DALI ADVANCED THEORY

ADVANCED CONCEPTS

COURSE PURPOSE

Advanced DALI topics.

This will help you to understand:

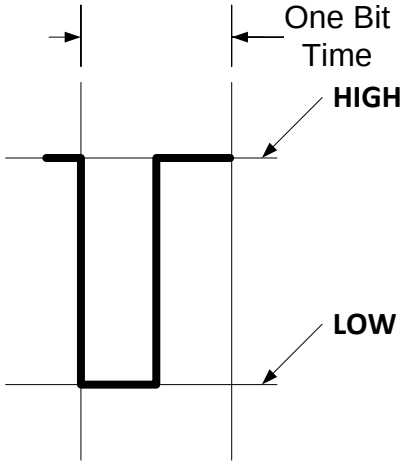
- How communication operates;
- Addresses;
- Forward Frame and Types of Commands;
- Dimming;
- Multi-Master;
- More than one single DALI line;
- Commissioning.

COMMUNICATION

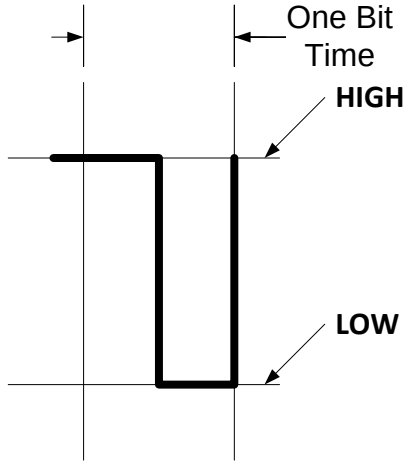
COMMUNICATION: SIGNALLING

- 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

ONE BIT



ZERO BIT



COMMUNICATION: FRAME TYPES

- DALI has 2 frame types:

  Forward Frame ***(FF)***

  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.

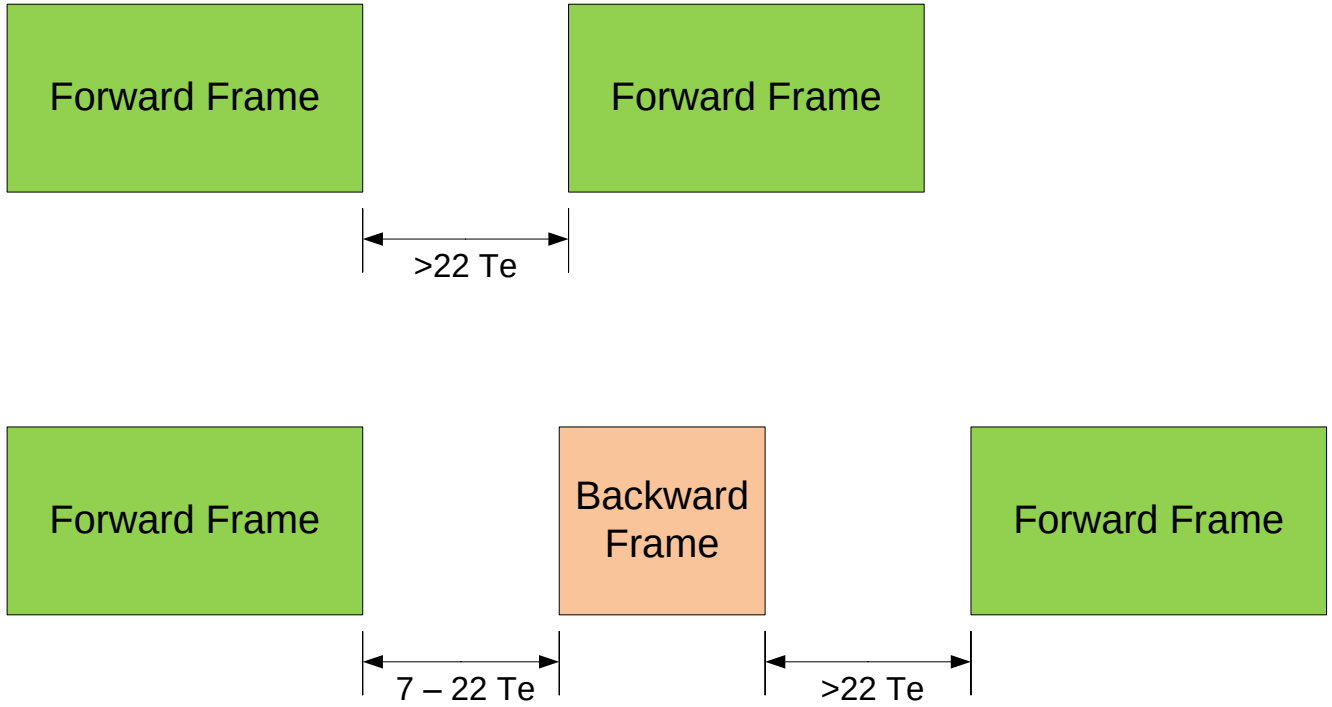
COMMUNICATION: FRAME STRUCTURES

- 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***

COMMUNICATIONS: FRAME TIMING (1)

- Frame – Frame Timing Rules:
  - BF is optional.
  - FF to FF time > 22 Te (9.17 ms).
  - If a BF is present it must appear between 7 and 22 Te after the FF.
  - A BF always applies ***only*** to the FF immediately in front of the BF.
    - BF is an answer.
  - Devices must conform to frame timing requirements when transmitting.
  - Receiving devices must check frame structure and timing (and reject frames that do not meet the rules).

COMMUNICATIONS: FRAME TIMING (2)



COMMUNICATIONS PRINCIPLES

- A Forward Frame has 258 possible answers:
  - Value in a Backward Frame: 0 .. 255 (1 byte)
  - DALI “NO”: No BF value was returned
  - Collision / Framing Error: Multiple devices transmitted BF, and these collided to make an error.

- Most documentation does not explain this!

- 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.

ADDRESSES

HOW DALI ADDRESSES WORK

ADDRESSES

- **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.
  - Do not confuse this with Group Addresses in other bus systems, such as KNX, C-Bus, Dynalite.

- Control Gear must also react to a ***Broadcast***.

FORWARD FRAME AND TYPES OF COMMANDS

FORWARD FRAME BYTES (1)

- Forward Frame has only 2 bytes:
  - Address Byte: **YAAA_AAAS** (bits)
  - Data Byte: **XXXX_XXXX** (bits)

- Address Byte:
  - S bit sets meaning of the Data Byte:
    - S = 0: Direct Arc Power Level
    - S = 1: Command

  - Y bit sets meaning of the address part of the Address Byte (AAAAAA bits).

FORWARD FRAME BYTES (2)

- Address Byte: **YAAA_AAAS** (bits)

  0AAA_AAAS: Sending to a Short Address AAAAAA (0 .. 63)

  100A_AAAS: Sending to a Group Address AAAA (0 .. 15)

  1111_111S: Sending to Broadcast

- S bit sets meaning of the Data Byte:
  - S = 0: Direct Arc Power Level
  - S = 1: Command

- Special values of Address byte: **1010_0000** to **1111_1101**
  - Used for special commands.

FORWARD FRAME BYTES (3)

- Examples:
  - 0000_0010 xxxx_xxxx: Short Address 1, Arc power = xxxx_xxxx
  - 1000_0100 xxxx_xxxx: Group Address 2, Arc power = xxxx_xxxx
  - 1111_1110 xxxx_xxxx: Broadcast, Arc power = xxxx_xxxx
  - 0000_0011 xxxx_xxxx: Short Address 1, Command xxxx_xxxx
  - 1010_0000 xxxx_xxxx: Special Command
- ***Good systems have a log function that will decode the commands.***

TYPES OF COMMANDS

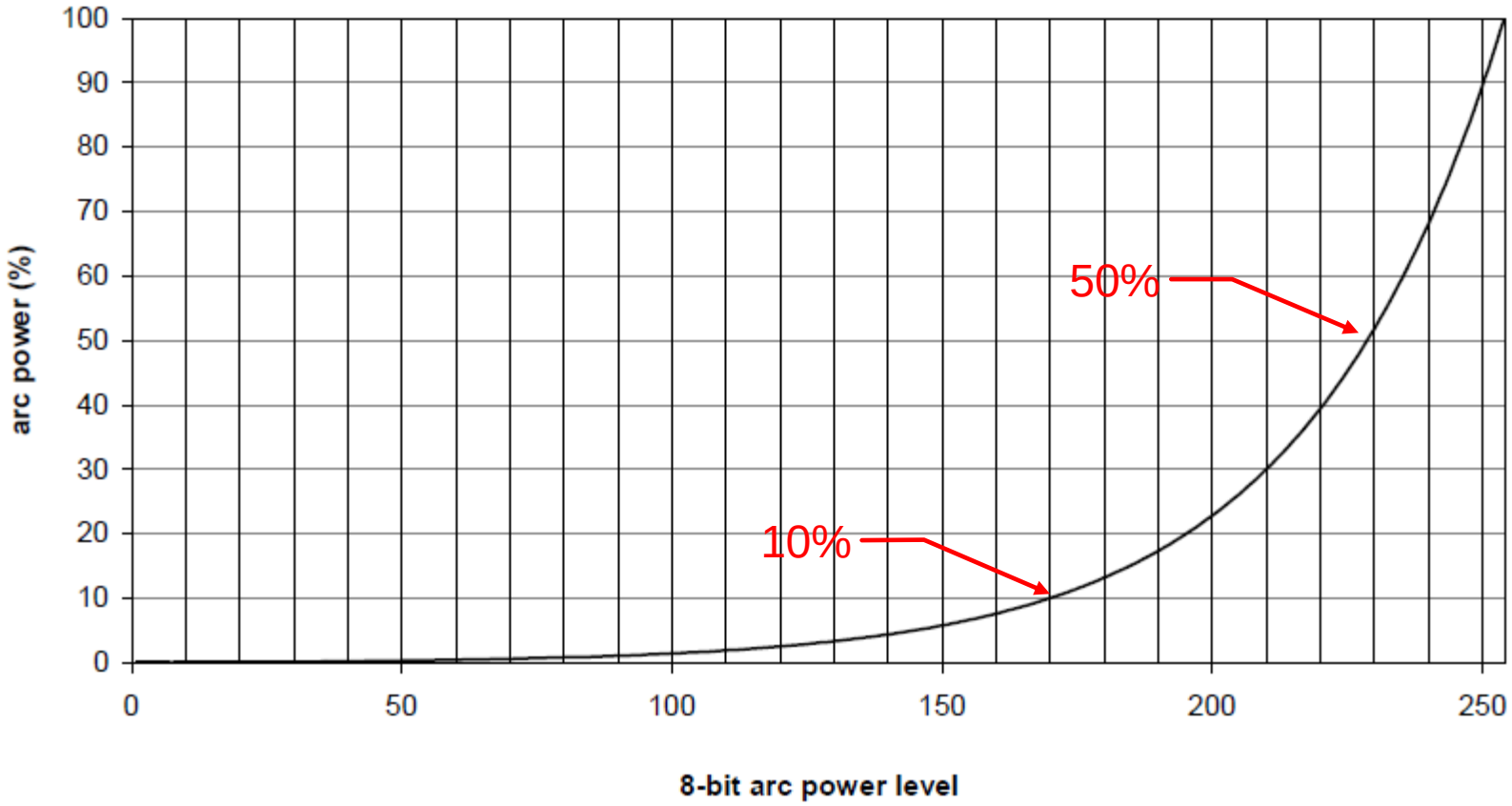
- Direct Arc Power Commands: Set a lighting level to a value.
- Indirect Arc Power Commands: Change lighting levels (OFF, UP, DOWN, RECALL MAX, GO TO SCENE)
- Configuration Commands: Set properties of Control Gear.
- Query Commands: Query Control Gear and get answers about setup, configuration, and similar.
- Special Commands: Generally used during commissioning and address assignment.

- ***A total of 349 commands are defined (many are reserved and not used).***
- ***Good systems for DALI mean it is not necessary to know the commands in detail.***

DIMMING

DIMMING CURVE

- DALI defines a ***logarithmic*** dimming curve.
- Level 0 = off
- Level 1 = 0.1%
- Level 254 = 100%



MINIMUM LEVEL

- DALI Control Gear supports a Minimum Level.
  - Set by commissioning software.

- Control Gear also has a PHYSICAL MINIMUM LEVEL
  - This is a property of the product.
  - The Minimum Level can’t be set lower than the PHYSICAL MINIMUM LEVEL.

- The PHYSICAL MINIMUM LEVEL is normally quoted by manufacturers in the product features.
  - Example: “1% to 100%” or “5% to 100%”

LINEAR CURVE

- Some DALI Control Gear also supports a linear curve.
  - Typically for Type 6 LED Control Gear and Type 4 Incandescent / Phase Dimmer.
  - This is not common and not always supported.

- Selecting Linear Curve (if supported) may help when using some lamp types.
  - Example: May help for lamps that already have their own logarithmic curve.

DIMMING: BE CAREFUL!

- Make sure all drivers in a common physical area have the same Physical Minimum Level.
  - Or dimming down will stop at different places.

- A driver (Control Gear) with a minimum level of 10% is hardly noticeable.
  - Human eye can work with a big range of light levels, there is not much noticeable change between 10% and 100%.
  - High quality Control Gear should have a minimum level < 3%
  - Very High quality Control Gear has a minimum level < 0.5%.

- Some applications require very low minimum levels.
  - Control Gear for minimum level < 0.5% is harder to find and more expensive.

MULTI-MASTER

MULTI-MASTER: PRINCIPLE

- An Application Controller ***transmits*** commands into a DALI line.
  - This is sometimes called a “Master” – because this device is in control.

- What happens if more than one Application Controller is connected to a line?
  - DEPENDS ON THE DEVICES!
  - Some devices do not check before transmitting: Causes errors and problems.
  - If 2 devices transmit at the same time: result is garbage. Called a ***collision***.

MULTI-MASTER: EXPECTED BEHAVIOUR

- Proper multi-master Application Controllers are designed to DALI-2 standards.
- This requires:
  - Check the line is available before transmitting;
  - Check the line ***during*** transmission;
  - Back-off, re-try, or destroy when a collision is detected.
- Problem:
  - ***Very small number of proper DALI 2 multi-master Application Controllers.***
  - ***Very poor testing. (Very difficult to test).***
  - ***Poor certification.***
  - Designed for multi-master, and working with original DALI and newer DALI 2.

MULTI-MASTER DEVICES

- All RAPIX (Diginet) devices are designed for Multi-Master.
- Extensively tested.
- Using multiple RAPIX devices on a line is OK.
- Using RAPIX devices with most equipment from most manufacturers is OK.
  - A very small amount of DALI equipment is so bad it will not work properly with any other transmitting devices.
  - These are only found by bad experiences.
- Most DALI-2 product available today is ***Control Gear***, where Multi-Master is not relevant.
  - Hard to rely on DALI-2 marking!

MORE THAN ONE DALI LINE

MORE THAN ONE DALI LINE

- More than 64 Control Gear items (lamps, luminaires) ?
  - -> Wire several DALI lines

- If using another system (KNX) then other system and its gateway will manage most expansion OK.

- If using only DALI systems, use a RAPIX ZONE CONTROLLER to expand:
  - Allows linking multiple DALI lines.
  - Includes floor plans, schedules, linking rules.
  - Scales up from 1 DALI line to thousands.

COMMISSIONING

COMMISSIONING

- Commissioning is:
  - Testing basic operation
    - Is the power connected?
    - Is DALI connected?
  - Assigning a Short Address.
  - Other settings:
    - Maybe set minimum levels.
    - Maybe set power-on condition.
    - Maybe set DALI failure condition.
    - Maybe set groups.
    - More…. (other systems, scenes, other devices……)

COMMISSIONING: BASIC OPERATION - TESTS

- When supplied, Control Gear has a default state:
  - Power on: Turn on the lamp
  - DALI fails: Turn on the lamp

- Simple test #1:
  - Apply power on DALI.
  - Apply mains power.
    - ===> ALL LAMPS ON??
    - If not, check mains power wiring.

COMMISSIONING: BASIC OPERATION – TESTS (2)

- Simple test #2:
  - Apply power on DALI.
  - Apply mains power. (Wiring OK – so all lamps on).
  - Inject DALI command “OFF”
    - ===> ALL LAMPS OFF??
    - If not, check DALI wiring.

- Simple test #3:
  - Inject DALI commands to toggle
    - All lamps turning on and off?
    - If not check mains AND DALI wiring

COMMISSIONING: ASSIGNING A SHORT ADDRESS

- Mark up floor plan with lamps.
- Write in or assign addresses on the plan.

- Use tool (RAPIX Addressing) to set the address for each lamp or luminaire.

- ***Separate training for RAPIX Addressing.***