live, earth, neutral, DA, DA) or 6-core (live, emergency live, earth, neutral, DA, DA).

SIGNALLING

Data communication uses Manchester Coding.

- ☐ Also called Bi-phase coding.
- ☐ Speed 1200 bits / second.
- ☐ A bit is 833.3 µs . A half-bit is 416.67 µs.
- ☐ The half-bit time has a special name: Te
- ☐ So Te = 416.67 µs



FRAME TYPES

DALI has 2 frame types:

1. Forward Frame (FF)
2. Backward Frame (BF)

A Forward Frame is directed to Control Gear

- It is a command to one or more devices that control delivery of electrical power.

A Backward Frame is a reply from the Control Gear

- A short answer from devices that control delivery of electrical power.

FRAME STRUCTURES

☐ Forward Frame (FF) Structure:

- 1 x Start Bit Logical “1” - Manchester (bi-phase) coded
- 2 x Data bytes (8 bits each) Manchester (bi-phase) coded
- 2 x Stop bit periods Line idle condition **not Manchester coded**
- Total: 19 bits = 38 Te = Duration 15.83 ms

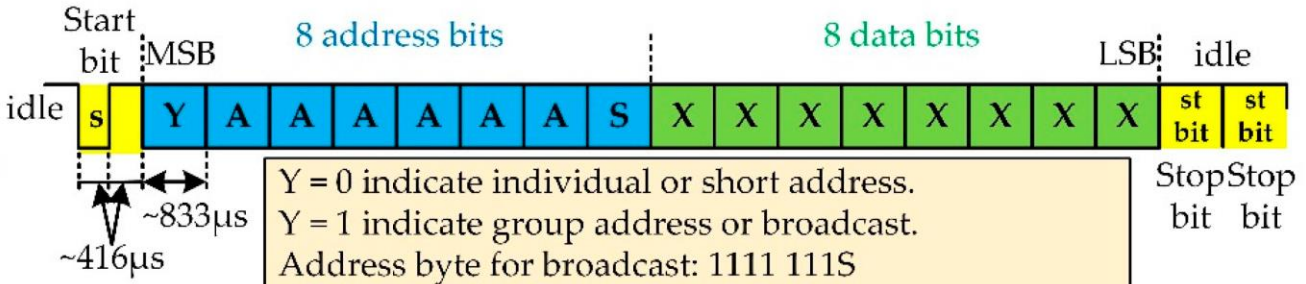
☐ Backward Frame (BF) Structure:

- 1 x Start Bit Logical “1” - Manchester (bi-phase) coded
- 1 x Data byte (8 bits) Manchester (bi-phase) coded
- 2 x Stop bit periods Line idle condition **not Manchester coded**
- Total: 11 bits = 22 Te = Duration 9.17 ms

FRAME STRUCTURES

s = Start bit which is a logical 1
YAAA AAAS = Address byte
XXXX XXXX = Data byte
st = Stop bit (Idle line)

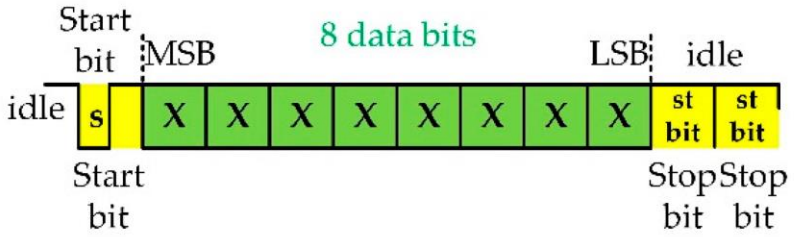
DALI FORWARD FRAME



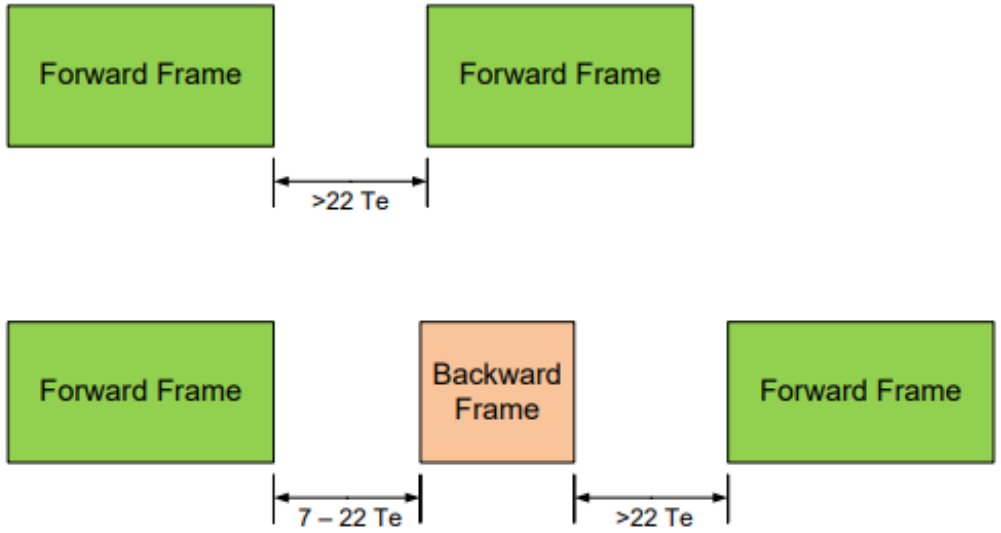
Y = 0 indicate individual or short address.
Y = 1 indicate group address or broadcast.
Address byte for broadcast: 1111 111S
S = Selector bit: If '0' data byte = direct arc power level
If '1' data byte = command

In Backward frame '0xFF' is considered a 'Yes'.
If the line stays idle, is considered a 'No'.
Other values vary depending on the command.

DALI BACKWARD FRAME

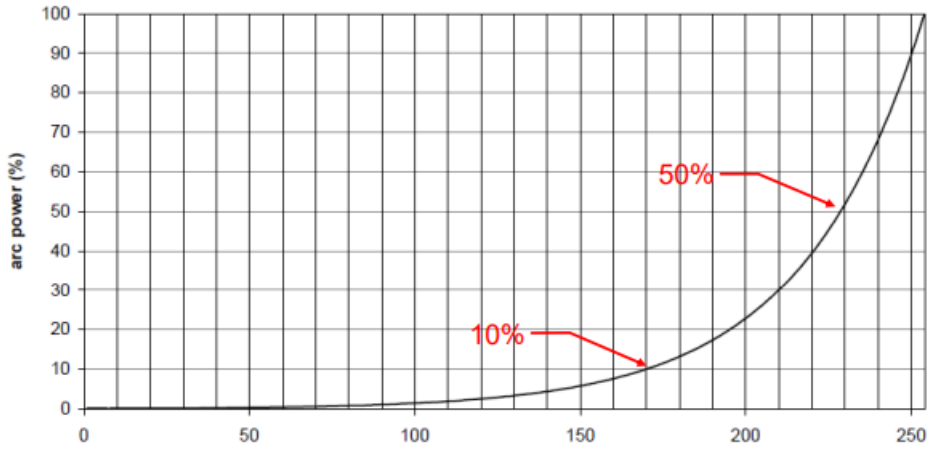


FRAME TIMING



Types of DALI Messages

- Direct Arc Power Commands
  - Set a specific light level (0–254) immediately.
  - Example: “Direct Arc Power = 230” sets 50% brightness.
- Indirect Arc Power Commands
  - Adjust lighting through preset or gradual steps rather than an absolute value.
  - Examples: RECALL MAX, GO TO SCENE, STEP UP, STEP DOWN.
- Configuration Commands
  - Alter internal settings of control gear (e.g., set short address, fade time, power-on behavior).
  - Used during commissioning to configure how devices respond.
- Query Commands
  - Request device status or operational data.
  - Examples: Query Lamp Failure, Query Current Brightness, Query Group Membership.
- Special Commands
  - Typically used for more advanced operations or device setup (like random addressing).
  - Often involved during large-scale commissioning or when changing system-wide parameters.



COMMUNICATIONS PRINCIPLES

A Forward Frame has 258 possible answers:

1. Value in a Backward Frame: 0 .. 255 (1 byte)
2. DALI “NO”: No BF value was returned
3. Collision / Framing Error: Multiple devices transmitted BF, and these collided to make an error.

All of these possible answers are used at different times.

- Some commands or operations rely on collisions.
- Some commands have a BF value answer for some conditions, and there is no BF returned for other conditions.

ADDRESSING

Control Gear has a Short Address.

- A number from 0 to 63. (6 bits)

Control Gear must also react to 16 Group Addresses.

- Numbered from 0 to 15.
- A Control Gear can be a member of a Group Address.
- If set to be a member, then it reacts to commands directed to the Group.

Control Gear must also react to a Broadcast.

Routing in DALI Systems

- Each DALI line can have up to 64 addresses.
- In larger systems, multiple DALI lines are connected through a router or gateway.
- When a command is sent, all devices on that line see the frame, but only the device(s) with a matching address respond.
- If the address doesn’t match, other devices ignore the command.
- This approach allows scaling beyond a single line while maintaining a unified control system.

Error Detection in DALI

- Collision Detection:
  - In multi-master setups, simultaneous transmissions can collide.
  - Devices detect mismatches between sent and received signals and discard the corrupted frame.

- Framing Errors:
  - DALI uses Manchester (bi-phase) coding at a fixed bit rate.
  - If timing or signal transitions do not match the standard, the frame is ignored as invalid.

Error Handling in DALI

- No Response:
  - If an error is found, no valid response (Backward Frame) is sent.
  - The controller may retry sending the command after a suitable delay.

- Simplified Recovery:
  - DALI does not implement advanced error-correction methods.
  - Retrying commands and adhering to timing rules are sufficient for most lighting control needs.

DALI Summary

Key Strengths:

- ✔ Interoperability: IEC 62386 standard ensures compatibility across vendors.
- ✔ Precision: Digital dimming with logarithmic curves (0.1%–100%).
- ✔ Flexibility: Dynamically reconfigure groups/scenes without rewiring.
- ✔ Energy Efficiency: Optimized lighting control reduces power consumption.
- ✔ Error Handling: Rejects corrupted frames; automatic retries ensure reliability.

Applications:

- ☑ Commercial/industrial lighting (offices, warehouses, retail).
- ☑ Smart buildings integrated with BMS or IoT platforms.
- ☑ Retrofitting analog systems (e.g., 1–10 V) for digital control.

References

1. https://ozuno.com/downloads/training/02%20-%20DALI%20ADVANCED%20THEORY.pdf
2. https://en.wikipedia.org/wiki/Digital_Addressable_Lighting_Interface
3. https://onlinedocs.microchip.com
4. https://www.nvcuk.com/technical-support/view/what-is-dali-8