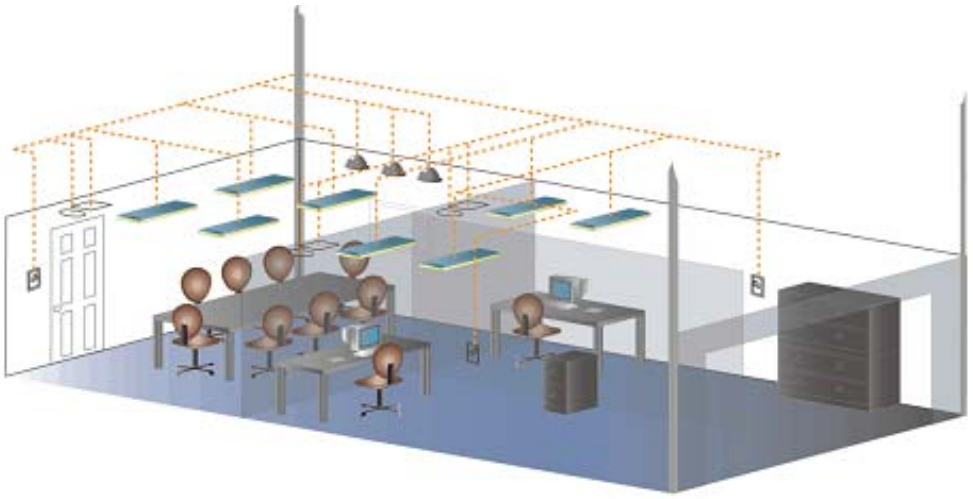
LIGHTING RESEARCH PROGRAM

Project 5.4 DALI Control Standard (NEMA Proposal)
FINAL REPORT



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Digital Addressable Lighting Interface (DALI) Control Devices Protocol

PART 1-2004

General Requirements

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CONTENTS

Foreword

This standard covers the performance requirements for lighting control devices used to control electronic ballasts conforming to IEC 60929, Annexes E and G. These ballasts are referred to as “DALI ballasts” (DALI—Digital Addressable Lighting Interface).

These ballasts are intended to operate lamps at various frequencies, including high frequencies, and at various lamp powers. They have the ability to vary the light output in response to a digital control signal and can also transmit their status on command.

In order to obtain satisfactory performance, it is necessary that the design of the electrical signal structure, communications medium, and commands be coordinated for both the ballasts and the control devices. It is essential, therefore, that specifications be written and measurable against some common base of reference, which must be reasonable, permanent, and reproducible.

Accordingly, the electrical signaling characteristics and wiring infrastructure of the control devices are identical to that of the ballasts using the same signal structure and wiring. Furthermore, the control devices use the same commands that are specified for the ballasts, ensuring that the ballasts will understand each message and act accordingly. In addition, the control-to-control communication is supported by using a modification to the ballast signal protocol.

To provide the desired performance, however, it is also necessary that there be agreement on the basic functions of common control devices and how they will be coordinated so that signals do not collide, losing messages.

In the preparation of this Standards Publication input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the concerned NEMA product Subdivision by contacting the:

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Section 1
GENERAL

1.1 SCOPE

This standard covers control devices connected to a DALI (Digital Addressable Lighting Interface) communications bus, as well as the bus and its power supply.

By way of example, typical control devices would include switches, scene controllers, dimmers, occupancy sensors, daylight controllers, and communications modules that link the DALI bus to other building control networks. This standard includes definitions of these common devices, their minimum functionality, and recommendations for ease of commissioning and operation.

The bus-wiring standard includes the electrical characteristics of the wire, size, and distance constraints and wiring topology. Class 1 and Class 2 low voltage wiring recommendations are included for reference.

The key performance and labeling requirements for a bus power supply are also included, as are the requirements for a communication module. (These two functions are often combined in a single piece of hardware.)

1.2 REFERENCES

The following publications are adopted in part, by reference in this publication, and are available from the organizations below.

1.2.1 Normative References

The following normative references contain provisions, which through reference in this text constitute provisions of this Standards Publication. By reference herein these publications are adopted, in whole or in part as indicated, in this Standards Publication.

International Electrotechnical Commission
3, rue de Varembe
Case postale 131
CH-1211 Geneva 20

IEC 50-200X,
IEC 60929-2003, Edition 2.0, *A.C. Supplied Electronic Ballasts for Tubular Fluorescent Lamps—Performance Requirements*, Annex E, “Control Interface for Controllable Ballasts”

National Fire Protection Association
One Batterymarch Park
Quincy, MA 02269

NFPA 70-2002, *National Electrical Code*

1.2.2 Other References

The following publications may be used to answer questions not covered by this Standards Publication or to provide supplemental information.

1.3 DEFINITIONS

arc power: A measure of the power provided by the ballast to the lamp. There are 254 steps in arc power defined in IEC 60929. The nominal dimming level for each arc power step is specified in Table E.4.3.8 of IEC 60929.

ballast: A device that provides arc power to a lamp. The ballast operates in the master-slave mode where the ballast is the slave and any control unit is the master. It responds to messages from a control unit. It does not initiate communication on its own,

baud rate: The transmission rate, expressed in bits per second. DALI uses 1200 bits per second +/- 10%.

bit: The smallest unit of binary information, consisting of a “1” or “0”. In a DALI installation; it is created when the bus voltage changes from high to low or low to high (bi-phase code).

broadcast command: A command to which all units connected to the DALI bus react.

bus: The medium (normally two wires) used to communicate between DALI devices.

byte: A message consisting of 8 bits.

current rating: The rating of any device on a DALI loop is defined as the steady state current draw when connected to the DALI bus.

current sinking: The maximum current each unit must be capable of handling when creating a low signal on the bus.

device: Any component connected to the DALI bus.

digital command: A command sent over the DALI bus consisting of a predefined set of bits..

direct arc power command: A message to set the output of a ballast (or other lighting device) to a specific arc power level.

channel, backward: A response from the unit receiving the message.

channel, forward: A message from one unit to another in a DALI installation.

group: A set of devices that will respond at the same time to messages on the DALI bus.

group command: A message to which all members of the group will respond.

Idevice: The maximum Iin a device draws from the DALI bus

Idevice total: The sum of the Idevice ratings for all devices connected to the DALI bus.

indirect arc power command: A command that changes the light output but does not have a specific arc power level in the command. Examples: DIM UP, DIM DOWN, ON, OFF.

Iin: The current drawn by a device.

Iout: The output current of the supply.

Isupply: The maximum Iout at any voltage over the full output voltage range 0 – Vsupply.

Isupply min: The minimum current sourced by a power supply at any voltage over the full output voltage range 0 – Vsupply min specified for the supply.

Isupply total: The sum of the Isupply ratings of all supplies connected to the DALI bus.

light level: A percentage from 0.1% to 100% of full light output of that ballast.

mask: A setting that tells a device not to respond to a specific command.

maximum run length: The longest distance between any device and the power supply on the DALI bus.

maximum aggregated run length: The total length of wiring connecting the DALI bus.

maximum device capacitance: The maximum capacitance applied to the DALI bus.

min level: A programmable setting that limits the arc power range on the low side..

max level: A programmable setting that limits the arc power range on the high side..

parameter bank: A collection of operating parameters for a device. Switching between different parameter banks allows for a device to operate in a different way for different building modes (like normal hours, after-hours, etc.) Switching to a different parameter bank is much quicker than actually reprogramming all the different operating characteristics.

power-on: The process of powering on a device after a power failure or when the power supply to the device has been interrupted.

random address: The sequentially assigned number for a device on the DALI bus without respect to the physical location.

scene: A digital light level associated with a preset (0-15) and stored in the ballast.

short address: An address between 0-63 that may be assigned to a device.

supply: A device supplying current to the DALI bus.

transmission protocol: A specified process for sending and receiving digital commands.

Vsupply: The maximum voltage a supply produces with 0 A loading.

Vsupply min: The minimum voltage a supply produces at Iout = Isupply.

Section 2
SYSTEM OVERVIEW

2.1 CONFIGURATION

2.1.1 Basic DALI Loop

The two-wire data bus is referred to as a "loop." A loop connects up to 64 lighting output devices (i.e., ballasts, transformers, relays, and others). The data bus is powered by at least one Loop Power Supply. Messages are sent by momentarily shorting and releasing the loop conductors to create a digital signal. See Figure 2-1.

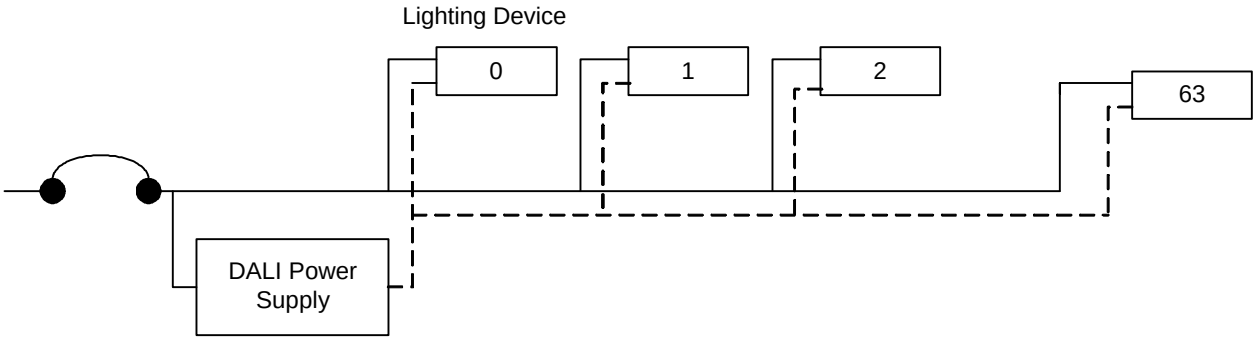


Figure 2-1. Basic DALI Loop

2.1.2 Basic Loop with Dimming Controller

As shown in Figure 2-2, all of the ballasts would be ON full. A control module could be added to dim all of the ballasts on the loop by sending a control command. There are 254 dimming steps to provide for a smooth response.

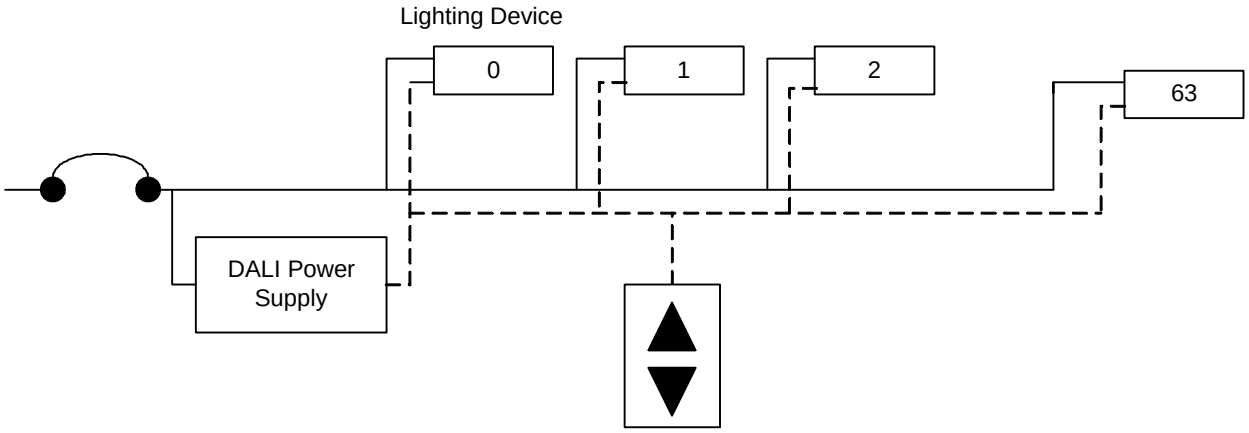


Figure 2-2. Basic DALI Loop with Dimming Controller

2.1.3 Controlling Selected Ballasts (rooms and zones)

Other control devices (up to a total of 64) could be added to the above configuration, as shown in Figure 2-3. In this case, the loop could be made of up a total of 128 addressable devices (64 output devices and 64 control devices). To control specific ballasts or groups of ballasts, however, the control module must be logically linked to those ballasts. This may be done by assigning the targeted ballasts to groups and then having the control module configured to talk to that specific group. Doing so requires a programming tool.

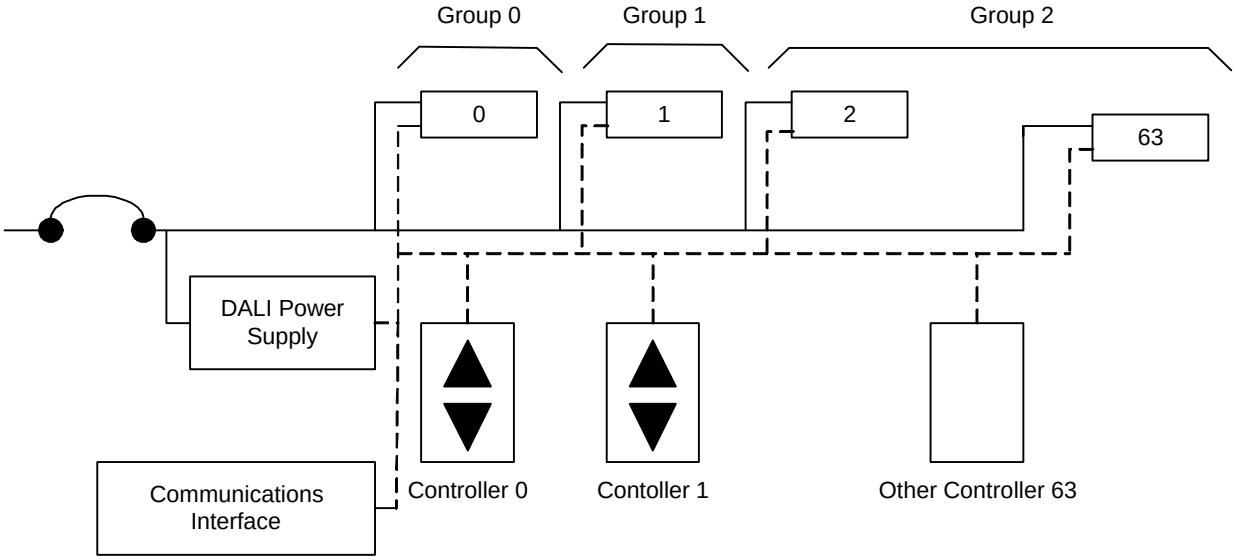


Figure 2-3. Controlling Selected Ballasts

2.2 BALLAST COMMAND TYPES

DALI has three addressing types in order to provide the control resolution desired. In all command types, control is achieved through DALI 2-byte commands sent on a DALI loop to ballast or other DALI output devices connected on that DALI loop.

2.2.1 DALI Broadcast Command

All ballasts connected to a loop respond to a command sent at the Broadcast Command Level. All ballasts on a DALI loop respond at the same time and in the same way to a broadcast command. No commissioning is required for a ballast to respond to a broadcast command.

Note—Broadcast commands are often used in startups or where there is a need to set all ballasts to the same digital light level.

2.2.2 DALI Group Command

Ballast may belong to one or several of 16 groups (0-15). Commissioning is required to place in the ballast memory those groups to which the ballast will respond. To be able to assign groups to the ballasts, the units need to be addressed. Commands to ballasts on a DALI loop may be sent to a specific group of ballasts by sending a Group Command. All ballasts belonging to this group shall respond at the same time and in the same way to this command.

Note—Group Commands are often used to control specific areas of a room, e.g., front wall washers, or to control multiple rooms on a DALI loop where each room is assigned a different group.

2.2.3 DALI Individual Address Command

Ballasts may be assigned a unique individual address. There are 64 possible addresses (0-63). No two ballasts shall have the same address on a DALI loop. Commissioning is required to place in the ballast an Individual Address Command. Sending an Individual Address Command shall send commands on a DALI loop to specific ballasts. The ballast with this address shall respond to the Individual Address Command.

Note—Individual Address Commands are often used to provide personal control to individual luminaires in an open plan office environment.

2.2.4 Go to Scene Command

Ballasts may have stored Scenes (digital light levels) in memory. There are 16 possible scenes (0-15), and each scene stores a digital light level (0-254). Commissioning is required to store a Scene Level in a ballast. Scenes may be recalled using the three address types (Broadcast, DALI Group, and Individual Address Commands).

Note—Stored Go to Scene Commands are often used in conference rooms to recall different task settings like audio-visual presentations or group meetings.

2.3 SYSTEM OPERATION

The DALI control devices can be configured to:

a) Directly control designated ballasts using 2-byte commands;
b) Communicate to other designated control devices using 3-byte commands; or
c) Both

2.3.1 Default Operation

Factory default operation of control devices is intended to provide minimum functionality without requiring commissioning (out-of-the-box operation). Refer to Section 7 for details of default operation of different control devices. Additionally, no manufacturer specific commands are enabled in the default operation.

The result is a system that works in a basic manner. All ballasts connected to the link will respond to all controls, which in turn perform their expected functions. Occupancy sensors will turn lights off, daylight sensors will change the light levels up and down and so on.

2.3.2 Commissioning

The commissioning process provides for enhanced operation of the system. During this process, the commissioning agent will perform the following tasks:

a) Address the ballasts,
b) Address the control devices,
c) Configure the control parameters for the system (define the control relationships and operating parameters for the system).

Section 3
METHOD OF OPERATION

The method of control defined herein builds on the specification for the DALI ballast since the ballast is the object of all operational commands (See IEC 60929). This section defines the rules (protocol) that control devices must follow to avoid conflicts and loss of functionality.

3.1 CONTROL BY DIGITAL SIGNALS

The standardization of the control interface for Control by Digital Signals of electronic ballasts is intended to support the use of ballasts and controls from multiple manufacturers. This interface has a robust, but limited specification to simplify the application and reduce costs.

3.2 POLARITY OF CONTROL DEVICES

3.2.1 Control Devices That Do Not Provide Loop Power

Control devices that do not provide loop power shall be polarity insensitive.

3.2.2 Control Devices That Provide Loop Power

Control devices that do provide loop power shall be labeled for polarity.

3.3 TRANSMISSION CHARACTERISTICS

The transmission timings used herein are based on controller-to-ballast communications. Controller-to-controller communications use the same rate, but have 8 extra bits.

3.3.1 Communication to the Ballast

Communication to the ballast must be done in accordance with IEC 60929, Annex E.

3.3.1.1 Transmission Rate

The transmission rate, expressed in bandwidth, is specified with 1,200 Hz $\pm$ 10% for the forward channel and for the backward channel.

3.3.1.2 Voltage and Current Levels

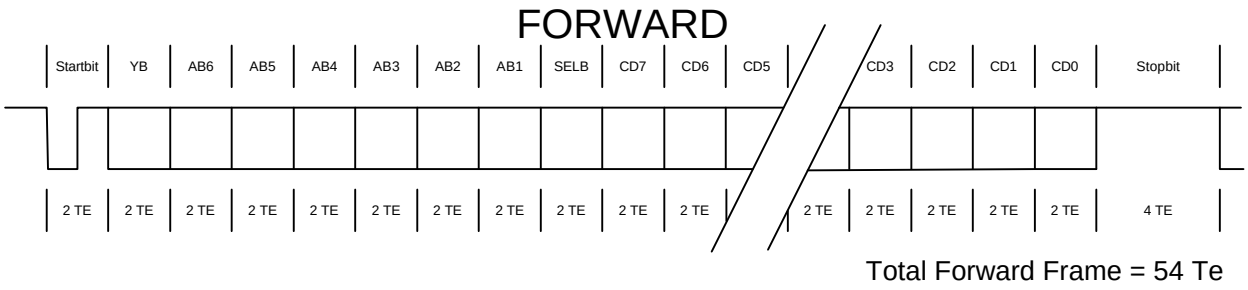
All specified voltage and current levels for controls shall be the same as specified for electronic ballasts in IEC 60929.

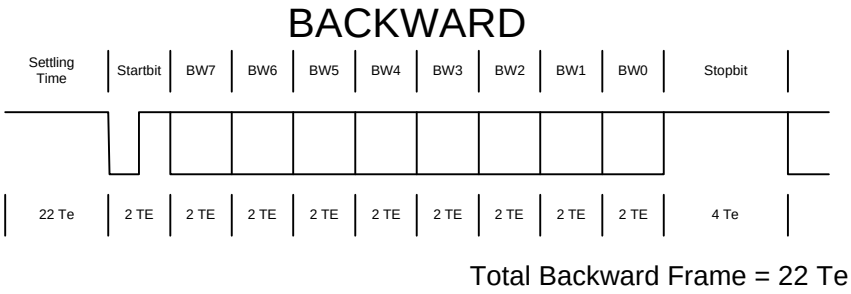
3.3.1.3 A Forward Message Frame

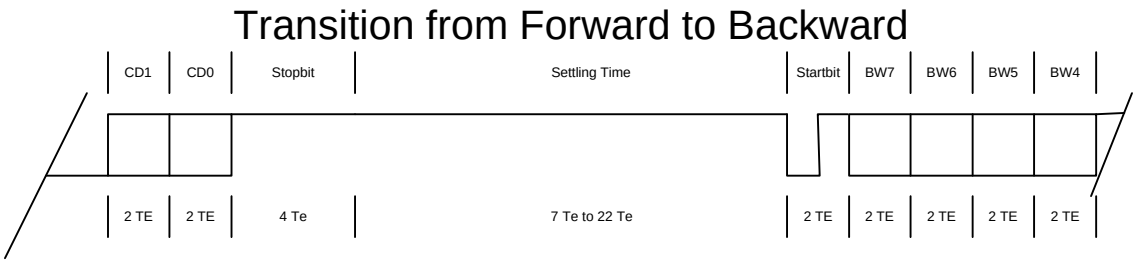
A forward message frame to a ballast shall consist of 19 bits, as follows:

a) 1 start bit
b) 1 address byte: 1 individual or group address bit, 6 address bits, and 1 select bit
c) 1 data byte: 8 data bits
d) 2 stop bits

See Figure 3-1.







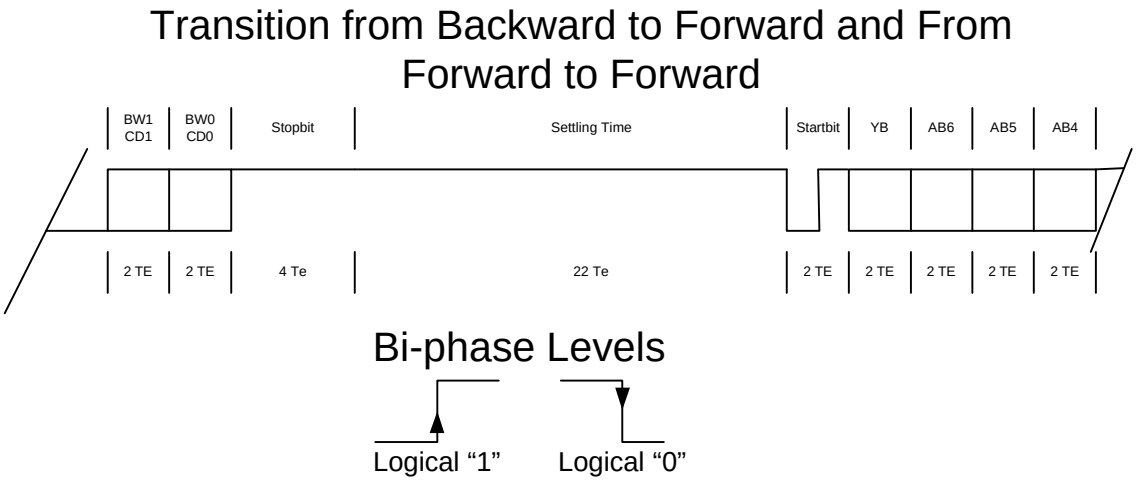


Figure 3-1. Pulse Diagram.

3.3.1.4 A Backward Message Frame

A backward message frame consists of 11 bits, as follows:

a) 1 start bit
b) 1 data byte: 8 data bits
c) 2 stop bits

See Figure 3-1.

3.3.2 Test Conditions

Ballast test procedures are defined in IEC 60929 Annex G.

3.3.3 Communication to the Controls

3.3.3.1 Transmission Rate

The transmission rate, expressed in bandwidth, is specified with 1,200 Hz ± 10% for the forward channel and for the backward channel.

3.3.3.2 Voltage and Current Levels

All specified voltage and current levels for controls shall be the same as specified for electronic ballasts in IEC 60929.

3.3.3.3 A Forward Message Frame

A forward message frame to a controller consists of 27 bits, as follows:

a) 1 start bit
b) 1 address byte: 1 individual or group address bit, 6 address bits, 1 select bit
c) 2 data bytes: 16 data bits
d) 2 stop bits

3.3.3.4 A Backward Message Frame

A backward message frame from a controller consists of 11 bits, as follows:

a) 1 start bit
b) 1 data byte: 8 data bits
c) 2 stop bits

3.4 ELECTRICAL SPECIFICATIONS

3.4.1 Voltage Rating

The signal levels specified in Figure 3-2 are considered to be reasonable for reliable operation of a control device over its operating temperature

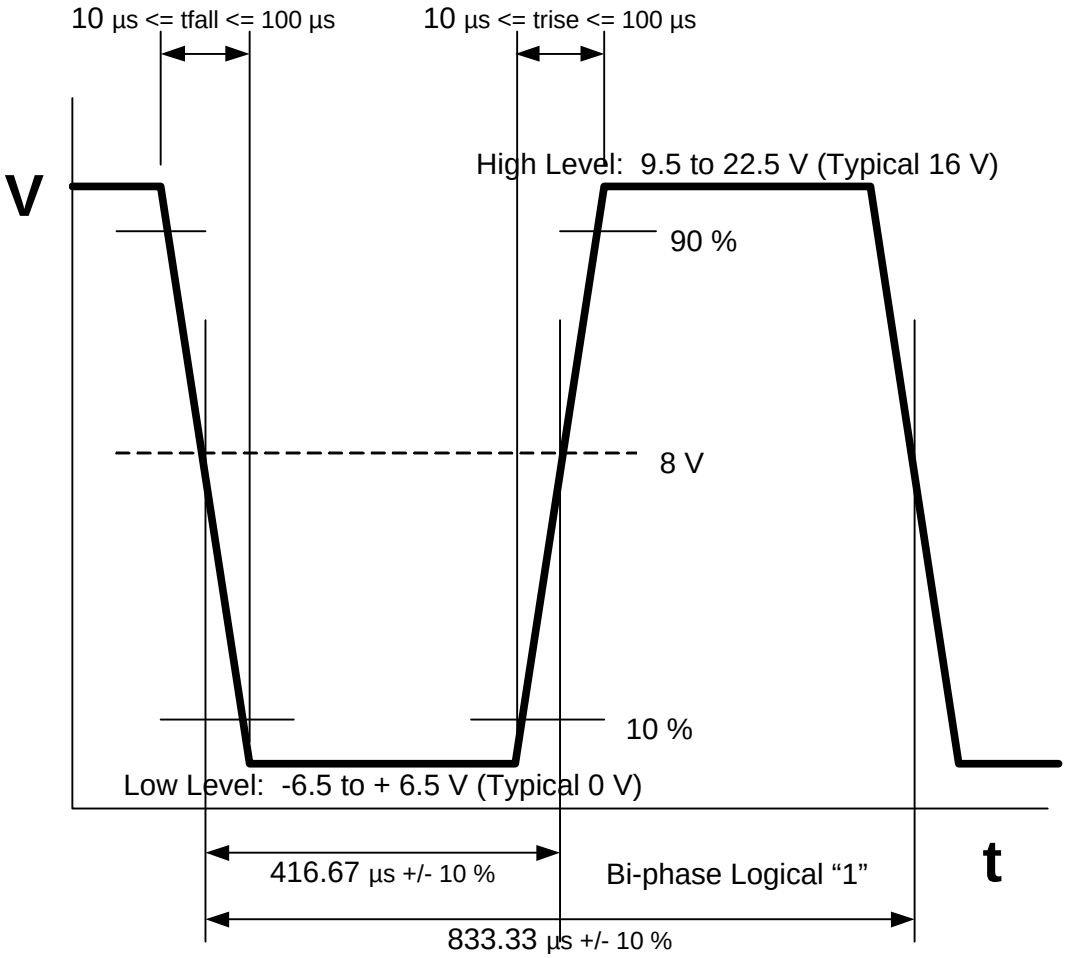


Figure 3-2. Signal Levels

3.4.1.1 Interface Voltage

In general, the interface voltage is high if there is no communication (idle state).

3.4.1.2 Received and Transmitted Data Signal

The slopes of the received and transmitted data signal shall be 10 µs = t_{fall} = 100 µs and 10 µs = t_{rise} = 100 µs at the ballast terminals of the digital interface. The specified t_{fall} and t_{rise} shall be achievable under all configurations of wire types and cable lengths.

3.4.1.3 Voltage Range

The voltage range shall be between 9.5 V and 22.5 V for "high level" and between –6.5 V and +6.5 V for "low level," respectively. The range between 6.5 V and 9.5 V is undefined.

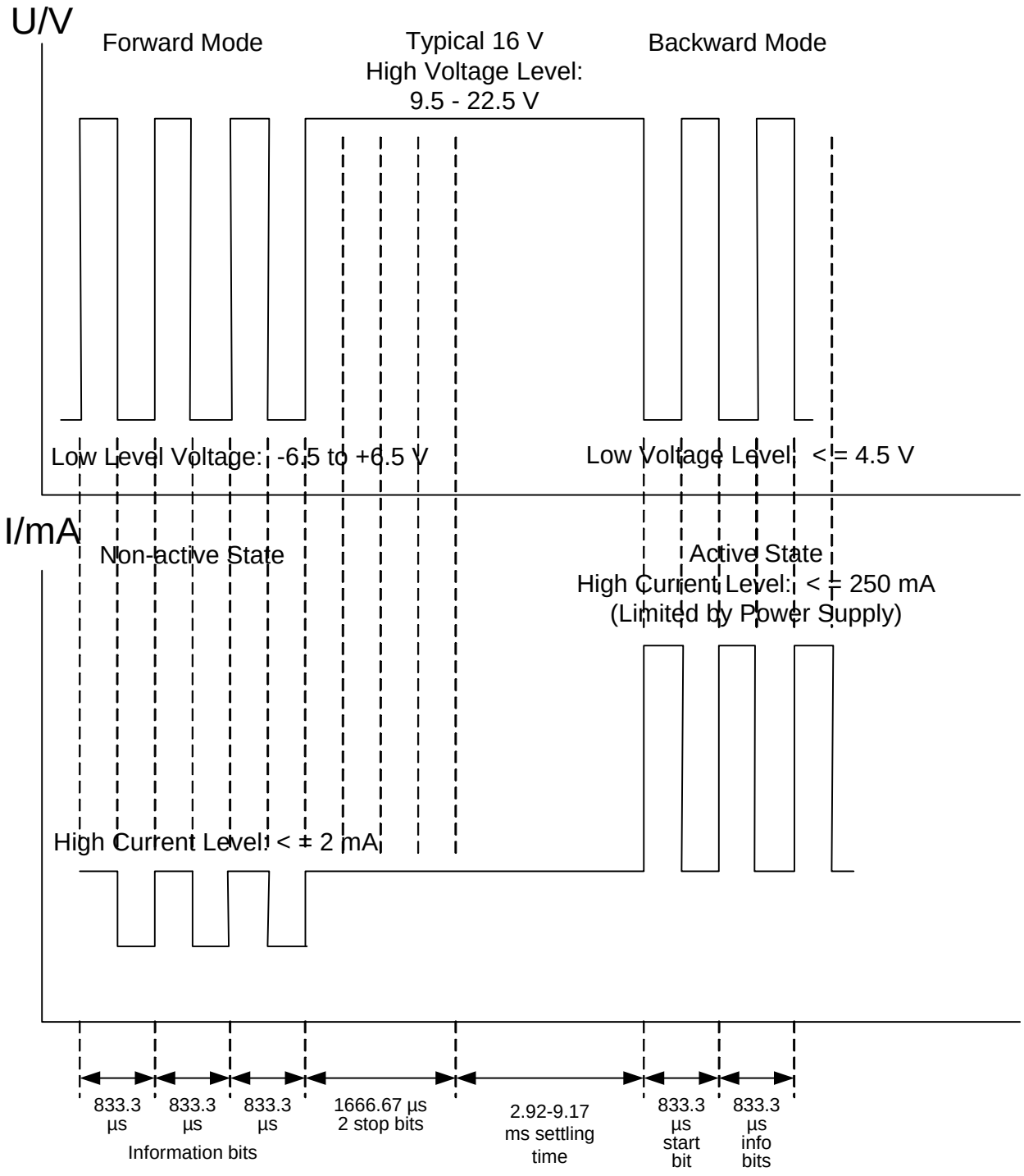


Figure 3-3. Voltage and Current Levels for Forward and Backward Channeling at the Control Device

3.5 OPERATIONAL SPECIFICATIONS FOR CONTROL DEVICES

3.5.1 Method of Operation

The ballast operates in the master-slave mode where the ballast is the slave and any control unit is the master. Controls shall use a 27 bit forward message and 11 bit backward message, following the signaling requirements described above. Messages that do not meet these specifications should be ignored. The control device shall be ready again for data reception 1.7 ms after message rejection. Controls shall also incorporate a bus access and collision management strategy defined below.

3.5.1.1 Access Protocol and Collision Management

This section describes the line access protocol and collision avoidance method to be used when designing DALI control devices. Taken together with other documents that describe the physical communication network, extended messages for controls, and the original DALI specification for ballasts, a complete DALI system can be designed that will allow devices from different manufacturers to co-exist (as a minimum) and eventually share and exchange data (co-operate).

To provide a proper operation (compatibility) with several control devices, sharing the same communication bus, a well-defined access, as follows, to the DALI control line is essential:

a) Command monitoring
b) Access priorities
c) Collision detection

3.5.1.2 Monitoring

The DALI addressing scheme is a multi-step process that cannot be identified solely by access priority to the communication bus. Because of this, in a multi-controller system that might potentially have more than one device attempting to utilize the communication bus at the same time, it is essential to guarantee that another controller does not accidentally disturb the addressing process. Therefore, every control device must detect the following standard DALI commands:

a) Cmd. 258: INITIALIZE
b) Cmd. 256: TERMINATE

While one control device is doing an address allocation, all other control devices in the system shall not transmit any frames. The other control devices shall remain in this locked-out mode until the TERMINATE command is received, or for a maximum of 30 minutes after the INITIALIZE command is received. This 30 minute timeout provides sufficient time to commission a complete DALI bus and gives the attached control devices a fail-safe timer to restore operation should they falsely detect an INITIALIZE command or fail to hear the TERMINATE command.

3.5.1.3 Application of Extended DALI Commands

In the DALI standard, there are additional commands reserved for special device types (other than ballasts that control fluorescent lamps). These device types are defined at command 272 in the DALI standard. To access these commands, a control device unit must first send command 272 with the appropriate device type number as a second byte. All devices of this device type will now be enabled for the reception of an application extended command. Since the next command received after command 272 will disable reception of an application extended command, the application extended command shall be sent with priority 0 to guarantee a proper command sequence for application extended commands. The command 272 shall be sent with a priority 1-4 according to the kind of application extended command (e.g., query = 4, configuration = 2, etc.)

> Example: Query the feature byte of a converter for halogen lamps (device type = 3)
> Cmd. 272 ENABLE DEVICE TYPE 3 (11000001 00000011) with priority 4 (Now all converters of the system will be enabled for the reception of an application extended command.)

Cmd. 240 QUERY FEATURE BYTE (YAAAAAA1 11110000) with priority 0 (The converter at the given address will send an answer and will disable the application extended commands until the next reception of command 272.

Note – If in-between, another command would be received, e.g. QUERY LAMP FAILURE, the converter would answer to the other command, e.g. NO, and would disable the application extended command. Thus, the following command 240 would be ignored by the converter.

3.5.1.4 Access Priorities

Levels of Priority

To assist in the orderly access of the communication bus and to minimize the chance of collisions, five levels of priority are defined, where 0 is the highest and 4 is the lowest priority. The five levels of priority are defined as 5 different settling times (gap times between frames). See Figure 3-5.

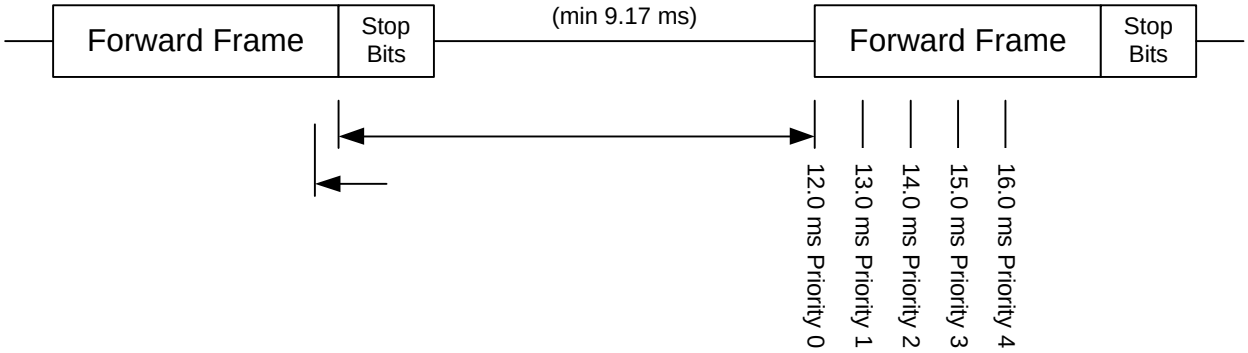


Figure 3-5. Settling Times

A new message of priority X (from 0 to 4) may be sent a minimum of 12 ms + X ms after the last edge of the message. Scanning the priority time-slots (see below) and the collision detection (see Clause 3.5.2.3) shall guarantee that commands of a higher priority will prevail over commands of lower priority.

Overview of Levels of Priority

Commands are assigned to levels of priority. The type of the command and the type of application determine the assignment, as follows:

a) Priority 0: Temporary priority for messages that must be repeated
b) Priority 1: User initiated arc power control commands and commands which have an impact on manual adjustment of arc power (e.g., dim up with a special fade time)
c) Priority 2: Configuration in general
d) Priority 3: Automatic arc power control commands
e) Priority 4: Queries

Priority 0

Several messages must be repeated within a specified time period for the command to be considered valid (see the DALI ballast specification for examples). Priority 0 shall be used to ensure that no other devices can access the bus before the second/repeated message is sent.

Address allocation is a special exception. The commands 258 INITIALISE and 256 TERMINATE shall always be sent with priority 0. All other addressing commands may be sent with any priority (since no other control device may send during address allocation), but priority 0 is recommended for speed reasons.

Priority 1

The second highest level of priority, Priority 1, shall be reserved for commands that are user initiated (e.g., a wall switch) or those that require fast action (e.g., a motion sensor). Therefore, all commands that should immediately affect the arc power level (including those configuration commands that would impact the response of the dimming, such as fade time) shall be sent with Priority 1.

Example: Recall scene 0 with fade time 5
Cmd. 257 DTR = 5 with priority 1
Cmd. 46 STORE DTR AS FADE TIME with priority 0 (first time)
Cmd. 46 STORE DTR AS FADE TIME with priority 0 (second time)
Cmd. 16 GOTO SCENE 0 with priority 1

In the above example, the user is initiating an action that is causing an adjustment to the fade time. This process actually takes three messages to complete. Because this is a user-initiated action that will have an impact on the visual response of the system, it will use Priority 1. To guarantee that no other device can get a message onto the bus before the three-step process has completed, the remaining two messages are sent at Priority 0.

Priority 2

All DALI commands, which shall be sent twice within 100 ms, fall into this category for the first message. Mostly these are configuration commands. Configuration commands are less time-critical than user initiated commands, but once they are started, they must be completed correctly. Therefore, the first of the two required messages shall be sent at priority 2, and the second shall be sent with priority 0.

Example: Set the Max Level to 50 percent (229)
Cmd. 257 DTR = 229 with priority 2
Cmd. 42 STORE DTR AS MAX LEVEL with priority 0 (first time)
Cmd. 42 STORE DTR AS MAX LEVEL with priority 0 (second time)

Example: Store the actual arc power level as scene 0
Cmd. 33 STORE ACTUAL LEVEL IN THE DTR with priority 2 (first time)
Cmd. 33 STORE ACTUAL LEVEL IN THE DTR with priority 0 (second time)
Cmd. 64 STORE DTR AS SCENE 0 with priority 0 (first time)
Cmd. 64 STORE DTR AS SCENE 0 with priority 0 (second time)

Again in the examples above, the first message is sent with priority 2. But, since each of these actions requires multiple messages, the remaining messages are sent at priority 0 to ensure their completion without interruption from other devices.

Priority 3

This level of priority shall be reserved for non-user initiated/automatic changes to arc power level, mainly defined by the type of application. These commands have a low priority, because there is little difference between a command received immediately and one received at a slightly later time. Typically, such commands are sent infrequently, and mostly by an automatic control device (e.g. light sensor/time clock).

Priority 4

Query commands shall have the lowest priority because they are least time critical.

Example: Query the light level of a device
Cmd. 160 QUERY ACTUAL LEVEL with priority 4

3.5.1.5 Access Timing

A successful transmission of a DALI frame shall take the following three steps:

a) Wait the DALI settling time
b) Scan the priority time-slots (commands with higher priorities)
c) Monitor the transmission (collision detection—see Clause 3.5.2.3)

Definition of Settling Time Measurement

The time measurement of the priority based settling-time starts with the final edge of the last bit of the current frame, applied to a forward frame or a backward frame. The first illustration in Figure 3-6 shows the final edge occurring in the middle of the final bit, which is the case when sending a logic one. The second illustration in Figure 3-6 shows the final edge occurring at the end of the final bit, which is the case when sending a logic zero.

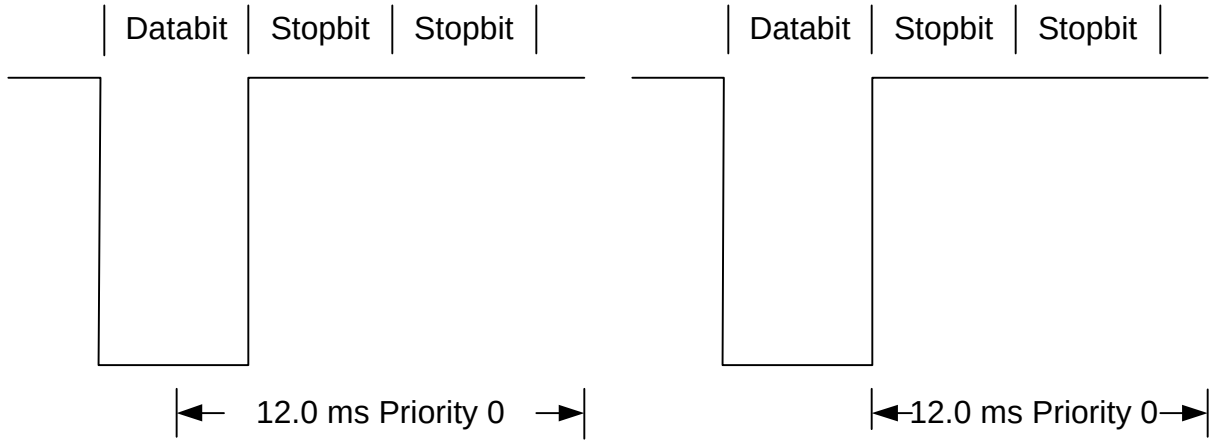


Figure 3-6. Settling Time Measurement

The time-slots of the priorities are defined with 1 ms ± 480 µs tolerance.

The minimum possible settling time for priority 0 is calculated as follows (standard DALI timing definitions plus priority tolerance):

DALI settling time + 110 % · (2 stop bits + ½ bit) + priority tolerance =
9.17 ms + 110 % · (2 · 833.3 ms + 416.7 ms) + 480 ms = 12.0 ms

Wait the DALI Settling Time

Priority 0 is defined as 12 ms as described above. All priorities shall be defined as follows:

a) Priority 0: 12.00 ms ± 480 µs
b) Priority 1: 13.00 ms ± 480 µs
c) Priority 2: 14.00 ms ± 480 µs
d) Priority 3: 15:00 ms ± 480 µs
e) Priority 4: 16.00 ms ± 480 µs

See Figure 3-5.

Scan the Priority Time-slots

The first priority time-slot (priority 0) shall start at 12.00 ms ± 480 µs after the last data bit.

If a control device wants to send a command with a certain priority, it has to scan the DALI control line beginning at 11.52 ms (12.00 ms - 480 µs) and continue until the desired priority time-slot has been reached. Prior to that time, a different device with a higher priority might begin its transmission.

If desired, to avoid continuously scanning the line and to free the control device for other tasks, it is possible to scan the line periodically at a rate that must be shorter than ½ data bit (i.e., less than 416.7 µs – 10 % → 375 µs).

3.5.1.6 Collision Detection

In a system with more than one controller, it is possible that two or more control devices might attempt to start a transmission at the same time (same priority). To avoid data collisions each control device shall monitor it's own transmission (collision detection).

Since a LOW is the dominant state (meaning that a LOW state will win over a HIGH state), collision detection shall be achieved by checking the DALI bus to assure it remains HIGH under following conditions:

a) 8µs before the bus is to be set to a LOW level
b) During the transmission of a HIGH-bit in the middle high part of this bit

If in any of these two cases a control device detects a LOW at the DALI bus, a collision has been detected. This means that a second control device is sending at the same time. In this case the first control device shall interrupt its transmission. The second device shall continue its message without interference. See Figure 3-7.

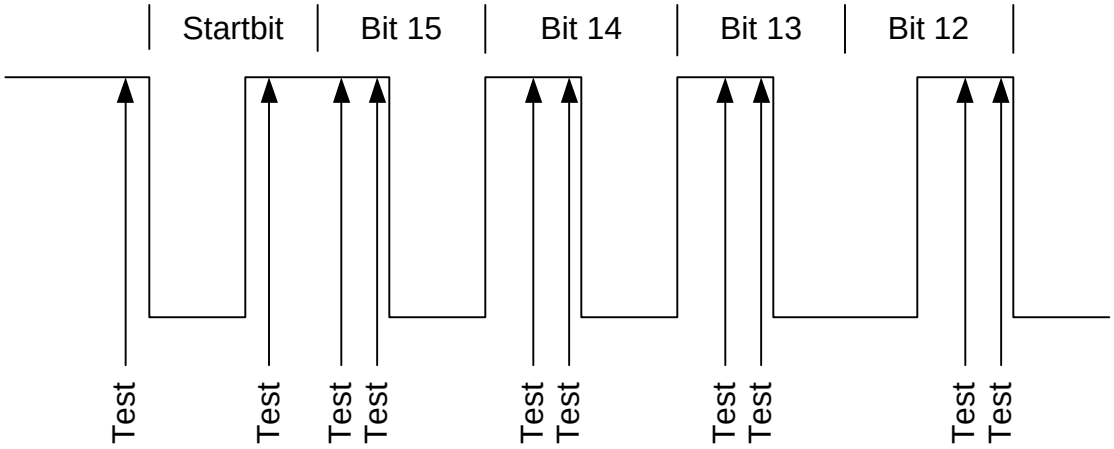


Figure 3-7. Collision Detection

An interrupted transmission may be started after waiting for the next appropriate priority slot. Note that there is no increase in priority level following a collision.

Section 4
EXTENDED CONTROL CONCEPT

4.1 GENERAL

This section covers the message structure for DALI Control Messages, and presents a list of defined DALI Control Device Types. Section 5 details the messages used by all DALI Control Devices (the generic command set). The messages that are specific to the DALI Control Device Types detailed in this section are covered in NEMA Standard 243, Part 2.

4.2 GENERAL FORMAT

The general format for DALI Control Message is as follows:

Byte One – Addressing (Who)
Byte Two – Command (What)
Byte Three – Data (How Much)

4.2.1 Address Byte

4.2.1.1 Addressing

The first byte will be used for addressing. It controls who will listen or react to the message. The following address types are supported by DALI Control Messages:

Controller Individual Addressing (sent *to* an individual device)
Controller Originator Addressing (received *from* an individual device)
Controller Type Addressing (sent *to* a specific type of devices)
Controller Group Addressing (sent *to* a group of devices)
Controller Broadcast Addressing (sent *to* all devices)

Control devices themselves can have the addresses assigned in a random fashion similar to the one used to randomly assign short addresses for DALI Ballasts. However, as control devices can often be thought of as a point of entry for the DALI bus, sometimes it is necessary to assign addresses by some other means (maybe by switch setting, factory setting, or IR command, for example). In those cases, the address can either be randomly set, or might be pre-specified. In these cases, the device will not respond to attempts to randomize its address. Whatever installation method is used to set the short address of other devices will have to detect this and ensure that these fixed addresses are not assigned to other devices. This, and random addressing, will be described in more detail later.

4.2.1.2 Controller Individual Addressing

No more than 64 control devices will be allowed on a DALI bus (the actual limit is determined by the current consumption and the power available to the DALI bus). The Individual Address for a controller can be from 0 to 63. At first glance it might appear that the control and ballast address space overlap, but they do not. Communication with ballasts is achieved using the two-byte DALI Ballast format and communication with controllers is accomplished with the three-byte DALI Controller format.

Individual Addressing is specified when the two upper bits of the address byte are both zero. The lower six bits of the address byte then contain the Individual Address. The address byte will range in value from 0 to 63 (0x00 to 0x3f hexadecimal).

Individual Addresses are either pre-determined or assigned during the installation process using methods detailed later.

4.2.1.3 Controller Originator Addressing

Some devices, such as occupancy sensors or light level sensors, need to send data periodically. Since there could be multiple sensors on a single DALI bus, it is also necessary for the sensors to identify themselves. To support this function, the address field, which usually identifies the *receiver* of the message, is used to identify the *source* of the message. When using Controller Originator Addressing, ALL devices on the bus receive the broadcast. However, only those that have been properly configured will act upon the message. The Controller Originator Address is the same as the individual address plus an offset of 64 (0x40 hexadecimal). Note, since different addressing is used, it would be possible to define a totally different command space to be used with Controller originator Addressing. This is not planned at this point, but is available for future expansion.

Controller Originator Addressing is specified when the uppermost bit of the address byte is a zero, and the next bit is a one. The lower six bits of the address byte then contain the Controller Originator Address. The address byte will range in value from 64 to 127 (0x40 to 0x7f hexadecimal).

4.2.1.4 Type Addressing

A third type of addressing is provided that allows one to communicate with all devices on a bus that are of the same Type. . The currently defined device types are detailed in section 4.3 DALI Control Device Type List. Up to 64 device types are possible. A devices type can be determined by a query to an individual address.

Type Addressing is specified when the uppermost bit of the address byte is a one, and the next bit is a zero. The remaining six bits then specify the Type Address. The address byte will range in value from 128 to 191 (0x80 to 0xbf hexadecimal).

4.2.1.5 Group Addressing

One of the more useful aspects of the original DALI Ballast protocol was the concept of Group Addressing. This was proven to be very effective in the field. Unfortunately, only 16 groups (0 to 15) were provided for, which proved to be somewhat limited in actual application – especially if one considered not just a single loop, but multiple loops, and you wanted to use the same group number for similar purposes on multiple loops. With the control protocol, the number of groups is expanded to 32.

To appreciate the importance of increased group addressing, consider the example of occupancy sensors. One might want to form a group of all occupancy sensors. Another group might define those sensors used in common areas (hallways, bathrooms). Additional groups might be used for open offices and private offices. Each of those groups might share common setup information with other members of their own group, yet have different setup information from other groups. For example, during normal work hours, you might want to lockout the sensor entirely from open offices and hallways (just keep the lights on). Bathroom sensors might be set with a fairly short timeout, while private offices might have a much longer timeout.

Group Addressing is specified when the uppermost bits of the address byte are both one, and the next bit is a zero. The lower five bits of the address byte then contain the Group Address. The address byte will range in value from 192 to 223 (0xc0 to 0xdf hexadecimal).

4.2.1.6 Reserved Addressing

The address field where the uppermost three bits are set to one is reserved for future expansion. The address byte will range in value from 224 to 254 (0xe0 to 0xfe hexadecimal). Note that this does not include the 0xff Broadcast Address.

4.2.1.7 Broadcast Addressing

This is the fifth type of addressing supported. This type of addressing is used when every control device on the bus is to receive the message.

Broadcast Addressing is specified when all the bits of the address byte are one, so the address byte will have a value of 255 (0xff hexadecimal).

4.2.2 Command Byte

4.2.2.1 Control Commands

The second byte of the three-byte DALI Control Message contains the Control Command. This specifies what is to be accomplished by the device(s) that was addressed in the first byte.

The addressing part of the protocol already recognizes that we need to allow for communication to up to 64 different types of devices (wall controllers, occupancy sensors, photocells, etc.) If a large number of different type devices are developed, and each one needs several unique messages to operate, then a pool of only 255 different commands (what would fit in a single byte) would quickly be exhausted. To obtain better efficiency from the command byte, the command byte will be interpreted based on its context as follows:

Controller Common Control Commands – 0 to 127 (0x00 to 0x7f hexadecimal)
Controller Specific Type Commands – 128 to 191 (0x80 to 0xbf hexadecimal)
Controller Manufacturing Specific Commands – 192 to 255 (0xc0 to 0xff hexadecimal)

A further improvement in efficiency is gained by understanding that some commands require data to complete the task (like set a time delay to a specific number of minutes), while many other commands can be carried out without data (like enabling a specific device). In the first case, the second byte will specify the command, and the third byte will specify the data. But, in the case of a command not requiring data, the second byte will indicate a “data-less” command. This means that the actual command can be found in the third byte. This provides for an additional 256 commands.

4.2.2.2 Common Control Commands

These are commands that are shared among all DALI control devices. For example, it was mentioned earlier that a means would be provided to allow for the automatic assignment of random addresses (to those devices that support such commands). Those commands that implement that addressing method would be considered common commands, and would be operated upon by any device connected to the bus. A simple command like go on-line or off-line might also be implemented this way. A total of 127 common commands (that specify data) are available (plus another 256 data-less commands). Those not specified are reserved for future use.

In general, a response to a query command will be 8 bits of data. However, it might be possible for the response to be in the form of a “Yes” or “No.” The “Yes” response shall be all 1s. If “No,” then no response is sent.

4.2.2.3 Specific Type Commands

This specification allows for the definition of up to 64 specific device types. This might be something like a photocell sensor. Assume that a photocell sensor is allowed to automatically send a light level reading periodically to a control group (a specific address, or group address containing those devices that are to listen to light levels). Command 128 (0x80 hexadecimal), for a photocell, might be a command that would set the repetition rate for resending the data (the number of minutes from 0 to 255). Command 128 (0x80 hexadecimal), for a different device type, like an occupancy sensor, might be something entirely different. This overlapping set of command codes means we can have over 16,000 unique commands for all the different device types.

Devices that contain multiple device types should be assigned a separate individual address for each device type.

4.2.2.4 Custom Lighting Control Commands (Non-reserved)

While many commands are specified, and their meaning and use are well known, it is still essential to provide a mechanism that will allow communication, in a controlled, non-destructive way, to a specific manufacturer's device. This will allow advancement in the state-of-the-art (features not anticipated by the specification), or enable the use of proprietary features.

By default all devices specifically ignore most manufacturing specific messages (it responds only to a Query Manufacturer Specific Identification message). To use, you must address a specific device and enable the manufacturing specific messages (using one of the Common Control Messages). Because of this disable/enable feature, it is possible for two manufacturers to use the same message flags in different ways, but not be concerned about impacting each other negatively.

The disable/enable approach works very well when sending data to a device, but it does not accommodate the unspecified transmission of data from a device to the outside world. Because this is a proprietary message, flowing between controllers, it is specific to a given manufacturer. Therefore, the data should be restricted to specific addresses (individual, group or type) that are known to accept and process the data correctly. Otherwise, if the information is simply broadcast, then the same message might be interpreted differently by two manufacturers with an improper result.

Broadcasting of manufacturer specific information is not advised, unless no other control devices are present on the network.

A read command is implemented in the Manufacturing Specific command space. This is required of ALL devices. It is used to interrogate manufacturer specific identification information that is used to identify the device (make, model, revision, feature list, etc. are some examples of what might be done). A minimum of 16 bytes may be retrieved this way, but up to 256 are allowed optionally. This command will always function, even if Manufacturer Specific Commands have been disabled. It is suggested that each Manufacturer detail the use of the identification fields and place it in the documentation supplied to the users/integrators, so that devices can be identified.

Note—these fields are read only and shall not change the operation of the device.

4.3 DALI CONTROL DEVICE TYPE LIST

The device type is used as the address byte when using Type Addressing. Specified devices are described below in Table XX. Types range in value from 128 to 191 (0x80 to 0xbf hexadecimal). All non-specified devices are reserved. See NEMA Standard 243, Part 2 and Section 7 for additional details

Table 4.1. DALI Control Device Type List

Type DEC	Type HEX	Name	Comments
128	0x80	Unknown Device	If one of the devices below don't apply
129	0x81	Switch Device	A Wall-Switch based Controller including, but not limited to ON/OFF devices, Scene switches, dimming device.
130	0x82	Slide Dimmer	An analog/positional dimming controller
131	0x83	Motion/Occupancy Sensor	A device that indicates the presence of people within a control area.
132	0x84	Open-loop daylight Controller	A device that outputs current light level and/or sends control messages to actuators based on light passing a threshold.
133	0x85	Closed-loop daylight controller	A device that outputs current light level and/or sends control messages to actuators based on a change in light level.
134	0x86	Scheduler	A device that establishes the building mode based on time of day, or which provides control outputs.
135	0x87	Gateway	An interface to other control systems or communication busses
136	0x88	Sequencer	A device which sequences lights based on a triggering event
137	0x89	Power Supply *)	A DALI Power Supply device which supplies power for the communication loop
138	0x8a	Emergency Lighting Controller	A device, which is certified for use in control of emergency lighting, or, if not certified, for non-critical backup lighting.
139	0x8b	Analog input unit	A general device with analog input.
140	0x8c	Data Logger	A unit logging data (can be digital or analog data)

*) A DALI lighting system requires a power supply with a current sourcing characteristic. The supply may be "stand alone" or be implemented as part of another DALI device. Multiple power supplies may be combined as long as the total power supplied to the DALI bus meets the requirements outlined in the following. A DALI power supply need not be addressable by the DALI bus. If the power supply is addressable, it should meet the requirements of Part II of this standard.

Section 5
EXTENDED DALI COMMAND SET FOR CONTROLS

5.1 GENERAL

One of the objectives of the protocol is to define a basic set of features that can be employed to make a generic sensor/controller. The messages used to define these basic features will become the basis for the Common Control Commands listed later. The purpose of the basic feature set is three-fold:

1) It allows for the development of devices that are currently not anticipated, or detailed within the current revision of the DALI Controller Specification, so that manufacturers of such devices can attempt to implement the desired functions without having to get the specification revised first.
2) It allows for system integrators to have a standard interface to configure many basic control functions, since set points, delays, and the like are setup in a similar fashion.
3) The primary operation of the device can be understood by all, while more detailed operation can be accomplished by developing detailed sensor specific commands for the desired device type.

Controller Specific Type Commands are detailed in Part 2 of this specification. Where applicable, Common Control Commands will be used within the Controller Specific sections, and a further description of the functionality shall be provided there.

5.2 CONFIGURATION OF GENERIC SENSORS/CONTROLLERS

Generic Sensor/Controllers are configured using parameter banks

5.2.1 Parameter Bank Selector

Parameter Bank Selector – The generic parameters (Output Control, Thresholds, Delays, and Repeat Timer) form the basis for specifying the operation of a generic sensor. However, during the normal operation of a building, it might be desirable to have the parameters change at different times of the day. Therefore, multiple sets, or banks, of parameters must be provided. A Parameter Bank Selector is provided to access multiple banks. The selector value can range from (0 to 255), and can be used to specify up to 256 different banks of parameters.

Each selector value can be thought of as a building mode. For example, the first selector might correspond to the operation of the building during normal hours (when the building is normally occupied). A second parameter bank might specify the operation when the building is in an after hour mode.

The minimum required number of banks is one. The user of a device can Query the Parameter Bank Count to determine the maximum number of banks. After using the Parameter Bank Selector to specify the desire bank, writing and reading the individual parameters will always take place within the selected parameter bank. Note that it is not possible to write/read from a bank that is not present in the device, and the use of spare banks for storage is not advised (and might cause improper operation of the device).

5.2.2 Output Control

Some devices may output control signals as a value. An example of this would be a light level sensor, which might output lux values. In this case the message would be sent using Controller Originator Addressing, in a 3-byte protocol. Devices might be alternatively configured to have direct control over actuators. In this case the message would be sent directly to the ballasts/actuators using their 2-byte

protocol (registers are provided to enter both bytes of the 2-byte protocol message, and two sets are provided; one for active to inactive transitions, and another for inactive to active). Either or both methods can be enabled for a generic device.

5.2.3 Thresholds

A threshold is some value that must be reached to cause a particular control output. Since a control device is capable of outputting one or more states (such as active/inactive, on/off, etc.), two thresholds are provided so that hysteresis can be accommodated (where there is a difference in set-point between the rising/falling trip points). In addition the threshold can be configured to represent either an absolute value (with "0" as reference value), or just a relative change (with the last output as reference). This relative change option supports closed-loop control, while the absolute threshold supports open-loop control.

In the case of a binary sensor, such as a switch, the threshold is interpreted as a Bit mask. In this case, bitwise information is provided for each input, and specifies which bit transition(s) will create a control output.

5.2.4 Delays

Time delays are provided prevent an immediate change in state of the control output. For a motion sensor, for example, if motion is no longer detected, it is desirable to avoid sending that fact immediately. Otherwise, if an occupant in an area was briefly at rest, the lights might turn off needlessly. Various sensors might need different delay values, so delay time can be specified in both minutes in the range 15 sec to 1 hour in increments of 15 sec. Two delays are provided, one for active to inactive, and another for inactive to active state changes, so that different delays can be specified for each. As a rule a reverse crossing of the threshold stops the timer and a renewed crossing restarts it.

5.2.5 Repeat Timer

Some sensors might have a need to repeat their output at some interval. An example of this might be a light level sensor, which can be configured to send the sensor value periodically by using a repeat timer. Other devices, particularly those involved in open-loop control may only produce an output on a transition from one state to another. The repeat function can be disabled in this case.

5.3 DATA REQUIREMENTS FOR GENERIC CONTROLLER/SENSOR

The amount of data required to implement a generic controller/sensor is minimal, and is detailed in the list below in Table 5.1. It totals 23 bytes, including a byte to retain the actual sensor value. Each of the items below will be described in detail when the messages that are used to set them are described later.

Table 5.1. Data Requirements for Generic Controller/Sensor

Read Data #	Byte #	Description	Default setting
0	0	FB (Feature byte) Read only Bit 7 Reserved for future use Bit 6 Reserved for future use Bit 5 Reserved for future use Bit 4 '1' if full addressing possible Bit 3 '1' if supports random addressing Bit 2 '1' if supports multiple parameter banks Bit 1 '1' if unit can output 3 byte commands Bit 0 '1' if unit can output 2 byte commands	No default here!
1	1	SB (Status byte) Read only Bit 7 '1' if Future 2-byte output pending Bit 6 '1' if above threshold A Bit 5 '1' if above threshold B Bit 4 Reserved for future use Bit 3 '1' if Other error Bit 2 '1' if Communication error detected Bit 1 '1' if Hardware error Bit 0 '1' if Power failure detected	
2	2	SV (Actual Sensor Value) Is set by the control device automatically	No default here
3	3	DTR-X (Data transfer register): Stores values for 2-Byte transfers	Def=0
4	4	DTR-Y (Data transfer register): Stores values for 2-Byte transfers	Def=0
5	5	CA (Control Address, 0…63); Address to identify the sensor in 3-byte communication. Data written by setup/addressing process	
6	6	CT (Control Type, 0…63); Specifies the type of controller (ref. Table 4.1)	No default here
7	7	CG_0 (Control Group Membership Byte_0) (each bit = 1 selects membership in group 0…7)	Default = 0
8	8	CG_1 (Control Group Membership Byte_1) (each bit = 1 selects membership in group 8…15)	Default = 0
9	9	CG_2 (Control Group Membership Byte_2) (each bit = 1 selects membership in group 16…23)	Default = 0
10	10	CG_3 (Control Group Membership Byte_3) (each bit = 1 selects membership in group 24…31)	Default = 0
11	11	PBC Parameter Bank Count (1 to 255) if count=1, only one bank is supported.	No default here
12	12	PBO Parameter Bank Operate (0 to255)	Default = 0
13	13	PB The actual Parameter Bank (specifies the parameter bank to be operated from bytes 15 to 25)	
14	14	PBRW Parameter Bank Read Write (specifies the parameter bank to be read from or written to)	

Read Data #	Byte #	Description	Default setting
15	15	Version (Read Only byte that specifies the version number met by the software and hardware of the present unit. Answer, first four bits is major version, second four bits is the minor version)	
16	16	MCAC Multifunction Controller Address Count (for single functions, responds with '1', otherwise contains the count of functional units contained in the same physical unit.	
17	17	BA Base Address (responds with the lowest number address for a multifunction controller)	
18	18	NCA Next Controller Address (responds with the next higher address number. Responds with its own address if this is the highest/last address in the controller)	
		Actual Parameter Bank (bytes 0 to 10)	
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	Default = 0 (0b00000000)
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	Default = 0
66	2	OBA_2– second byte output pattern A	Default = 0
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	Default = 0
68	4	OBB_2– second byte output pattern B	Default = 0
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	Default = 0
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	Default = 0
71	7	DA Delay value A 15 sec (1 byte timer)	Default = 0
72	8	DB Delay value B 1 min (1 byte timer)	Default = 0
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	Default = 0
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or "auto" if appropriate)	Default = 0
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	Default = 255

Conventions used in the above data structures in Table 5.1 are as follows:

a) Timer=0 means no timing, timer deactivated

b) Threshold “0” means “deactivate” threshold
c) If the threshold is set to relative, then a threshold value of 1 will cause an “output on any change”, since it is the smallest detectable change.
d) Relative threshold definition is “all positive logic”. With relative threshold B this is achieved by “Activate if current Value + Th_b < last output”
e) When “enable 3 byte output to controllers” is ‘1’, the unit will send the Actual Sensor Value using the Controller Originated Sensor Address space. Any other 3-byte output must be enabled by a different means.

5.4 ESTABLISHING THE CONTROLLER INDIVIDUAL ADDRESS

5.4.1 General

Recall that because the Ballasts/Actuators use a 2-byte protocol to communicate, and Controllers use a 3-byte protocol, the address spaces do not collide. This means that there can be 64 individual Ballasts/Actuators AND 64 individual Controllers on the same bus without conflict. In other words, short address 13 for a ballast is not the same device as individual address 13 for a controller.

5.4.2 Methods of Establishing Controller Individual Address

Three methods of establishing the Controller Individual Address are to be provided. They are:

- Random address allocation
- Physical selection
- Pre-selection

5.4.2.1 Random Address Allocation

This technique, assigns an individual address to each device based on a large random number generated within the device). While the assignment of random addresses does not require user intervention with this method, it still leaves the step of identifying which device is which up to the user. The Identify Device command can be used for that purpose.

5.4.2.2 Physical Selection

This technique involves an installation tool and the user taking some positive action with respect to the controller, like pressing a button, removing a lamp, etc. The installation tool detects the physical selection and assigns the next available individual address.

5.4.2.3 Pre-selection

The individual address is pre-assigned by some method (fixed by the factory, assigned by address switches/knobs, etc.) While also automatic (in theory), this can lead to improper address settings, or duplication, if care is not taken in the setting of knobs/switches. Also, because this technique is now available, installation tools must be capable of detecting that a pre-selection has been made, which has removed an individual address from the pool that can be assigned by the other two methods.

5.4.3 Automatic Short Address Assignment Method

When a controller is not being delivered with a pre-selected address the following shall apply.

The address range is set to a maximum of 24-bit (3 bytes) which leads to 16.777.216 different addresses.
There are Addressing Commands where the controller shall respond as if it was a Query Command. Multiple class devices shall react on each specific class number and they shall take one address for each class they belong to.

Needed commands are given in Table 5.2 below.

ATTENTION when addressing a multifunction controller each function shall accept a single address. That means that it will be necessary for each functional unit to create a long address.

Table 5.2. Needed Commands for the Automatic Short Address Assignment Method

Command Dec	Command HEX	Name	Comments
26	0x1a	Extended Terminate	This command shall terminate all special process (e.g. the assignment of short addresses)
27	0x1b	Extended Initialize	This command is used for addressing controls. It is possible to initialize a specific Address Type unit. This command shall be received a second time in the next 100 ms. No other commands addressing the same device shall received be sent between these two commands, otherwise the other command and the enhanced Command shall be ignored. The command shall start or re-trigger a timer for 15 minutes; the standard addressing commands can only be processed within this period. *The other commands can still be processed during this period.* Depending on the content of the Address Byte the requested controller shall react.
28	0x1c	Extended Randomize	This command shall be sent a second time within the next 100ms. No other command shall be sent between these two commands otherwise these shall be ignored. The ballast shall generate a new random address upon receipt of this command. The new random address shall be available within a time period of 100ms.
29	0x1d	Extended Compare	The control unit shall compare its random address with the combined search address stored in SEARCHADDRH, SEARCHADDRM and SEARCHADDRL. If it's random address is smaller or equal to the combined search address stored in SEARCHADDRH, SEARCHADDRM and SEARCHADDRL then the controller shall generate a query "yes" (0000 0001)
30	0x1e	Extended Withdraw	The controller with the random address that is equal to the combined search address stored in SEARCHADDRH, SEARCHADDRM and SEARCHADDRL shall be excluded from the compare process. This ballast shall not be separated from the initialization process.
31	0x1f	Extended SEARCHADDRH	Sets the 8 high bits of the search address.*
32	0x20	Extended SEARCHADDRM	Sets the 8 mid bits of the search address.*
33	0x21	Extended	Sets the 8 low bits of the search address.*

Command Dec	Command HEX	Name	Comments
		SEARCHADDRL	
34	0x22	Extended Program short Address	The controller shall store the address received in <Data> as it's short address if selected. Selected means: • The controller's random Address shall be equal to the combined search address stored in SEARCHADDRH, SEARCHADDRM and SEARCHADDRL • Physical selection for individual addressing of the controller has been detected (e.g. pushing a button) and after reception of Command 37. The short address shall be deleted after receipt of command 34 with value 255 in <Data>
35	0x23	Extended Save short address	Memorize value in <Data> as short address
36	0x24	Extended Verify short address	The controller shall respond with a query "yes" (0000 0001) if value contained in <Data> is equal to own short address.
37	0x25	Extended Physical selection	If a controller receives this command it shall cancel its physical selection and shall set the controller to "Physical selection mode". In this mode the compare of Search and Random Addresses shall be disabled.
38	0x26	Extended Query Random Address (H)	The 8 high bits of the random address
39	0x27	Extended Query Random Address (M)	The 8 mid bits of the random address
40	0x28	Extended Query Random Address (L)	The 8 low bits of the random address
* The combination of this three address shall represent the 24-bit address HHHHHHHHMMMMMMMMLLLLLLLL.			

5.4.4 Examples of Automatic Short Address Assignment

5.4.4.1 Controllers Installed in a System Using Random Addressing

The following commands can be sent as Broadcast or for selected Controls Type units by selecting the appropriate Address Byte.

I. Start the algorithm with command 27 "Extended Initialize" which enables the next addressing command for 15 minutes.
II. Send command 28 "Extended Randomize". All controller that are specified in the Address Byte will create a binary random number (BRN) so that $0 <\_ BRN <\_ +2^{24}-1$.
III. The controller performing the addressing searches the controller with the lowest BRN by means of an algorithm which uses command 31 to 33 (Extended SEARCHADDRH, Extended SEARCHADDRM, Extended SEARCHADDRL) and command 29 "Extended Compare". The controller with the lowest BRN is found.
IV. The found controller will have assigned a unique short address with the command 34 "Extended Program short Address".
V. Verify the assigned short address with command 36 "Extended Verify short address"
VI. The found controller shall be retracted from the search process by means of command 30 "Extended Withdraw".
VII. If not all controller are found, repeat from step III on until no further unit can be found.
VIII. Stop the process by sending command 26 "Extended Terminate".

IX. In case of two controllers having the same short address, restart the addressing procedure only for the controllers with this specific address by sending the “Extended initialize” command to this short address.

5.4.4.2 Only One Controller Connected to the System

Use command 35 “Extended Save short address” sent as broadcast command with the required short address in <Data>

5.4.4.3 Assigning Addresses by Means of Physical Selection

I. The Control unit performing the addressing shall sent command 27 “Extended Initialize”
II. Sent the command 37 “Extended Physical selection”
III. The programming Control unit shall repeat command 0 “Query Data” with value 5 in <Data> periodically until a control replies. In order to reply, the Controller has to be physically selected by pressing a button, or any other means to activate the address assignment (this control unit is in physical selection mode)
IV. The programming controller shall send command 34 “Extended Program short Address” with the required short address in <Data>. If <Data> is 0000 0000 the actual address selected by the addressed control unit shall be memorized as short address.
V. Steps II to IV shall be repeated for all connected controllers.
VI. The programming controller shall end the procedure with the command 26 “Extended Terminate”.

5.5 COMMON CONTROL COMMANDS

Table 5.3 below lists the command value, name and gives some general comments for each of the Common Control Commands. More details are given for each command at the end of this document. All unused commands to 0x3f are reserved, and may not be used.

Table 5.3. Common Control Commands

Command Dec	Command HEX	Name	Comments
0	0x00	Query Data	Used to read data specified by the 3rd byte (See Table 5.1 a for details)
1	0x01	Query Feature Support	Used to determine if a feature is supported or not.
2	0x02	Set DTR-X	Used to set the DTR X register
3	0x03	Set DTR-Y	Used to set the DTR Y register
4	0x04	Save <data> at DTR X,Y location	Store <data> into memory location specified by DTR X/Y
5	0x05	Read value from location DTR X,<data>	Read memory location specified by DTR X. Use <data> as second pointer
6	0x06	AND <data> into memory location DTR X, DTR Y	<data> lists bits to clear in the memory location pointed to by DTR X/Y
7	0x07	OR <data> into memory location DTR X, DTR Y	<data> lists bits to set in the memory location pointed to by DTR X/Y
8	0x08	Set CG_0 Group Assign-ment for Groups 0-7	<data> bits set to '1' to join each desired group
9	0x09	Set CG_1 Group Assign-ment for Groups 8-15	<data> bits set to '1' to join each desired group
10	0x0a	Set CG_2 Group Assign-ment for Groups 16-23	<data> bits set to '1' to join each desired group
11	0x0b	Set CG_3 Group Assign-ment for Groups 24-31	<data> bits set to '1' to join each desired group
12	0x0c	Set PBO (Parameter Bank Operate)	Bank 0 is "normal operation", bank 1 is e.g. "after hours" operation if supported
13	0x0d	Set PBRW (Parameter Bank Read Write)	<data> specifies bank being written/read to/from
14	0x0e	Data-less command contained in <data>	See Common Control Data-less Commands listed below
15	0x0f	Restore Factory Default	<data> sets upper limit. All registers below or equal are reset to default values
		Beginning of Parameter Bank	
64	0x0f	Set OBA_0 2-Byte Control Output A Byte 1	<data> contains first byte of inactive to active output byte (ballast/actuator)
65	0x10	Set OBA_1 2-Byte Control Output A Byte 2	<data> contains second byte of inactive to active output byte (ballast/actuator)
66	0x11	Set OBB_0 2-Byte Control Output B Byte 1	<data> contains first byte of active to inactive output byte (ballast/actuator)
67	0x12	Set OBB_1 2-Byte Control Output B Byte 2	<data> contains second byte of active to inactive output byte (ballast/actuator)
68	0x13	Set TA Threshold value A	<data> contains desired A Threshold Value
69	0x14	Set TB Threshold value B	<data> contains desired B Threshold Value
70	0x15	Set DA Delay A (15 sec)	Sets Delay A 15 Sec. Value in <data>
71	0x16	Set DB Delay B (15 sec)	Sets Delay B 15 Sec. Value in <data>

Command Dec	Command HEX	Name	Comments
72	0x17	Set RT Repeat Interval (15 sec)	If non-zero repeat sensor output every <data> 15 sec
73	0x18	SV Sensor Value	Actual sensor value sent in <data> using Controller Originator Addressing
74	0x19	Set SEN Sensitivity	Setting of Controller sensitivity/range to the value defined in <DATA>

5.6 COMMON CONTROL DATA-LESS COMMANDS

Table 5.4 below gives data-less commands.

NOTE These are commands that do not require data values. Common Command 0x09 is the command that is used to start the process, and the data-less commands are found by examining the 3rd byte.

Table 5.4. Common Control Data-less Commands

Command DEC	Command HEX	Name	Comments
13-0	0x00	Identify Device	The addressed device is to identify itself by blinking a light, making a sound, for example. This command is used to assist in installation.
13-1	0x01	Enable 3-byte Data Output	Allows controller to send 3-byte commands to other control devices
13-2	0x02	Disable 3-byte Data Output	Stops controller from sending 3-byte commands to other control devices
13-3	0x03	Enable 2-byte Data Output	Allows controller to send 2-byte commands to ballasts/actuators
13-4	0x04	Disable 2-byte Data Output	Stops controller from sending 2-byte commands to ballasts/actuators
13-5	0x05	Enable Manufacturer Specific Commands	Allows Manufacturer Specific Commands to be processed
13-6	0x06	Disable Manufacturer Specific Commands	Disables the processing of Manufacturer Specific Commands
13-7	0x07	Enable Manufacturer Specific Commands for 60 Sec.	Allows Manufacturer Specific Commands to be processed within the next 60 seconds. The function shall be disabled automatically after this time.
13-8	0x08	Read Value From Memory Location Specified by DTR X/Y	Read Memory using DTR X/Y
13-9	0x09	Enable Upper Threshold Relative	Causes threshold to be processed as a relative change amount
13-10	0x0a	Disable Upper Threshold Relative	Causes threshold to be processed as an absolute change amount
13-11	0x0b	Enable Lower Threshold Relative	Causes threshold to be processed as a relative change amount
13-12	0x0c	Disable Lower Threshold Relative	Causes threshold to be processed as an absolute change amount

5.7 DEVICE TYPE COMMANDS

A set of commands must be specified for each defined device type. Commands can range in value from 0x80 to 0xbf.

These commands are specified in NEMA Standard 243, Part 2.

5.8 CUSTOM LIGHTING CONTROL COMMANDS (NON RESERVED)

By default all devices specifically ignore manufacturing specific messages. To use them, you must address a specific device and enable the manufacturing specific messages using a common control message defined for that purpose. Once enabled, the manufacturer may use any unspecified commands as desired. The ability to read the identifier codes is always enabled. This allows a user to determine what kind of device is attached to the bus before enabling Manufacturer Specific Commands (which could potentially cause conflict).

Command DEC	Command HEX	Name	Comments
41	0x29	Read Manufacturer Identifier Code	The <data> part of the message points to a code number. A minimum of 16 codes is to be provided in each device. All 256 codes can optionally be implemented.

5.9 DETAILED COMMAND DESCRIPTION

<The following commands are not updated; Bob Beatty/Guido Walther shall update them.>

<Add a binary equivalent for each one (after renumbering them to match earlier sections)>

5.9.1.1 Query Data

Command Value DEC	0
Command Value HEX	0x00
Command Name	Query Data
Optional/Mandatory	Mandatory
Addressing Modes	Individual only
Description	This message is sent to a DALI Control Device to query it for the desired data item. The desired data item is specified in the <data> portion of the message. This command can be used to solicit data for general devices (<data> part is from 0x00 to 0x3f), specific types (<data> part from 0x80 to 0xbf), or manufacturer specific devices (<data> part is from 0xc0 to 0xff). The addressed device will respond with a single byte corresponding to the item requested. See Table 5.1a for possible data. This command should not be sent using group, type, or broadcast messaging, since that could cause multiple responses, and it will not be possible to determine the source of the response.
Example	<address><command><data>=0x1e, 0x00, 0x01 This message is a request for the feature byte. The control device at address 30 will respond with its feature byte.

5.9.1.2 Query Feature Support

Command Value DEC 1

Command Value 0x01

Command Name Query Feature Support

Optional/Mandatory Mandatory

Addressing Modes Individual only

Description This message is sent to a DALI Control Device to determine if a desired feature is supported. The desired feature is specified in the <data> portion of the message. This command can be used to solicit data for general devices (<data> part is from 0x00 to 0x7f), specific types (<data> part from 0x80 to 0xbf), or manufacturer specific devices (<data> part is from 0xc0 to 0xff).

The addressed device will respond with a single byte equal to zero if the feature is not supported, or non-zero otherwise.

This command should not be sent using group, type, or broadcast messaging, since that could cause multiple responses, and it will not be possible to determine the source of the response.

Example <address><command><data>=0x07, 0x01, 0x15

This message is a request to see if feature 0x15 (21d) is supported (the repeat timer). If it is, the control device at address 7 will respond with a non-zero value, otherwise it will respond with a zero. If the feature is not supported, then attempts to utilize it will fail. Attempting to read a non-supported value would result in the unit not responding at all, for example.

5.9.1.3 Set DTR X

Command Value DEC 2

Command Value 0x02

Command Name Set DTR X

Optional/Mandatory Mandatory

Addressing Modes Any

Description This message is sent to a DALI Control Device to set the 'X' Data Transfer Register (DTR). The DTR X is used as an index for accessing large amounts of data. In combination with the DTR Y, up to 65,535 bytes of memory can be accessed.

While this command may be used with any addressing mode, care must be used to ensure that the group, type, or broadcast setting of DTR X is appropriate.

Example <address><command><data>=0x3f, 0x02, 0xfe

This message will set the DTR X register to 0xfe in the control device at address 63.

5.9.1.4 Set DTR Y

Command Value DEC 3

Command Value 0x03

Command Name Set DTR Y

Optional/Mandatory Optional

Addressing Modes Any

Description This message is sent to a DALI Control Device to set the 'Y' Data Transfer Register (DTR). The DTR Y is used as an index for accessing large amounts of data. In combination with the DTR X, up to 65,535 bytes of memory can be accessed. Used by itself, up to 256 bytes of memory can be accessed, or the DTR X can be used as a temporary holding register for multi-byte commands.

While this command may be used with any addressing mode, care must be used to ensure that the group, type, or broadcast setting of DTR Y is appropriate.

Example <address><command><data>=0x3e, 0x03, 0x55

This message will set the DTR X register to 0x55 in the control device at address 62.

5.9.1.5 Save <data> at DTR X, Y Location

Command Value DEC 4

Command Value 0x04

Command Name Save <data> at DTR X,Y location

Optional/Mandatory Optional

Addressing Modes Any

Description This message is sent to a DALI Control Device to set the memory location pointed to by the DTR X and DTR Y register to the value specified in the <data> part of the message.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Note that this command must be used with great care, as unpredictable results may occur if improper locations or values are used. This is mostly use for manufacturer specific transfers of information.

Example <address><command><data>=0x30, 0x04, 0xaa

This message will place the value 0xaa into the memory location specified by the current setting of the DTR X and DTR Y registers in control device 48.

5.9.1.6 Read Value from Location DTR X, <data>

Command Value DEC 5

Command Value 0x05

Command Name Read value from location DTR X,<data>

Optional/Mandatory Optional

Addressing Modes Individual only

Description This message is sent to a DALI Control Device to read the value contained in the memory location pointed to by the DTR X register. The second address pointer is supplied in the data part of the message. The second pointer could be thought of as the “Y” part of an X, Y matrix.

This command should be used with individual addressing only to avoid multiple responses.

Example <address><command><data>=0x10, 0x05, 0x11

This message will read the memory location specified by DTR X, and a second pointer with the value of 0x11.

5.9.1.7 AND <data> Into Memory Location DTR X, DTR Y

Command Value DEC 6

Command Value 0x06

Command Name AND <data> into memory location DTR X, DTR Y

Optional/Mandatory Optional

Addressing Modes Any

Description This message is sent to a DALI Control Device to logically AND the value contained in the data part of the message with the contents of the memory location in the addressed device that is pointed to by the DTR X and DTR Y registers. The result is stored in the device's memory location.

This command is useful for clearing one or more individual bits from a memory location, while leaving the remaining bits unchanged.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Note that this command must be used with great care, as unpredictable results may occur if improper locations or values are used. This is mostly use for manufacturer specific transfers of information.

Example <address><command><data>=0x15, 0x06, 0xfe

Assume that the device at address 31 currently has 0x37 stored in the location pointed to by the DTR X and DTR Y registers. When the above command is sent to device 31, 0xfe is logically ANDed with 0x37. The result, 0x36, is stored back in the same memory location.

5.9.1.8 OR <data> Into Memory Location DTR X, DTR Y

Command Value DEC 7

Command Value 0x07

Command Name OR <data> into memory location DTR X, DTR Y

Optional/Mandatory Optional

Addressing Modes Any

Description This message is sent to a DALI Control Device to logically OR the value contained in the data part of the message with the contents of the memory location in the addressed device that is pointed to by the DTR X and DTR Y registers. The result is stored in the device's memory location.

This command is useful for setting one or more individual bits from a memory location, while leaving the remaining bits unchanged.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Note that this command must be used with great care, as unpredictable results may occur if improper locations or values are used. This is mostly use for manufacturer specific transfers of information.

Example <address><command><data>=0x17, 0x07, 0x81

Assume that the device at address 33 currently has 0x7e stored in the location pointed to by the DTR X and DTR Y registers. When the above command is sent to device 33, 0x81 is logically ORed with 0x7e. The result, 0xff, is stored back in the same memory location.

5.9.1.9 Set CG_0 Group Assignment for Groups 0-7

Command Value DEC 8

Command Value 0x08

Command Name Set CG_0 Group Assignment for Groups 0-7

Optional/Mandatory Mandatory

Addressing Modes Any

Description This message is sent to a DALI Control Device and specifies which control groups it will respond. Any device can be programmed this way to belong to any group (including multiple groups). Starting with the least significant bit, which represents group 0, if the bit is set, the device is a member of that group.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x23, 0x08, 0x18

The control device at individual address 35 will be set to belong to groups 3 and 4 by this command.

5.9.1.10 Set GC_1 Group Assignment for Groups 8-15

Command Value DEC 9

Command Value 0x09

Command Name Set GC_1 Group Assignment for Groups 8-15

Optional/Mandatory Mandatory

Addressing Modes Any

Description This message is sent to a DALI Control Device and specifies which control groups it will respond. Any device can be programmed this way to belong to any group (including multiple groups). Starting with the least significant bit, which represents group 8, if the bit is set, the device is a member of that group.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x23, 0x09, 0x81

The control device at individual address 35 will be set to belong to groups 8 and 15 by this command.

5.9.1.11 Set GC_2 Group Assignment for Groups 16-23

Command Value DEC 10

Command Value 0x0a

Command Name Set GC_2 Group Assignment for Groups 16-23

Optional/Mandatory Mandatory

Addressing Modes Any

Description This message is sent to a DALI Control Device and specifies which control groups it will respond. Any device can be programmed this way to belong to any group (including multiple groups). Starting with the least significant bit, which represents group 16, if the bit is set, the device is a member of that group.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x23, 0x0a, 0x03

The control device at individual address 35 will be set to belong to groups 16 and 17 by this command.

5.9.1.12 Set GC_3 Group Assignment for Groups 24-31

Command Value DEC 11

Command Value 0x0b

Command Name Set GC_3 Group Assignment for Groups 24-31

Optional/Mandatory Mandatory

Addressing Modes Any

Description This message is sent to a DALI Control Device and specifies which control groups it will respond. Any device can be programmed this way to belong to any group (including multiple groups). Starting with the least significant bit, which represents group 24, if the bit is set, the device is a member of that group.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x23, 0x0b, 0x81

The control device at individual address 35 will be set to belong to groups 24 and 31 by this command.

5.9.1.13 Set PBS (Parameter Bank Select)

Command Value DEC 12

Command Value 0x0c

Command Name Set PBS (Parameter Bank Select)

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the current building mode into the addressed DALI Control Device. The building mode is specified as follows:

PBS = 0x00 means “After Hours”
PBS = 0x01 means “Normal Hours”

Normal Hours means that the building or area in question is expected to be open and lighted as normal. This might be the period of 7 AM to 6 PM, for example. After Hours means that the building is expected to be closed, from 6 PM to 7 AM, for example. The mode of the building is used to determine the operational characteristics of the addressed control device. For example, during Normal Hours, an occupancy sensor might be configured to avoid turning lights off.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x23, 0x0c, 0x01

The control device at individual address 35 will have its building mode set to Normal Hours.

5.9.1.14 Identify Device

Command Value DEC	13-0
Command Value	0x0d (See Note Below)
Sub-Command (in <data> field)	0x00
Command Name	Identify Device
Optional/Mandatory	Mandatory
Addressing Modes	Any
Description	The addressed device shall identify itself by some method (blinking a LED, sounding a chime, setting a light level). This is used to assist in the installation of Control Devices. While random addresses can be assigned to physical devices, there is no way to know which device is which, unless the device can identify itself some way. While this command can be sent using any addressing mode, if the point is to identify a specific device, it should be sent to an individual address.
Example	<address><command><data>=0x05, 0x0d, 0x00 The control device at individual address 5 will identify itself.
Note:	While many of the commands that are sent to a DALI Control Device require data to be sent with the command, some do not. While they could be assigned the next sequential command number, it would not be very efficient, as the message would include a data byte that was not required. Instead, a single command number can be assigned that represents up to 256 additional commands that don't require data, by specifying the sub-command in the data field (the third byte of the message).

5.9.1.15 Enable 3-byte Data Output

Command Value DEC	13-1
Command Value	0x0d (See Note Below)
Sub-Command (in <data> field)	0x01
Command Name	Enable 3-byte Data Output
Optional/Mandatory	Mandatory
Addressing Modes	Any
Description	The addressed device shall start providing 3-byte control output. For example, for an occupancy sensor, enabling 3-byte control will start sending occupancy information over the bus using the specified 3-byte message. These messages will use Controller Originator Addressing (to indicate the message is FROM a Controller). Other DALI Control Devices can receive that message (the address of the message identifies the individual address of the sensor) and act upon it accordingly. Note that 3-byte control output (if available) can be enabled at the same time that 2-byte control is enabled.
Example	<address><command><data>=0x06, 0x0d, 0x01 The control device at individual address 5 will enable 3-byte control output.

5.9.1.16 Disable 3-byte Data Output

Command Value DEC	13-2
Command Value	0x0d (See Note Below)
Sub-Command (in <data> field)	0x02
Command Name	Disable 3-byte Data Output
Optional/Mandatory	Mandatory
Addressing Modes	Any
Description	The addressed device shall stop providing 3-byte control output. Note that 3-byte control output (if available) can be disabled independently from 2-byte control output that is intended to control ballasts directly.
Example	<address><command><data>=0x03, 0x0d, 0x02 The control device at individual address 3 will disable 3-byte control output.

5.9.1.17 Enable 2-byte Data Output

Command Value DEC	13-3
Command Value	0x0d (See Note Below)
Sub-Command (in <data> field)	0x03
Command Name	Enable 2-byte Data Output
Optional/Mandatory	Optional
Addressing Modes	Any
Description	The addressed device shall start providing 2-byte control output. 2-byte control output is used to control ballasts directly. For example, a 2-byte command to turn a group of ballasts OFF can be sent by this technique. Note that 2-byte control output (if available) can be enabled independently from 3-byte control output.
Example	<address><command><data>=0x09, 0x0d, 0x03 The control device at individual address 9 will enable 2-byte control output.

5.9.1.18 Disable 2-byte Data Output

Command Value DEC	13-4
Command Value	0x0d (See Note Below)
Sub-Command (in <data> field)	0x04
Command Name	Disable 2-byte Data Output
Optional/Mandatory	Optional
Addressing Modes	Any
Description	The addressed device shall stop providing 2-byte control output. Note that 2-byte control output (if available) can be disabled independently from 3-byte control output.
Example	<address><command><data>=0x02, 0x0d, 0x04 The control device at individual address 2 will disable 2-byte control output.

5.9.1.19 Enable Manufacturer Specific Commands

Command Value DEC	13-5
Command Value	0x0d (See Note Below)
Sub-Command (in <data> field)	0x05
Command Name	Enable Manufacturer Specific Commands
Optional/Mandatory	Optional
Addressing Modes	Any
Description	The addressed device shall enable Manufacturer Specific Commands. Note that although any address mode may be used, be sure that the appropriate units are being enabled. Most likely this command will be sent using an individual address.
Example	<address><command><data>=0x11, 0x0d, 0x05 The control device at individual address 16 will enable Manufacturer Specific Commands.

5.9.1.20 Disable Manufacturer Specific Commands

Command Value DEC	13-6
Command Value	0x0d (See Note Below)
Sub-Command (in <data> field)	0x06
Command Name	Disable Manufacturer Specific Commands
Optional/Mandatory	Optional
Addressing Modes	Any
Description	The addressed device shall disable Manufacturer Specific Commands. Note that disabling Manufacturer Specific Commands shall not prevent the first 16 bytes (the identification bytes) from being read from the addressed DALI Control Device. Note that although any address mode may be used, be sure that the appropriate units are being enabled. Most likely this command will be sent using an individual address.
Example	<address><command><data>=0x11, 0x0d, 0x06 The control device at individual address 16 will disable Manufacturer Specific Commands.

5.9.1.21 Read Value from Memory Location Specified by DTR X/Y

Command Value DEC	13-7
Command Value	0x0d (See Note Below)
Sub-Command (in <data> field)	0x07
Command Name	Read Value From Memory Location Specified by DTR X/Y
Optional/Mandatory	Optional
Addressing Modes	Any
Description	The addressed device shall disable Manufacturer Specific Commands. Note that disabling Manufacturer Specific Commands shall not prevent the first 16 bytes (the identification bytes) from being read from the addressed DALI Control Device. Note that although any address mode may be used, be sure that the appropriate units are being enabled. Most likely this command will be sent using an individual address.
Example	<address><command><data>=0x11, 0x0d, 0x07 The control device at individual address 16 will return the value of the memory location specified by the DTR X and DTR Y value.

5.9.1.22 Enable Upper Threshold Relative

Command Value DEC 13-8

Command Value 0x0d (See Note Below)

Sub-Command (in <data> field) 0x08

Command Name Enable Upper Threshold Relative

Optional/Mandatory Optional

Addressing Modes Any

Description The addressed device shall use the threshold value as a send on change amount, rather than a send when the absolute value is exceeded. This enables a device, such as a light sensor, to provide a new output after a specified amount of light change, which is useful in providing closed loop control (the 2-byte output could be configured to send a step down command to a group of ballasts in this case).

Note that although any address mode may be used, be sure that the appropriate units are being enabled. Most likely this command will be sent using an individual address.

Example <address><command><data>=0x11, 0x0d, 0x08

The controller at address 17 will interpret the threshold as a change amount rather than an absolute value, and will cause a controller output every time the sensor value changes by at least this amount.

5.9.1.23 Disable Upper Threshold Relative

Command Value DEC 13-9

Command Value 0x0d (See Note Below)

Sub-Command (in <data> field) 0x09

Command Name Disable Upper Threshold Relative

Optional/Mandatory Optional

Addressing Modes Any

Description The addressed device shall use the threshold value as an absolute amount, and generate an output when the absolute value is exceeded. This is typically used for an open loop device, where passing the threshold causes a single output.

Note that although any address mode may be used, be sure that the appropriate units are being enabled. Most likely this command will be sent using an individual address.

Example <address><command><data>=0x11, 0x0d, 0x09

The controller at address 17 will interpret the threshold as an absolute value, and will cause a controller output once the sensor value exceeds the threshold.

5.9.1.24 Enable Lower Threshold Relative

Command Value DEC 13-10

Command Value 0x0d (See Note Below)

Sub-Command (in <data> field) 0x0a

Command Name Enable Lower Threshold Relative

Optional/Mandatory Optional

Addressing Modes Any

Description The addressed device shall use the threshold value as a send on change amount, rather than a send when the absolute value is exceeded. This enables a device, such as a light sensor, to provide a new output after a specified amount of light change, which is useful in providing closed loop control (the 2-byte output could be configured to send a step down command to a group of ballasts in this case).

Note that although any address mode may be used, be sure that the appropriate units are being enabled. Most likely this command will be sent using an individual address.

Example <address><command><data>=0x11, 0x0d, 0x0a

The controller at address 17 will interpret the threshold as a change amount rather than an absolute value, and will cause a controller output every time the sensor value changes by at least this amount.

5.9.1.25 Disable Lower Threshold Relative

Command Value DEC 13-11

Command Value 0x0d (See Note Below)

Sub-Command (in <data> field) 0x0b

Command Name Disable Lower Threshold Relative

Optional/Mandatory Optional

Addressing Modes Any

Description The addressed device shall use the threshold value as an absolute amount, and generate an output when the absolute value is exceeded. This is typically used for an open loop device, where passing the threshold causes a single output.

Note that although any address mode may be used, be sure that the appropriate units are being enabled. Most likely this command will be sent using an individual address.

Example <address><command><data>=0x11, 0x0d, 0x0b

The controller at address 17 will interpret the threshold as an absolute value, and will cause a controller output once the sensor value exceeds the threshold.

5.9.1.26 Restore Factory Defaults

Command Value DEC 13-12

Command Value 0x0e

Command Name Restore Factory Defaults

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to restore factory default values to the addressed DALI Control Device. Registers up to and including the one specified in the third byte of the message (the data byte) shall be restored. Registers above that value will remain untouched.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x23, 0x0e, 0x10

The control device at individual address 35 will have its data registers, up to, and including number 16, restored to factory default values.

5.9.1.27 Restore Factory Default

Command Value DEC 14

Command Value 0x0e

Command Name Restore Factory Default

Optional/Mandatory Mandatory

Addressing Modes Any

Description

Example <address><command><data>=

The control device at

5.9.1.28 Set OBA_0 2-byte Control Output A Byte 1

Command Value DEC 15

Command Value 0x0f

Command Name Set OBA_0 2-Byte Control Output A Byte 1

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the first byte of a 2-byte DALI command that will be sent when the control device is active. (See Command 0x11 for setting the second byte).

2-byte DALI commands are used to communicate with ballasts directly.

Note that a 2-byte Control Output must be enabled.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x17, 0x0f, 0xff

The control device at individual address 23 will have the first byte of the active 2-byte output control message set to 0xff.

5.9.1.29 Set OBA_1 2-byte Control Output A Byte 2

Command Value DEC 16

Command Value 0x10

Command Name Set OBA_1 2-Byte Control Output A Byte 2

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the second byte of a 2-byte DALI command that will be sent when the control device is active. (See Command 0x0f for setting the first byte).

2-byte DALI commands are used to communicate with ballasts directly.

Note that a 2-byte Control Output must be enabled.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x17, 0x10, 0x80

The control device at individual address 23 will have the second byte of the active 2-byte output control message set to 0x80. Assuming the first byte was set to 0xff, the two-byte command would be broadcast to all devices and would set the arc power level to 0x80.

5.9.1.30 Set OBB_0 2-byte Control Output B Byte 1

Command Value DEC 17

Command Value 0x11

Command Name Set OBB_0 2-Byte Control Output B Byte 1

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the first byte of a 2-byte DALI command that will be sent when the control device is inactive. (See Command 0x12 for setting the second byte).

2-byte DALI commands are used to communicate with ballasts directly.

Note that a 2-byte Control Output must be enabled.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x17, 0x11, 0xff

The control device at individual address 23 will have the first byte of the inactive 2-byte output control message set to 0xff.

5.9.1.31 Set OBB_1 2-byte Control Output B Byte 2

Command Value DEC 18

Command Value 0x12

Command Name Set OBB_1 2-Byte Control Output B Byte 2

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the second byte of a 2-byte DALI command that will be sent when the control device is inactive. (See Command 0x11 for setting the first byte).

2-byte DALI commands are used to communicate with ballasts directly.

Note that a 2-byte Control Output must be enabled.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x17, 0x12, 0x01

The control device at individual address 23 will have the second byte of the inactive 2-byte output control message set to 0x01. Assuming the first byte was set to 0xff, the two-byte command would be broadcast to all devices and would set the arc power level to 0x01.

5.9.1.32 Set TA Threshold Value A

Command Value DEC 19

Command Value 0x13

Command Name Set TA Threshold value A

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the threshold of the generic control device. When this threshold is passed the device will switch from passive to active.

If the device was a light sensor, for example, and the light level was rising from 0x01 and passed this threshold, the control device would output an active state.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x17, 0x13, 0x40

The control device at individual address 23 will set the active threshold to 0x40.

5.9.1.33 Set TB Threshold Value B

Command Value DEC 20

Command Value 0x14

Command Name Set TB Threshold value B

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the threshold of the generic control device. When this threshold is passed the device will switch from active to passive state.

If the device was a light sensor, for example, and the light level was falling and passed this threshold, the control device would output an inactive state.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x17, 0x14, 0x40

The control device at individual address 23 will set the inactive threshold to 0x40.

5.9.1.34 Set DA Delay Value A (15 seconds)

Command Value DEC **21**

Command Value 0x15

Command Name Set DA Delay Value A (15 seconds)

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the generic delay timer when the device is active. Each count represents 15 seconds. So a maximum of 3825 seconds (63h 45s) can be specified.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x17, 0x15, 0x40

The control device at individual address 23 will set the active timer to 960 seconds.

5.9.1.35 Set Delay Value B (15 Seconds)

Command Value DEC 22

Command Value 0x16

Command Name Set Delay Value B (15 seconds)

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the generic delay timer when the device is inactive. Each count represents 15 seconds. So a maximum 3825 seconds (63h 45s) can be specified.

While this command may be used with any addressing mode, care must be used to ensure that the use of group, type, or broadcast addressing is appropriate.

Example <address><command><data>=0x16, 0x17, 0x40

The control device at individual address 22 will set the inactive timer to 960 seconds.

5.9.1.36 Set RT Repeat Interval (15 Seconds)

Command Value DEC 23

Command Value 0x19

Command Name Set RT Repeat Interval (15 Seconds)

Optional/Mandatory Optional

Addressing Modes Any

Description This message is used to set the repeat interval. This specifies the frequency that control outputs should be repeated. If set to zero, the control output will not be repeated (it will be sent once on change of state only).

Example <address><command><data>=0x17, 0x19, 0x00

The control device at individual address 23 will turn off the repeating of control output.

5.9.1.37 SV Sensor Value

Command Value DEC 24

Command Value 0x18

Command Name SV Sensor Value

Optional/Mandatory Optional

Addressing Modes Any

Description This message is SENT BY THE CONTROL DEVICE automatically. This is the 3-byte control output. It must be specifically enabled. Also, it may be repeated by adjusting the repeat timer.

Controller Originator Addressing is used for this message, which means that the data is FROM a controller. Address range in value from 0x40 to 0x7f.

Example <address><command><data>=0x57, 0x1a, 0xff

The control device at individual address 23 is indicating that its sensor value is 0xff. Note that Controller Originator Addressing is used, indicating that the message is FROM a controller.

5.9.1.38 Set SEN Sensitivity

Command Value DEC	25
Command Value	0x19
Command Name	Set SEN Sensitivity
Optional/Mandatory	Optional
Addressing Modes	Any
Description	This message is. .
Example	<address><command><data>=0x57, 0x1a, ???? The control device at individual address 23 is.

5.9.1.39 Extended Terminate

Command Value DEC 26

Command Value 0x1a

Command Name Extended Terminate

Optional/Mandatory Optional

Addressing Modes Any

Description This message is.

.

Example <address><command><data>=0x57, 0x1a, ????

The control device at individual address 23 is.

5.9.1.40 Extended Initialize

Command Value DEC	27
Command Value	0x1b
Command Name	Extended Initialize
Optional/Mandatory	Optional
Addressing Modes	Any
Description	This message is. .
Example	<address><command><data>=0x57, 0x1a, ???? The control device at individual address 23 is.

5.9.1.41 Extended Randomize

Command Value DEC	28
Command Value	0x1c
Command Name	Extended Randomize
Optional/Mandatory	Optional
Addressing Modes	Any
Description	This message is. .
Example	<address><command><data>=0x57, 0x1a, ???? The control device at individual address 23 is.

5.9.1.42 Extended Compare

Command Value DEC	29
Command Value	0x1d
Command Name	Extended Compare
Optional/Mandatory	Optional
Addressing Modes	Any
Description	This message is. .
Example	<address><command><data>=0x57, 0x1a, ???? The control device at individual address 23 is.

5.9.1.43 Extended Withdraw

Command Value DEC 30

Command Value 0x1e

Command Name Extended Withdraw

Optional/Mandatory Optional

Addressing Modes Any

Description This message is.

.

Example <address><command><data>=0x57, 0x1a, ????

The control device at individual address 23 is.

5.9.1.44 Extended SEARCHADDRH

Command Value DEC 31

Command Value 0x1f

Command Name Extended SEARCHADDRH

Optional/Mandatory Optional

Addressing Modes Any

Description This message is.

.

Example <address><command><data>=0x57, 0x1a, ????

The control device at individual address 23 is.

5.9.1.45 Extended SEARCHADDRM

Command Value DEC	32
Command Value	0x20
Command Name	Extended SEARCHADDRM
Optional/Mandatory	Optional
Addressing Modes	Any
Description	This message is. .
Example	<address><command><data>=0x57, 0x1a, ???? The control device at individual address 23 is.

5.9.1.46 Extended SEARCHADDRL

Command Value DEC 33

Command Value 0x21

Command Name Extended SEARCHADDRL

Optional/Mandatory Optional

Addressing Modes Any

Description This message is.

.

Example <address><command><data>=0x57, 0x1a, ????

The control device at individual address 23 is.

5.9.1.47 Extended Program Short Address

Command Value DEC	34
Command Value	0x22
Command Name	Extended Program short Address
Optional/Mandatory	Optional
Addressing Modes	Any
Description	This message is. .
Example	<address><command><data>=0x57, 0x1a, ???? The control device at individual address 23 is.

5.9.1.48 Extended Save Short Address

Command Value DEC 35

Command Value 0x23

Command Name Extended Save short Address

Optional/Mandatory Optional

Addressing Modes Any

Description This message is.

.

Example <address><command><data>=0x57, 0x1a, ????

The control device at individual address 23 is.

5.9.1.49 Extended Verify Short Address

Command Value DEC	36
Command Value	0x24
Command Name	Extended Verify short Address
Optional/Mandatory	Optional
Addressing Modes	Any
Description	This message is. .
Example	<address><command><data>=0x57, 0x1a, ???? The control device at individual address 23 is.

5.9.1.50 Extended Physical Selection

Command Value DEC 37

Command Value 0x25

Command Name Extended Physical Selection

Optional/Mandatory Optional

Addressing Modes Any

Description This message is.

.

Example <address><command><data>=0x57, 0x1a, ????

The control device at individual address 23 is.

5.9.1.51 Extended Query Random Address (H)

Command Value DEC	38
Command Value	0x26
Command Name	Extended Query Random Address (H)
Optional/Mandatory	Optional
Addressing Modes	Any
Description	This message is. .
Example	<address><command><data>=0x57, 0x1a, ???? The control device at individual address 23 is.

5.9.1.52 Extended Query Random Address (M)

Command Value DEC 39

Command Value 0x27

Command Name Extended Query Random Address (M)

Optional/Mandatory Optional

Addressing Modes Any

Description This message is.

.

Example <address><command><data>=0x57, 0x1a, ????

The control device at individual address 23 is.

5.9.1.53 Extended Query Random Address (L)

Command Value DEC 40

Command Value 0x28

Command Name Extended Query Random Address (L)

Optional/Mandatory Optional

Addressing Modes Any

Description This message is.

.

Example <address><command><data>=0x57, 0x1a, ????

The control device at individual address 23 is.

5.9.1.54 Read Manufacturer Identification Code

Command Value DEC 41

Command Value 0x29

Command Name Read Manufacturer Identification Code

Optional/Mandatory Mandatory

Addressing Modes Any

Description This message is sent to the control device to read identification information from the device (such as the make, model, version, serial number, etc.). The <data> part of the message specifies which identifier byte is being requested.

Note: A minimum of 16 identification bytes must be supported by every device (not all of them have to be used, but a minimum of 16 must be capable of being read.) Optionally, up to 256 identification bytes can be supported, if desired.

Requests to groups or multiple devices should be avoided, as it will not be possible to determine the origin of multiple responses.

Example <address><command><data>=0x13, 0xc0, 0x0f

The control device at individual address 19 will return the 15th identification byte upon receipt of this message

Section 6
DALI DEVICE POWER SUPPLY REQUIREMENTS

A DALI lighting system requires a power supply with a current sourcing characteristic. The supply may be "stand alone" or be implemented as part of another DALI device. Multiple power supplies may be combined as long as the total power supplied to the DALI bus meets the requirements outlined in the following. A DALI power supply need not be addressable by the DALI bus. If the power supply is addressable, it should meet the requirements of Part II of this standard.

6.1 DEFINITIONS

DALI bus: The wiring connecting DALI devices for the purposes of communication and supplying power via the DALI protocol.

device: Any device connected to and drawing current from or supplying current to the DALI bus.

Idevice: The maximum Iin a device draws from the DALI bus over a DALI bus voltage range between 9.5 and 22.5 V.

Idevice total: The sum of the Idevice ratings for all devices connected to the DALI bus.

Iin: The current drawn by a device.

Iout: The output current of the supply.

Isupply: The maximum Iout at any voltage over the full output voltage range 0 – Vsupply.

Isupply min: The minimum current sourced by a power supply at any voltage over the full output voltage range 0 – Vsupply min specified for the supply.

Isupply total: The sum of the Isupply ratings of all supplies connected to the DALI bus.

maximum run length: The longest distance between any device and any power supply on the DALI bus.

maximum aggregated run length: The longest total length of all total wiring connecting the DALI bus.

maximum device capacitance: The maximum capacitance applied to the DALI bus over the voltage range of 0 – 9.5 V by a given device.

supply: A device supplying current to the DALI bus.

Vsupply: The maximum voltage a supply produces with 0 A loading.

Vsupply min: The minimum voltage a supply produces at Iout = Isupply.

6.2 POWER SUPPLY SPECIFICATIONS

6.2.1 Voltage Rating

Any device supplying power to the DALI bus shall be specified with a voltage rating equal to Vsupply.

6.2.2 Current Rating

Any device supplying current to the DALI bus shall be specified with a current rating equal to Isupply.

6.2.3 Vsupply min

Vsupply min shall be greater than or equal to 11.5 V.

6.2.4 Vsupply

Vsupply shall be within the range of 11.5 – 22.5 V.

6.2.5 Isupply

Isupply shall be less than or equal to 250 mA.

6.2.6 Isupply min

Isupply min shall be greater than or equal to 0.9 x Isupply.

6.2.7 Output Protection Against Over current

The output should be protected against over current in accordance with the *National Electrical Code*. Over current protection should not exceed 7 A.

6.3 DEVICE SPECIFICATIONS

6.3.1 Current Rating

Any device drawing current from the DALI bus shall be specified with a current rating equal to Idevice.

6.3.2 Voltage Rating

Any device drawing current from the DALI bus shall be operable over a supply voltage range of 9.5 V – 22.5 V.

6.3.3 Idevice

Idevice shall equal the peak current draw of the device over the voltage range of 0 – 22.5 V.

6.3.4 Idevice low

Idevice low shall be greater than or equal to 250 mA.

6.3.5 Maximum Device Capacitance

Maximum device capacitance shall be 1 nF.

6.3.6 DALI Device Ratings

All DALI devices shall be rated as Class 1 and/or Class 2 compatible, in accordance with the *National Electrical Code* and so marked.

6.4 DALI BUS SUPPLY/LOADING REQUIREMENTS

6.4.1 Isupply total

Isupply total shall be less than or equal to 250 mA.

6.4.2 Idevice total

Idevice total shall be less than or equal to 0.8 x Isupply total.

Section 7
CONTROL DEVICE MINIMUM FUNCTIONALITY

7.1 GENERAL

DALI control devices are used to send DALI commands to ballasts and other DALI devices. These devices can send commands that have a resolution of a complete loop (broadcast commands, send commands that have a resolution of a group (group commands), or have resolution of an individual ballast (individual address commands). There are seven main classifications of these devices. In addition, controls can be combinations of these devices (e.g., combined occupancy sensor and switch).

For each of the listed units an example will be listed on how a controller can be programmed/built by using only the “generic controls”. The functionality will be restricted do to the usage of this command. In order to develop more complex units refer to part 2 where a specific section has several specific commands. The addressing data part will not be included in the examples. The example will show one possible parameter bank setting.

The examples shall only represent one possibility on how the issue can be solved, other way can lead to the same functionality.

7.2 DALI SWITCH DEVICE

Dali Switch Devices can, depending on the setting be configured as different functional unit. The most common are listed below.

7.2.1 DALI Switch device

7.2.1.1 Ability

The DALI switch device shall be capable of switching the controlled lighting load high/low.

7.2.1.2 Possible Controlled Lighting Load

The possible controlled lighting load may include:
a) Broadcast
b) Selected group (0 – 15)

7.2.1.3 Recommended Factory Default Setting

The recommended factory default setting shall be Broadcast ON/OFF.

7.2.1.4 Possible Commands

Possible commands may include:
a) Direct arc power commands (commands that send a digital light level message to a ballast from 0 – 255)
b) Recall MIN/MAX level
c) Any other command that sets the requested load to a certain light level

7.2.1.5 Recommended Operation

Recommended operation should include group ON/OFF command that is group selectable. Commissioning of the ballast to store group assignments in ballast memory is required for group messages.

7.2.1.6 Optional

The following features are optional:
a) LED showing controlled group
b) Controlled load on address base (0-63)
c) Multiple groups controlled with the same switch
d) Groups freely assignable to switches in multiple switches
e) Device can assign ballast to different groups

7.2.1.7 Example

The unit shall switch ON/OFF in broadcast mode (all connected ballast shall react). No 3 byte protocol commands are sent. Example is solved with a closing/opening type switch.

Settings for SWITCH DEVICE

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands	Only 2 byte enabled 0000 0001

Read Data #	Byte #	Description	Setting
		Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	Broadcast (no direct arc) 1111 1111
66	2	OBA_2– second byte output pattern A	RECALL MAX LEVEL (5) 0000 0101
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	Broadcast (no direct arc) 1111 1111
68	4	OBB_2– second byte output pattern B	OFF (0) 0000 0000
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	1
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	1
71	7	DA Delay value A 15 sec (1 byte timer)	0
72	8	DB Delay value B 1 min (1 byte timer)	0
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	0
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	0
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

7.2.2 DALI Raise-lower dimmer device

7.2.2.1 Ability

The DALI raise-lower dimmer device shall be capable or raising or lowering the intensity of the controlled lighting load levels at a preset fade rate by pressing and holding a button.

7.2.2.2 Possible Controlled Lighting Load

The possible controlled lighting load may include:
a) Broadcast
b) Selected group (0 – 15)

7.2.2.3 Recommended Factory Default Setting

The recommended factory default setting shall be broadcast commands DIM UP/DIM DOWN.

7.2.2.4 Possible Commands

Possible commands may include DIM UP/DIM DOWN.

7.2.2.5 Recommended Operation

The recommended operation should include group DIM UP/DIM DOWN from a device that is group selectable. Commissioning of the ballast to store group assignments in ballast memory is required for group messages.

7.2.2.6 Optional

The following features are optional:
a) LED showing controlled group
b) Multiple groups controlled from the same unit
c) Controlled load on address base (0 – 63)
d) Device can assign ballast to different groups

7.2.2.7 Example

The unit shall dim the lights up, down at all fixtures that belong to group 6. No 3 byte protocol commands are sent. Unit is solved with two momentary switches, reacting at contact closure only.

Settings for Dimming unit, button UP

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	Only 2 byte enabled 0000 0001
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	Group 6 (no direct arc) 1100 1101
66	2	OBA_2– second byte output pattern A	UP (1) 0000 0001
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	N/A
68	4	OBB_2– second byte output pattern B	N/A
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	1
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	0
71	7	DA Delay value A 15 sec (1 byte timer)	0
72	8	DB Delay value B 1 min (1 byte timer)	0
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	0
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	0
75	11	ICA Interlocking Controller Address (address of	255

Read Data #	Byte #	Description	Setting
		controlling device that modifies behavior of current controller) (255=no ICA)	

Settings for Dimming unit, button DOWN

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	Only 2 byte enabled 0000 0001
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	Group 6 (no direct arc) 1100 1101
66	2	OBA_2– second byte output pattern A	DOWN (2) 0000 0010
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	N/A
68	4	OBB_2– second byte output pattern B	N/A
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	1
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	0
71	7	DA Delay value A 15 sec (1 byte timer)	0
72	8	DB Delay value B 1 min (1 byte timer)	0
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	0
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	0
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

It is suggested to use the specific command to create a device with additional functionality.

7.2.3 Scene controller

7.2.3.1 Ability

The scene controller shall be capable of issuing a DALI command for lighting loads to GO TO a specific stored scene (digital light level from 0 – 255) in ballasts. Commissioning is required to store the light level scenes in a ballast.

7.2.3.2 Possible Controlled Lighting Load

The possible controlled lighting load may include:
a) Selectable group (0 – 15)
b) Broadcast

7.2.3.3 Recommended Factory Default Setting

The recommended factory default should be that the scene buttons start with Scene 0 and increment by 1 for each scene button on the device.

7.2.3.4 Possible Commands

Possible commands may include GO TO SCENE.

7.2.3.5 Recommended Operation

Recommended operation should include the group GO TO SCENE command from a device that is group selectable. Commissioning of the ballast to store group assignments in ballast memory is required for group messages.

7.2.3.6 Optional

The following features are optional:
a) Add visual response with an LED being lit based on last command being the last recalled scene on that loop (monitoring of the loop is required to allow proper scene control in multiple room locations)
b) Dimming the actual levels of all relevant ballasts UP/DOWN
c) Possibility to broadcast ON/OFF all lighting loads
d) Unit is able to program the scenes
e) Controlled load on individual address basis (0 – 63)

7.2.3.7 Example

The unit shall recall Scene 1 in all fixtures that belong to address 20. No 3 byte protocol commands are sent. Unit is solved with one momentary switch, reacting at contact closure only.

Settings for unit to RECALL SCENE

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	Only 2 byte enabled 0000 0001
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	Address 20 (no direct arc) 0010 1001
66	2	OBA_2– second byte output pattern A	GO TO SCENE 1 (17) 0001 0001
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	N/A
68	4	OBB_2– second byte output pattern B	N/A
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When	1

Read Data #	Byte #	Description	Setting
		relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	0
71	7	DA Delay value A 15 sec (1 byte timer)	0
72	8	DB Delay value B 1 min (1 byte timer)	0
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	0
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	0
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

If the unit is used to recall more then one scene (multiple buttons), it is suggested to use the specific command to create such a device.

7.3 DALI DIMMING SLIDE DEVICE

7.3.1 Ability

The DALI dimming slide device shall be capable of varying the intensity of the controlled lighting load levels by the displacement of the control actuator.

7.3.2 Possible Controlled Lighting Load

The possible controlled lighting load may include:
a) Selectable group (0 – 15)
b) Broadcast

7.3.3 Recommended Factory Default Setting

The recommended factory default setting should be the capability of sending broadcast DIRECT ARC POWER commands (commands that send a digital light level message to a ballast from (0 – 255) related to the mechanical position of the controller.

7.3.4 Possible Commands

Possible commands may include the DIRECT ARC POWER command (commands that send a digital light level message to a ballast from 0 – 255).

7.3.5 Recommended Operation

Recommended operation should include group DIRECT ARC POWER commands (commands which send a digital light level message to a ballast from 0 – 255) from a device that is group selectable. Commissioning of the ballast to store group assignments in ballast memory is required for group messages.

7.3.6 Optional

The following features are optional:
a) LED showing controlled group
b) Multiple groups controlled individually through separate sliders
c) Controlled load on individual address basis (0 – 63)
d) Device capable of commission ballast to different groups

7.3.7 Example

The unit shall be able to set the light to a certain level and combine the ON/OFF functionality as explained in the section SWITCH DEVICE above. In the following table the dimming part only will be explained. We assume that the input would be a slide dimmer with the possibility to be set from a-b this difference is equal c. The range c is divided in 255 parts each of with are = x. All commands shall be sent in broadcast mode. No 3 byte protocol commands are sent.

Settings for Slide Device

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	2 byte enabled, interpretation relative 0000 1001

Read Data #	Byte #	Description	Setting
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	Broadcast (direct arc) 1111 1110
66	2	OBA_2– second byte output pattern A	STEP UP (3) 0000 0011
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	Broadcast (direct arc) 1111 1110
68	4	OBB_2– second byte output pattern B	STEP DOWN (4) 0000 0100
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	1
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	1
71	7	DA Delay value A 15 sec (1 byte timer)	0
72	8	DB Delay value B 1 min (1 byte timer)	0
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	0
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	0
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

Instead of sending STEP UP and STEP DOWN a direct arc power directly related to the measured value command can be sent. Bit 3 of the control byte would have to be set to 0 if this system would be used.

This is only an example and the requested feature could also be solved in a different way.

It is suggested to use the specific command to create a device with additional features.

7.4 MOTION SENSOR/PRESENCE DETECTOR

7.4.1 Ability

The motion sensor/presence detector shall be capable of recalling level high/low depending on motion/occupancy detection.

7.4.2 Recommended Factory Default Setting

The recommended factory default setting should include:
a) Send broadcast RECALL MAX LEVEL command upon occupancy
b) Send broadcast OFF command when unoccupied

Alternate factory default setting for restoring last level:
a) Send broadcast RECALL MAX LEVEL followed by broadcast GO TO SCENE 15 upon occupancy
b) Send the following broadcast commands when unoccupied, STORE ACTUAL LEVEL IN THE DTR ➔ STORE THE DTR AS SCENE 15 ➔ STORE THE DTR AS SCENE 15 [command has to be repeated within 50 ms as per DALI specification] ➔ OFF

7.4.3 Possible Controlled Lighting Load

The possible controlled lighting loads should include:
a) Address (0 – 63)
b) Group (0 – 15)
c) Broadcast

7.4.4 Possible Commands

Possible commands may include:
a) Direct arc power commands (commands that send a digital light level message to a ballast from 0 – 255)
b) Recall scenes
c) Recall MIN/MAX level
d) Any other command that sets the requested ballast to a certain light level

7.4.5 Recommended Operation

Recommended operation includes recall scenes, respectively, using the OFF command on the group lighting load level.

7.4.6 Optional

The following features are optional:
a) Recalling last light level by monitoring the relevant ballast
b) Recalling low level before switching the lights off

7.4.7 Example

The unit shall switch the lights on by recalling the MAX LEVEL and switching off by recalling an OFF command on broadcast mode (all connected ballast shall react). The OFF command shall be sent with a delay of 20 minutes. No 3 byte protocol commands are sent.

Settings for Motion Sensor Controller

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved	Only 2 byte enabled 0000 0001

Read Data #	Byte #	Description	Setting
		Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	Broadcast (no direct arc) 1111 1111
66	2	OBA_2– second byte output pattern A	RECALL MAX LEVEL (5) 0000 0101
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	Broadcast (no direct arc) 1111 1111
68	4	OBB_2– second byte output pattern B	OFF (0) 0000 0000
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	1
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	1
71	7	DA Delay value A 15 sec (1 byte timer)	0
72	8	DB Delay value B 1 min (1 byte timer)	Timer set to 20 minutes 000 1010
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	0
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	0
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

It is suggested to use the specific command to create a device with additional features.

7.5 OPEN LOOP DAYLIGHT CONTROLLER

7.5.1 Ability

The open loop daylight controller shall be capable of dimming the lights related to the actual available amount of daylight.

7.5.2 Recommended Factory Default Setting

The recommended factory default setting should include:
a) Send broadcast STEP DOWN when measured daylight is increasing
b) Send broadcast STEP UP when measured daylight is decreasing

7.5.3 Possible Controlled Lighting Load

The possible controlled lighting loads should include:
a) Address (0 – 63)
b) Group (0 – 15)
c) Broadcast

7.5.4 Possible Commands

Possible commands may include:
a) Direct arc power commands (commands that send a digital light level message to a ballast from 0 – 255)
b) Recall scenes
c) Recall MIN/MAX level
d) UP DOWN
e) STEP DOWN AND OFF / ON AND STEP UP
f) Any other command that sets the requested ballast to a certain light level

7.5.5 Recommended Operation

Recommended operation is STEP UP and STEP DOWN at the group lighting load level.

7.5.6 Optional

The following features are optional:
a) Switch the Lights OFF when a high daylight level is available
b) Sending light level information to other controllers only

7.5.7 Example

The unit shall dim the lights in accordance with the available daylight level. The daylight correction shall be delayed by 1 minute in order not to react on wrong measured temporary light changes (e.g. a person walking in the measurement field). We assume that the input would be a measuring device with a measuring field ranging from a-b this difference is equal c. The range c is divided in 255 parts each of with are = x. All commands shall be sent in broadcast mode. No 3 byte protocol commands are sent.

Settings for Open Loop Daylight Controller

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands	Only 2 byte enabled 0000 1001

Read Data #	Byte #	Description	Setting
		Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	Broadcast (no direct arc) 1111 1111
66	2	OBA_2– second byte output pattern A	STEP UP (3) 0000 0011
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	Broadcast (no direct arc) 1111 1111
68	4	OBB_2– second byte output pattern B	STEP DOWN (4) 0000 0000
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	Deviation from x 5 0000 0101
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	Deviation from x 5 0000 0101
71	7	DA Delay value A 15 sec (1 byte timer)	Timer set to 1 minute 000 0100
72	8	DB Delay value B 1 min (1 byte timer)	Timer set to 1 minute 000 0001
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	0
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	0
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

The SEN byte could be used to switch the sensor between different measuring ranges, depending on the amount of light the sensor is exposed.

It is suggested to use the specific command to create a device with additional features.

7.6 CLOSED LOOP DAYLIGHT CONTROLLER

7.6.1 Ability

The closed loop daylight controller shall be capable of dimming the lights related to the actual available amount of total light (artificial + daylight).

7.6.2 Recommended Factory Default Setting

The recommended factory default setting should include:
c) Send broadcast STEP DOWN when measured total light is increasing
d) Send broadcast STEP UP when measured total light is decreasing

7.6.3 Possible Controlled Lighting Load

The possible controlled lighting loads should include:
d) Address (0 – 63)
e) Group (0 – 15)
f) Broadcast

7.6.4 Possible Commands

Possible commands may include:
g) Direct arc power commands
h) Recall scenes
i) Recall MIN/MAX level
j) UP DOWN
k) STEP DOWN AND OFF / ON AND STEP UP
l) Any other command that sets the requested ballast to a certain light level

7.6.5 Recommended Operation

Recommended operation is STEP UP and STEP DOWN at the group lighting load level.

7.6.6 Optional

The following features are optional:
c) Switch the Lights OFF when a high total light level is available
d) Sending light level information to other controllers only

7.6.7 Example

The unit shall dim the lights in accordance with the available total light measured. The correction shall be delayed by 1 minute in order not to react on wrong measured temporary light changes (e.g. a person walking in the measurement field). We assume that the input would be a measuring device with a measuring field ranging from a-b this difference is equal c. The range c is divided in 255 parts each of with are = x. All commands shall be sent in broadcast mode. No 3 byte protocol commands are sent.

Settings for Open Loop Daylight Controller

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers	Only 2 byte enabled 0000 1001

Read Data #	Byte #	Description	Setting
		Bit 0 Set to 1 to enable 2 byte output to ballasts	
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	Broadcast (no direct arc) 1111 1111
66	2	OBA_2– second byte output pattern A	STEP UP (3) 0000 0011
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	Broadcast (no direct arc) 1111 1111
68	4	OBB_2– second byte output pattern B	STEP DOWN (4) 0000 0000
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	Deviation from x 1 0000 0001
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	Deviation from x 1 0000 0001
71	7	DA Delay value A 15 sec (1 byte timer)	Timer set to 1 minute 000 0100
72	8	DB Delay value B 1 min (1 byte timer)	Timer set to 1 minute 000 0001
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	0
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	x
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

The SEN byte could be used to set the value x where the sensor is supposed to regulate the light to.

It is suggested to use the specific command to create a device with additional features.

7.7 SCHEDULER

7.7.1 Ability

The scheduler shall be capable of recalling 2 and or 3 byte commands at a certain defined time.

7.7.2 Recommended Factory Default Setting

Do to the several functions that a scheduler can perform and do to that a scheduler will always need commissioning no default settings are specified.

7.7.3 Possible Controlled Lighting Load

The possible controlled lighting loads should include:
a) Address (0 – 63)
b) Group (0 – 15)
c) Broadcast

7.7.4 Possible Commands

All commands shall be possible.

7.7.5 Recommended Operation

Recommended operation is to be able to send 2 byte commands to output units as e.g. ballast.

7.7.6 Optional

The capability to send 3 byte commands to other controllers.

7.7.7 Example

Do to the possible complexity, no examples are described in this section. So possible features are been shown. Refer to Part II for detailed specified commands.

Settings for Scheduler

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	With Bit 0 and 1 the ability to send commands can be activated or deactivated.
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	N/A
66	2	OBA_2– second byte output pattern A	N/A
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	N/A
68	4	OBB_2– second byte output pattern B	N/A
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will	N/A

Read Data #	Byte #	Description	Setting
		trigger output A) (When binary, this enables output 0➔1)	
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	N/A
71	7	DA Delay value A 15 sec (1 byte timer)	N/A
72	8	DB Delay value B 1 min (1 byte timer)	N/A
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	N/A
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	N/A
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

7.8 GATEWAY

7.8.1 Ability

The gateway shall be capable of connecting the controlled DALI loop to other systems. Other systems could be e.g. TCP/IP, LONWorks or other Building Management systems.

7.8.2 Recommended Factory Default Setting

Do to the several functions that a gateway can perform and do to that a gateway will most likely need commissioning no default settings are specified.

7.8.3 Possible Controlled Lighting Load

The possible controlled lighting loads should include:
d) Address (0 – 63)
e) Group (0 – 15)
f) Broadcast

7.8.4 Possible Commands

All commands shall be possible.

7.8.5 Recommended Operation

Recommended operation is to be able to communicate to a specified other system.

7.8.6 Optional

N/A

7.8.7 Example

Do to the possible complexity, no examples are described in this section. So possible features are been shown. Refer to Part II for detailed specified commands.

Settings for Scheduler

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	With Bit 0 and 1 the ability to send commands can be activated or deactivated.
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	N/A
66	2	OBA_2– second byte output pattern A	N/A
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	N/A
68	4	OBB_2– second byte output pattern B	N/A
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When	N/A

Read Data #	Byte #	Description	Setting
		relative, and increasing by this relative amount, will trigger output A) (When binary, this enables output 0➔1)	
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	N/A
71	7	DA Delay value A 15 sec (1 byte timer)	N/A
72	8	DB Delay value B 1 min (1 byte timer)	N/A
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	N/A
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	N/A
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

7.9 SEQUENCER

7.9.1 Ability

The sequencer shall be capable of recalling a sequence of preprogrammed commands.

7.9.2 Recommended Factory Default Setting

Do to the several functions that a sequencer can perform and do to that a sequencer will always need commissioning no default settings are specified.

7.9.3 Possible Controlled Lighting Load

The possible controlled lighting loads should include:
g) Address (0 – 63)
h) Group (0 – 15)
i) Broadcast

7.9.4 Possible Commands

All commands shall be possible.

7.9.5 Recommended Operation

Recommended operation is to be able to send 2 byte commands to output units as e.g. ballast.

7.9.6 Optional

The capability to send 3 byte commands to other controllers.

7.9.7 Example

Do to the possible complexity, no examples are described in this section. So possible features are been shown. Refer to Part II for detailed specified commands.

Settings for Scheduler

Read Data #	Byte #	Description	Setting
64	0	CB (Control Byte, Flag register with control bits) Bit 7 Reserved Bit 6 Reserved Bit 5 Reserved Bit 4 Reserved Bit 3 Set to 1 to set threshold interpretation to relative Bit 2 Set to 1 to enable Custom Lighting Commands Bit 1 Set to 1 to enable 3 byte output to controllers Bit 0 Set to 1 to enable 2 byte output to ballasts	With Bit 0 and 1 the ability to send commands can be activated or deactivated.
65	1	OBA_1 Output Byte DALI 2 Byte command A (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from passive to active state)	N/A
66	2	OBA_2– second byte output pattern A	N/A
67	3	OBB_1 Output Byte DALI 2 byte Command B (2 Byte DALI bit pattern to be sent when sensor value changes the threshold from active to passive state)	N/A
68	4	OBB_2– second byte output pattern B	N/A
69	5	TA Threshold value A (When absolute, and pass through this threshold, increasing, will trigger output A) (When relative, and increasing by this relative amount, will	N/A

Read Data #	Byte #	Description	Setting
		trigger output A) (When binary, this enables output 0➔1)	
70	6	TB Threshold value B (When absolute, and pass through this threshold, decreasing, will trigger output B) (When relative, and decreasing by this relative amount, will trigger output B) (When binary, this enables output 1➔0)	N/A
71	7	DA Delay value A 15 sec (1 byte timer)	N/A
72	8	DB Delay value B 1 min (1 byte timer)	N/A
73	9	RT 3-byte Repeat timer 1 min (0=no repeat, 1 byte timer)	N/A
74	10	SEN Sensitivity (1 byte Sensitivity/Gain setting, 0= standard sensitivity or “auto” if appropriate)	N/A
75	11	ICA Interlocking Controller Address (address of controlling device that modifies behavior of current controller) (255=no ICA)	255

7.10 POWER SUPPLY

7.10.1 Ability

The power supply shall supply the needed power to one loop.

7.10.2 Recommended Factory Default Setting

No specific functions are specified for the power supply.

7.10.3 Possible Controlled Lighting Load

N/A

7.10.4 Possible Commands

N/A

7.10.5 Recommended Operation

N/A

7.10.6 Optional

a) The power supply shall be able to report his maximal possible load.
b) The unit shall be able to report the actual load

7.10.7 Example

In byte 2 the maximal load shall be shown in 1mA steps. Only information shall be reported in power supplies. Any error reporting shall be done in byte 1.

Read Data #	Byte #	Description	Setting
2	2	SV (Actual Sensor Value) Is set by the control device automatically	Reports the maximal possible load this power supply will be able to support. E.g. 200mA 1100 1000

Refer to Part II for additional features.

7.11 EMERGENCY LIGHTING CONTROLLER

To be determined.

Section 8
DALI BUS WIRING

8.1 GENERAL

The voltage drop between a power supply and any device shall not exceed 2.0 V.

It is recommended that DALI controls be wired as Class 1 wiring systems. If wired as Class 2 systems, care should be taken to keep all Class 2 wiring separate from Class 1 wiring in accordance with the *National Electrical Code*. In both cases all wiring shall be done in accordance with the *National Electrical Code*.

8.2 CLASS 1 REQUIREMENTS

8.2.1 Minimum Wire Diameter

Minimum wire diameter shall be 18 AWG (1mm^2).

8.2.2 Maximum Run Length

See Table 1 for suggested maximum run lengths.

8.2.3 Maximum Aggregate Run Length

See Table 1 for suggested maximum aggregated run lengths.

Table 1. Run Lengths and Number of Devices—Class 1

Isupply total	**Maximum Number of Devices[1]**	Maximum Run Length				**Maximum Aggregate Run Length**
		AWG 18 1mm^2	**AWG 16 1.3 mm^2**	**AWG 14 1.6 mm^2**	**AWG 12 2 mm^2**	
250 mA	128	570 ft 175 m	900 ft 275 m	1,430 ft 435 m	2,280 ft 700 m	3,000 ft 900 m
[1] Must also meet Idevice total requirements—the actual allowable number of devices will likely be lower.						

8.3 CLASS 2 REQUIREMENTS

The DALI bus can be wired as a Class 2 system if separation from Class 1 wiring is maintained per the National Electrical Code. For low voltage wiring such as CAT 3 or CAT 5, the wiring guidelines of Table 2 apply.

Table 2. Run Lengths and Number of Devices—Class 2

Isupply total	**Maximum Number of Devices[1]**	**Maximum Run Length[2]**		**Maximum Aggregate Run Length[2]**	
		CAT 3	**CAT 5**	**CAT 3**	**CAT 5**
250 mA	128	65 ft 20 m	130 ft 40 m	3,000 ft 900 m	3,000 ft 900 m

[1] Must also meet Idevice total requirements—the actual allowable number of devices may likely be lower.
[2] Note that wire resistance determines maximum run length, and maximum run length can be increased by parallel connection of wires. For parallel wire connections, multiply run length by the number of wires in parallel.

Section 9
MARKING

9.1 GENERAL

All control devices must be marked with their bus current draw in the non-active state.

Note – For ballast this is less than 2 mA.

NEMA Standards Publication 243-2004

Digital Addressable Lighting Interface (DALI) Control Devices Protocol

PART 2-2004

Specific Commands for Control Devices

Version 1.3
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Foreword

This standard covers the specific commands for various lighting control devices used to control electronic ballasts conforming to IEC 60929, Annexes E and G. These ballasts are referred to as “DALI ballasts” (DALI—Digital Addressable Lighting Interface).

In the preparation of this Standards Publication input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the concerned NEMA product Subdivision by contacting the:

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Section 1
GENERAL

1.1 SCOPE

This standard covers the specific commands for the various control devices connected to a DALI (Digital Addressable Lighting Interface) communications bus, as well as the bus and its power supply.

Section 2
DALI SWITCH DEVICE

2.1 GENERAL

Switch Devices (SD) type commands are used when a device at a specific individual address has been queried and determined to be an SD. Commands can be sent to all SD's by setting the address byte to a value of 0x81 (the SD type). Allowable commands, specified in the second byte of the message, can range in value from 0x80 to 0xbf. All non-specified commands are reserved.
Switch Devices shall be able to control each 8 single units.

2.2 SPECIFIC COMMANDS

The use of Generic Device Commands, as detailed in NEMA STANDARD 243-2004, Part 1-2004, section 5 is still required. These commands are used to establish the short address the SC (see Table 5.2), check error conditions, and set group membership (see Table 5.1 and 5.3).

2.3 PARAMETER BANK SELECTION

As with generic devices, parameter banks are optionally used to enable different operating modes for the device that corresponds to different building modes. While only a single parameter bank is required, manufacturers that implement more than one parameter bank allow the user to change the operating characteristics of the device at will. Manufacturers are only required to implement a single Parameter Bank (Bank 0). All other banks are optional. Note that the parameter bank count and pointers specified here are used in the same way as their equivalents in the generic devices, but they are separate and refer to a sensor specific parameter bank(s).

2.4 SWITCH BANK SELECTION

In every SD an additional selectable bank has been added. This will allow to select the functionality of up to 254 connected buttons. Each button will have the possibility to have assigned one of the following commands:

- Two byte commands sent to the ballast
    - Commands sent one time only
        - Single command repeated every time the button will be pressed (e.g to be used for a ON only button functionality) = Functionality A
        - Single Toggle command (e.g. to be used for a ON/OFF button functionality) = Functionality B
    - Repeated commands
        - Repeated commands automatically repeated every 50ms as long as button is pressed (e.g. to be used for DIM UP functionality) = Functionality C
        - Repeated Toggle command (e.g. to be used for a DIM UP/ DIM DOWN functionality. = Functionality D
- Set of 3 Two Byte commands used for programming ballast
        - One single set of three DALI ballast 2 byte commands can be programmed in order to be able to e.g. memorize the actual level in the connected output units (e.g. ballast) = Functionality E
- Three byte command
        - One 3 byte command to allow communicating to other controllers (can be used to e.g. set a different parameter bank) = Functionality F

By recalling on of the functionalities A-F the SD shall execute the requested command.

2.5 DATA REQUIREMENTS FOR SWITCH DEVICES

The amount of data required to implement an Switch Device is minimal, and is detailed below in Table 2.1. The number of Parameter and Switch Banks that the vendor chooses to implement determines the total table size. With the required initial parameter bank (Bank 0) and one switch bank (switch bank 0) a total of 15 bytes is required (single functionality e.g. ON/OFF). Additional parameter banks and multiple button units require a higher number of bytes.

Table 2-1
DATA REQUIREMENTS FOR SWITCH DEVICE

Read Byte # 0xXX=Hex (xxx)=Dec	Byte #	Description	Default
0x80 (128)	0	Parameter Bank Count (PBC): Ranges from 1 to 255, this indicates the number of implemented parameter banks. If 1, then a single parameter bank is supported. Zero is not a valid number.	N/A
0x81 (129)	1	Parameter Bank Read/Write (PBRW): Set to the desired parameter bank to be read from (command 0x00), or programmed (commands 0x81 to 0x8e).	0x01
0x82 (130)	2	Parameter Bank Operate (PBO): Set to the desired parameter bank to operate from given the current mode of the building	0x01
0x83 (131)	3	FB (Feature Byte): Read only byte that indicates the capabilities implemented by the vendor (0 means not supported, 1 means supported) Bit 7 – Reserved for future use Bit 6 – Reserved for future use Bit 5 – Reserved for future use Bit 4 – Supports status information Bit 3 – Supports 3-byte outputs Bit 2 – Supports programming feature outputs Bit 1 – Supports 2-byte outputs Bit 0 – Multiple switch implemented	N/A
		PB The actual Parameter Bank (bytes 1 to 3)	
0x84 (132)	1	Switch Bank Count (SBC): Ranges from 1 to 255, this gives the count of buttons the units is supporting. Zero is not a valid number.	0x01
0x85 (133)	2	Switch Bank Read/Write (SBRW): Set to the desired switch bank to be read from (command 0x80), or programmed to (commands 0x81 to 0x93).	0x01
0x86 (134)	3	Sensor Output Enable (SOE): Used to enable/disable two byte, programming and/or three byte commands: Bit 7 Reserved for future use Bit 6 Reserved for future use Bit 5 Reserved for future use Bit 4 Reserved for future use Bit 3 Reserved for future use Bit 2 set to 1 to enable 3-byte commands Bit 1 set to 1 to enable programming commands Bit 0 set to 1 to enable 2-byte commands	0x01

		SB The actual Switch Bank (Bytes 1 to 18)	
0x87 (135)	1	Button Status (BS): This byte shall reflect the status of the corresponding Switch Bank. Bit 7 Reserved for future use Bit 6 set to 1 reflects last recalled function F Bit 5 set to 1 reflects last recalled function E Bit 4 set to 1 reflects last recalled function D Bit 3 set to 1 reflects last recalled function C Bit 2 set to 1 reflects last recalled function B Bit 1 set to 1 reflects last recalled function A Bit 0 set to 1 reflects lights to be on	N/A
0x88 (136)	2	Command Activated (CA) This byte reflects the activated Functions. Bit 7 Reserved for future use Bit 6 Reserved for future use Bit 5 set to 1 function F activated Bit 4 set to 1 function E activated Bit 3 set to 1 function D activated Bit 2 set to 1 function C activated Bit 1 set to 1 function B activated Bit 0 set to 1 function A activated	N/A
0x89 (137)	3	Timer CD (TCD): This will set the time in 50ms increments on how long the command has to be recalled in order to send the commands specified in function C and D. If this timer is set Functions A and B only be executed if the command has been recalled for less then the set time.	N/A
0x8a (138)	4	Timer E (TE): This will set the time in 100ms increments on how long the command has to be recalled in order to send the commands specified in function E.	N/A
0x8b (139)	5	Timer F (TF): This will set the time in 100ms increments on how long the command has to be recalled in order to send the commands specified in function F. If set to 0 the command will sent after having executed Function AB, CD or E.	N/A
		Commands set in A and B shall be sent only once.	
0x8c (140)	6	Function A first byte (FA1) defines first byte for function A If set to 255 (MASK) the function is deactivated.	N/A
0x8d (141)	7	Function A second byte (FA2) defines the second byte for function A.	N/A
0x8e (142)	8	Function B second byte (FB2) defines the second byte for function B. The same 1st byte shall be used as used in Function A. If deactivated (byte 0x89 (137) / 2) function A shall be repeated.	N/A
		Commands set in C and D shall be repeated every 50 ms as long as recalled.	
0x8f (143)	9	Function C first byte (FC1) defines first byte for function C If set to 255 (MASK) the function is deactivated.	N/A
0x90 (144)	10	Function C second byte (FC2) defines the second byte for function C.	N/A
0x91 (145)	11	Function D second byte (FD2) defines the second byte for function D. The same 1st byte shall be used as used for Function C. If deactivated (byte 0x89 (137) / 2) function C shall be	N/A

		repeated.	
		Commands set in E shall be sent only once 1)	
0x92 (146)	12	Function E first byte (FE1) defines first byte for function E.	N/A
0x93 (147)	13	Function E second byte (FE2A) defines the second byte for the first of the three commands.	N/A
0x94 (148)	14	Function E second byte (FE2B) defines the second byte for the second of the three commands.	N/A
		Commands set in F shall be sent only once 2)	
0x95 (149)	15	Function F first byte (FF1) defines first byte for function F	N/A
0x96 (150)	16	Function F second byte (FF2) defines the second byte for function F.	N/A
0x97 (151)	17	Function F third byte (FF3) defines the third byte for function F.	N/A

Commands set in E shall be sent:

- 1st byte (FE1), second byte A (FE2A)
- 1st byte (FE1), second byte B (FE2B) this command shall be repeated twice within 50 ms.

2.6 THREE-BYTE COMMANDS

It is also possible to broadcast a 3-byte command to other devices using sensor addressing. Such a command does not impact ballast light output directly (the ballasts ignore 3-byte commands), but another control device on the same bus can receive this information and react accordingly. This information can be sent once, on change only by specifying the functionality F. If the function F is specified, the command will be sent after sending all other commands.

2.7 SWITCH DEVICEC CONTROL MESSAGES

In addition to the Common Control Commands detailed in table 2.3 of NS 243-2004, Part 1-2004, some additional command are specified in order to provide all possible features to be implemented.

Table 2.3
SWITCH DEVICE CONTROL COMMANDS

Command		Purpose	Comments
Dec	**Hex**		
0	0x00	Query Data	Used to read data specified by the 3rd byte (See table 6.1 for byte # and details). Note, PBRW must be set to the appropriate parameter bank before the read command is issued
128	0x80	Set Parameter Bank Read/Write (PBRW)	Used to select which bank to read from or write to. Note, this does not change the operating bank!
129	0x81	Set Parameter Bank Operate (PBO)	Used to select which

			parameter bank the sensor is operating from.
130	0x82	Set Switch Bank Read/Write (PBRW)	Used to select which bank to read from or write to. Note, all switch banks are always active.
131	0x83	Set Sensor Output Enable (SOE)	Sets the capability of the unit to send 2 byte, programming and/or 3 byte commands.
132	0x84	Set Command Activated (CA)	Sets what function will be activated (what button press will recall a command)
133	0x85	Set Timer CD (TCD)	Will specify the time, in 50mS increments, the button has to be pressed in order to send the commands C and /or D
134	0x86	Set Timer E (TE)	Will specify the time in 100mS increments, the button has to be kept press in order to sent the command set specified in E.
135	0x87	Set Timer F (F)	Will specify the time in 100mS increments, the button has to be kept press in order to sent the command set specified in E.
136	0x88	Set FA1	In this byte the first byte for command sent with function A and B is specified.
137	0x89	Set FA2	The second byte for function A is specified.
138	0x8a	Set FB2	The second byte for function B is specified.
139	0x8b	Set FC1	In this byte the first byte for command sent with function C and D is specified.
140	0x8c	Set FC2	The second byte for function C is specified.
140	0x8d	Set FD2	The second byte for function D is specified.
142	0x8e	Set FE1	In this byte the first byte for command sent with function E is specified.
143	0x8f	Set FE2A	The second byte for the first command in function E is specified.
144	0x90	Set FE2B	The second byte for the second command in function E is specified.
145	0x91	Set FF1	In this byte the first byte for command sent with function F is specified.

146	0x92	Set FF2	The second byte for function F is specified.
147	0x93	Set FF3	The third byte for function F is specified.

2.8 SWITCH DEVICE EXAMPLES OF COMMAND SETS

2.8.1 SINGLE BUTTON ON/OFF, RAISE/LOWER DEVICE

In the following table it is shown on how a momentary switch would be programmed that would be toggling between ON and OFF on a short push of the button and would DIM UP respectively DIM DOWN when the button is pressed for longer.

		SB The actual Switch Bank for single toggle switch	**Set to Command # (code)**
0x88 (136)	1	Button Status (BS)	N/A
0x89 (137)	2	Command Activated (CA)	(0000 1111)
0x8a (138)	3	Timer CD (TCD)	3 (0000 0011)
0x8b (139)	4	Timer E (TE)	N/A
0x8c (140)	5	Timer F (TF)	N/A
		Commands set A and B	
0x8d (141)	6	Function A first byte (FA1)	Group 1 (10000011)
0x8e (142)	7	Function A second byte (FA2)	RECALL MAX LEVEL 5 (0000 0101)
0x8f (143)	8	Function B second byte (FB2)	OFF 0 (00000000)
		Commands set C and D	
0x90 (144)	9	Function C first byte (FC1)	Group 1 (10000011)
0x91 (145)	10	Function C second byte (FC2)	UP 1 (0000 0001)
0x92 (146)	11	Function D second byte (FD2)	DOWN 2 (0000 0010)

If the button will be pressed for less then 150ms the switch will sent alternately the commands RECALL MAX and OFF to group 1. If the buttons are pressed for more then 150ms the send commands will be UP respectively DOWN to Group 1.

2.8.2 TWO BUTTON DEVICE ON/RAISE ON ONE BUTTON, OFF/LOWER ON THE SECOND

As we do have two buttons, two switch banks will need to be set. In the following table it is shown on how a momentary switch would be programmed to fulfill the function ON/UP and the second will list the settings for OFF/DOWN. The functions UP and DOWN shall be activated if the button is pressed and hold for more then 100ms.

		SB The actual Switch Bank for ON/UP switch	**Set to Command # (code)**
0x88 (136)	1	Button Status (BS)	N/A
0x89 (137)	2	Command Activated (CA)	(0000 0101)

0x8a (138)	3	Timer CD (TCD)	3 (0000 0011)
0x8b (139)	4	Timer E (TE)	N/A
0x8c (140)	5	Timer F (TF)	N/A
		Commands set A and B	
0x8d (141)	6	Function A first byte (FA1)	Group 1 (10000011)
0x8e (142)	7	Function A second byte (FA2)	RECALL MAX LEVEL 5 (0000 0101)
0x8f (143)	8	Function B second byte (FB2)	N/A
		Commands set C and D	
0x90 (144)	9	Function C first byte (FC1)	Group 1 (10000011)
0x91 (145)	10	Function C second byte (FC2)	UP 1 (0000 0001)
0x92 (146)	11	Function D second byte (FD2)	N/A

		SB The actual Switch Bank for OFF/DOWN switch	**Set to Command # (code)**
0x88 (136)	1	Button Status (BS)	N/A
0x89 (137)	2	Command Activated (CA)	(0000 0101)
0x8a (138)	2	Timer CD (TCD)	3 (0000 0011)
0x8b (139)	3	Timer E (TE)	N/A
0x8c (140)	4	Timer F (TF)	N/A
		Commands set A and B	
0x8d (141)	5	Function A first byte (FA1)	Group 1 (10000011)
0x8e (142)	6	Function A second byte (FA2)	OFF 0 (00000000)
0x8f (143)	7	Function B second byte (FB2)	N/A
		Commands set C and D	
0x90 (144)	8	Function C first byte (FC1)	Group 1 (10000011)
0x91 (145)	9	Function C second byte (FC2)	DOWN 2 (0000 0010)
0x92 (146)	10	Function D second byte (FD2)	N/A

All commands are sent to Group 1. By pressing button 1 for less then 150ms the unit shall recall ON, if pressed longer the command shall be UP. For the second button the command for a short press in OFF and for a long press it will be DOWN. The commands will be repeated every 50 ms for the time the button is pressed.

By setting the FC1 commands to MASK the same setting could be used for a manual 3 way switch that would switch the lights ON and OFF only.

2.8.3 SCENE SWITCH DEVICE INCLUDING MEMORIZING THE SCENE

The example will only specify one single button. To create a multiple button device the relative number of switch banks would need to be defined. As an additional feature the button would memorize the actual level as scene if hold for more then 10 seconds.

		SB The actual Switch Bank for SCENE switch including Memorizing actual level as Scene	**Set to Command # (code)**
0x88 (136)	1	Button Status (BS)	N/A
0x89 (137)	2	Command Activated (CA)	(0001 0001)
0x8a (138)	3	Timer CD (TCD)	N/A
0x8b (139)	4	Timer E (TE)	100 (0011 0100)
0x8c (140)	5	Timer F (TF)	N/A
		Commands set A and B	
0x8d (141)	6	Function A first byte (FA1)	Group 1 (10000011)
0x8e (142)	7	Function A second byte (FA2)	GO TO SCENE 5 21 (0001 1101)
0x8f (143)	8	Function B second byte (FB2)	N/A
		Commands set C and D	
0x90 (144)	9	Function C first byte (FC1)	N/A
0x91 (145)	10	Function C second byte (FC2)	N/A
0x92 (146)	11	Function D second byte (FD2)	N/A
		Commands set E	
0x93 (147)	12	Function E first byte (FE1	Group 1 (10000011)
0x94 (148)	13	Function E second byte (FE2A)	STORE ACTUAL LEVEL IN THE DTR 33 (0010 0001)
0x95 (149)	14	Function E second byte (FE2B)	STORE THE DTR AS SCENE 5 69 (0100 0101)
0x96 (150)	15	Function E second byte (FE2C)	STORE THE DTR AS SCENE 5 69 (0100 0101)

Section 3
DALI DIMMING SLIDE DEVICE

3.1 GENERAL

To be determined.

3.2 SPECIFIC COMMANDS

To be determined.

Section 4
OCCUPANCY/MOTION DETECTOR OR PRESENCE DETECTOR

4.1 GENERAL

Occupancy sensor type commands are used when a device at a specific individual address has been queried and determined to be a motion/occupancy sensor. Commands can be sent to all occupancy/motion detectors by setting the address byte to a value of 0x85 (the motion/occupancy sensor type). Allowable commands, specified in the second byte of the message, can range in value from 0x80 to 0xbf. All non-specified commands are reserved.

4.2 USE OF GENERAL COMMANDS

The use of Generic Device Commands, as detailed in NS 243-2004, Part 1-2004, section 5 is still required. These commands are used to establish the short address the occupancy detector (see Table 5.2), check error conditions, and set group membership (see Table 5.1 and 5.3).

4.3 PARAMETER BANK SELECTION

As with generic devices, parameter banks are optionally used to enable different operating modes for the device that correspond to different building modes. While only a single parameter bank is required, manufacturers that implement more than one parameter bank allow the user to change the operating characteristics of the device at will. Manufacturers are only required to implement a single Parameter Bank (Bank 0). All other banks are optional. Note that the parameter bank count and pointers specified here are used in the same way as their equivalents in the generic devices, but they are separate and refer to a sensor specific parameter bank(s). Rather than have some parts of the parameters contained in the generic parameter bank, and other newer parts in the sensor specific section, it was decided to group the sensor related parameters into a sensor specific section for clarity and consistency.

4.4 DATA REQUIREMENTS FOR OCCUPANCY/MOTION DETECTORS

The amount of data required to implement an Occupancy/Motion Detector is minimal, and is detailed below in Table 6.1. The total table size is determined by the number of parameter banks that the vendor chooses to implement, but with the required initial parameter bank (Bank 0), a total of 17 bytes is required. Additional parameter banks require 13 bytes each.

Table 6-1
DATA REQUIREMENTS FOR OCCUPANCY/MOTION DETECTOR

Read Byte # 0xXX=Hex (xxx)=Dec	Byte #	Description	Default
0x80 (128)	0	Parameter Bank Count (PBC): Ranges from 1 to 255, this indicates the number of implemented parameter banks. If 1, then a single parameter bank is supported. Zero is not a valid number.	N/A
0x81 (129)	1	Parameter Bank Read/Write (PBRW): Set to the desired parameter bank to be read from (command 0x00), or programmed (commands 0x81 to 0x8e).	0x00
0x82 (130)	2	Parameter Bank Operate (PBO): Set to the desired parameter bank to operate from given the current mode of the building	0x00
0x83 (131)	3	FB (Feature Byte): Read only byte that indicates the capabilities implemented by the vendor (0 means not supported, 1 means supported) Bit 7 – Reserved for future use Bit 6 – Reserved for future use Bit 5 – Supports 2-byte outputs Bit 4 – Adjustable Warning Delay Bit 3 – Adjustable Occupancy Delay Bit 2 – Adjustable Output Enables Bit 1 – Adjustable Sensitivity Bit 0 – Adjustable Repeat Intervals	N/A
	4	**PB The actual Parameter Bank (bytes 4 to 16)**	
0x84 (132)	4	Occupied Repeat Interval (ORI): Set number of minutes between 2-byte occupied broadcasts. Zero indicates no repeat will occur (broadcast will happen on change of occupancy only)	0x00
0x85 (133)	5	Unoccupied Repeat Interval (URI): Set number of minutes between 2-byte unoccupied broadcasts. Zero indicates no repeat will occur (broadcast will happen on change of occupancy only)	0x00
0x86 (134)	6	Sensor Repeat Interval (SRI): Set number of minutes between 3-byte sensor state broadcasts. Zero indicates no repeat will occur (broadcast will happen on change only)	
0x87 (135)	7	Sensor Sensitivity (SS): Specifies sensitivity to motion. 1 is least sensitive, 255 is the most sensitive, 0 is factory default	0x00
0x88 (136)	8	Sensor Output Enable (SOE): Used to enable/disable two byte and/or three byte sensor state messages as follows: Bit 2 set to 1 to enable 3-byte broadcasts Bit 1 set to 1 to enable 2-byte occupied broadcasts Bit 0 set to 1 to enable 2-byte unoccupied broadcasts	0x04
0x89 (137)	9	Occupancy Delay (OD): Specifies amount of time the sensor must remain unoccupied before reporting a lack of occupancy. Time is in minutes. 0 is reserved for factory default. 255 is reserved for a test interval less than 1 minute	0x00
0x8a (138)	10	Warn Timer (WT): Specifies the amount of time the area should remain in a dim (warning) mode before turning off. 0 indicates no delay, 255 is reserved for a test interval less than	0x05

		1 minute.	
0x8b (139)	11	2-byte occupied output, byte 1 (OO1): First byte of 2-byte command sent when occupied	N/A
0x8c (140)	12	2-byte occupied output, byte 2 (OO2): Second byte of 2-byte command sent when occupied	N/A
0x8d (141)	13	2-byte warn output, byte 1 (WO1): First byte of 2-byte command sent when warning	N/A
0x8e (142)	14	2-byte warn output, byte 2 (WO2): Second byte of 2-byte command sent when warning	N/A
0x8f (143)	15	2-byte unoccupied output, byte 1 (UO1): First byte of 2-byte command sent when unoccupied	N/A
0x90 (144)	16	2-byte unoccupied output, byte 2 (UO2)): Second byte of 2-byte command sent when unoccupied	N/A

4.5 OCCUPANCY/MOTION DETECTOR BROADCAST MESSAGES

4.5.1 TWO-BYTE COMMANDS

The occupancy/motion detector can be configured to send control information to other devices in two ways. First, it can directly control ballasts when enabled and appropriate 2-byte ballast commands are programmed into the sensor. The 2-byte command that is sent is fully programmable (see table 6.1 above), and could correspond to a ballast command to turn a group off when unoccupied, for example. The 2-byte commands can repeat automatically at the rate specified in the ORI and URI bytes shown above in table 6.1.

4.5.2 THREE-BYTE COMMANDS

It is also possible to broadcast a 3-byte command to other devices using sensor addressing. Such a command does not impact ballast light output directly (the ballasts ignore 3-byte commands), but another control device on the same bus can receive this information and react accordingly. This information can be sent once, on change only, or repeated automatically at the rate specified in the SRI byte shown above in table 6.1.

In the case of the 3-byte command, the sensor short address is placed in the address field (see the CA parameter in Table 5.1 from NEMA Standard 243-2004, Part 1-2004), with an offset of 0x40 to indicate the message is controller originated (the address byte will then range in value from 0x40 to 0x7f for sensors 0 to 63). The command field specifies the type of data being sent; and in the case of the Occupancy/Motion Detector, the command field is set to a value of 0x02, which indicates an Occupancy/Motion Detector Sensor value is being sent. The value, contained in the third byte of the message, is set per Table 6.2 below:

Table 6.2
THREE-BYTE OCCUPANCY SENSOR VALUE BROADCAST MESSAGES

Address Byte	Command Byte	Data Byte	Description
0x40 to 0x7f	0x02	0x00	Occupancy Sensor Value (OSV)= Unoccupied (no people present)
	0x02	0x01	Occupancy Sensor Value (OSV)= Unoccupied and in warning interval
	0x02	0x02	Occupancy Sensor Value (OSV)= Occupied (people present)

4.6 OCCUPANCY/MOTION DETECTOR CONTROL MESSAGES

In addition to the Common Control Commands detailed in table 5.3 of NS 243-2004, Part 1-2004, some Occupancy/Motion Detector Specific commands exist that are used to program or query the device. These commands are shown in table 6.3 below.

NOTE the Query Data command, a generic command, is repeated here for completeness.

Table 6.3
OCCUPANCY/MOTION DETECTOR CONTROL MESSAGES

Command		Purpose	Comments
Dec	**Hex**		
0	0x00	Query Data	Used to read data specified by the 3rd byte (See table 6.1 for byte # and details). Note, PBRW must be set to the appropriate parameter bank before the read command is issued
128	0x80	Set Parameter Bank Read/Write (PBRW)	Used to select which bank to read from or write to. Note, this does not change the operating bank!
129	0x81	Set Parameter Bank Operate (PBO)	Used to select which parameter bank the sensor is operating from.
130	0x82	Set Occupied Repeat Interval (ORI)	Sets the ORI field in the Parameter Bank specified by PBRW (see Table 6.1)
131	0x83	Set Unoccupied Repeat Interval (URI)	Sets the URI field in the Parameter Bank specified by PBRW (see Table 6.1)
132	0x84	Sensor Repeat Interval (SRI)	Sets the SRI field in the Parameter Bank specified by PBRW (see Table 6.1)
133	0x85	Sensor Sensitivity (SS)	Sets the SS field in the Parameter Bank specified by PBRW (see Table 6.1)
134	0x86	Sensor Output Enable (SOE)	Sets the SOE field in the Parameter Bank specified by PBRW (see Table 6.1)
135	0x87	Occupancy Delay (OD)	Sets the OD field in the Parameter Bank specified by PBRW (see Table 6.1)
136	0x88	Warn Timer (WT)	Sets the WT field in the Parameter Bank specified by PBRW (see Table 6.1)
137	0x89	2-byte occupied output, byte 1 (OO1)	Sets the OO1 field in the Parameter Bank specified by PBRW (see Table 6.1)
138	0x8a	2-byte occupied output, byte 2 (OO2)	Sets the OO2 field in the Parameter Bank specified by

			PBRW (see Table 6.1)
139	0x8b	2-byte warn output, byte 1 (WO1)	Sets the WO1 field in the Parameter Bank specified by PBRW (see Table 6.1)
140	0x8c	2-byte warn output, byte 2 (WO2)	Sets the WO2 field in the Parameter Bank specified by PBRW (see Table 6.1)
141	0x8d	2-byte unoccupied output, byte 1 (UO1)	Sets the UO1 field in the Parameter Bank specified by PBRW (see Table 6.1)
142	0x8e	2-byte unoccupied output, byte 2 (UO2)	Sets the UO1 field in the Parameter Bank specified by PBRW (see Table 6.1)

Section 5
OPEN LOOP DAYLIGHT CONTROLLER

5.1 GENERAL

Open Loop Daylight Controller (OLDC) type commands are used when a device at a specific individual address has been queried and determined to be an OLDC. Commands can be sent to all OLDCs by setting the address byte to a value of 0x86 (the OLDC type). Allowable commands, specified in the second byte of the message, can range in value from 0x80 to 0xbf. All non-specified commands are reserved.

5.2 SPECIFIC COMMANDS

The use of Generic Device Commands, as detailed in NEMA STANDARD 243-2004, Part 1-2004, section 5 is still required. These commands are used to establish the short address the OLDC (see Table 5.2), check error conditions, and set group membership (see Table 5.1 and 5.3).

5.3 PARAMETER BANK SELECTION

As with generic devices, parameter banks are optionally used to enable different operating modes for the device that correspond to different building modes. While only a single parameter bank is required, manufacturers that implement more than one parameter bank allow the user to change the operating characteristics of the device at will. Manufacturers are only required to implement a single Parameter Bank (Bank 0). All other banks are optional. Note that the parameter bank count and pointers specified here are used in the same way as their equivalents in the generic devices, but they are separate and refer to a sensor specific parameter bank(s). Rather than have some parts of the parameters contained in the generic parameter bank, and other newer parts in the sensor specific section, it was decided to group the sensor related parameters into a sensor specific section for clarity and consistency.

5.4 DATA REQUIREMENTS FOR OCCUPANCY/MOTION DETECTORS

The amount of data required to implement an OLDC is minimal, and is detailed below in Table 7.1. The total table size is determined by the number of parameter banks that the vendor chooses to implement, but with the required initial parameter bank (Bank 0), a total of 21 bytes is required. Additional parameter banks require 17 bytes each.

Table 7.1
DATA REQUIREMENTS FOR OPEN LOOP DAYLIGHT CONTROLLER

Read Byte # 0xXX=Hex (xxx)=Dec	Byte #	Description	Default
0x80 (128)	0	Parameter Bank Count (PBC): Ranges from 1 to 255, this indicates the number of implemented parameter banks. If 1, then a single parameter bank is supported. Zero is not a valid number.	N/A
0x81 (129)	1	Parameter Bank Read/Write (PBRW): Set to the desired parameter bank to be read from (command 0x00), or programmed (commands 0x81 to 0x8e).	0x00
0x82 (130)	2	Parameter Bank Operate (PBO): Set to the desired parameter bank to operate from given the current mode of the building	0x00

0x83 (131)	3	FB (Feature Byte): Read only byte that indicates the capabilities implemented by the vendor (0 means not supported, 1 means supported) Bit 7 – Reserved for future use Bit 6 – Reserved for future use Bit 5 – Supports 2-byte outputs Bit 4 – Adjustable Bright Delay Bit 3 – Adjustable Dark Delay Bit 2 – Adjustable Output Enables Bit 1 – Adjustable Scale Bit 0 – Adjustable Repeat Intervals	N/A
	4	**PB The actual Parameter Bank (bytes 4 to 20)**	
0x84 (132)	4	Dark Repeat Interval (DRI): Set number of minutes between 2-byte dark broadcasts. Zero indicates no repeat will occur (broadcast will happen on change of state only)	0x00
0x85 (133)	5	Bright Repeat Interval (BRI): Set number of minutes between 2-byte bright broadcasts. Zero indicates no repeat will occur (broadcast will happen on change of state only)	0x00
0x86 (134)	6	Sensor Repeat Interval (SRI): Set number of minutes between 3-byte OLDC broadcasts. Zero indicates no repeat will occur (broadcast will happen on change only)	0x00
0x87 (135)	7	Sensor Scale (SS): Specifies type of sensor or scale/range of sensor. 0 is factory default	0x00
0x88 (136)	8	Sensor Output Enable (SOE): Used to enable/disable two byte and/or three byte sensor state broadcasts as follows: Bit 4 set to 1 to listen to 3-byte Occ Sensor broadcasts Bit 3 set to 1 to enable 3-byte Level broadcasts Bit 2 set to 1 to enable 3-byte OLDC broadcasts Bit 1 set to 1 to enable 2-byte dark broadcasts Bit 0 set to 1 to enable 2-byte bright broadcasts	0x04
0x89 (137)	9	Dark Threshold byte 1 (DT1): Specifies number of lux beneath which it is considered dark. This is the lower 8 bits of the 16 bit threshold.	N/A
0x8a (138)	10	Dark Threshold byte 2 (DT2): Specifies number of lux beneath which it is considered dark. This is the upper 8 bits of the 16 bit threshold.	N/A
0x8b (139)	11	Bright Threshold byte 1 (BT1): Specifies number of lux above which it is considered bright. This is the lower 8 bits of the 16 bit threshold.	N/A
0x8c (140)	12	Bright Threshold byte 2 (BT2): Specifies number of lux above which it is considered bright. This is the upper 8 bits of the 16 bit threshold.	N/A
0x8d (141)	13	Dark Delay Timer (DDT): Set number of minutes that light must remain below threshold before 2-byte Dark output is sent	0x00
0x8e (142)	14	Bright Delay Timer (BDT): Set number of minutes that light must remain above threshold before 2-byte Bright output is sent	0x00
0x8f (143)	15	Tracking Occ Sensor (TOS): Specify address of Occupancy Sensor to track (prevents controlling lights if area is unoccupied). Must be enabled (see 0x88). See Occ Sensor info in Section 6.	N/A
0x90 (144)	16	2-byte Dark output, byte 1 (DO1): First byte of 2-byte command sent when light level is dark	N/A

0x91 (145)	17	2-byte Dark output, byte 2 (DO2): Second byte of 2-byte command sent when light level is dark	N/A
0x92 (146)	18	2-byte Bright output, byte 1 (BO1): First byte of 2-byte command sent when light level is dark	N/A
0x93 (147)	19	2-byte Bright output, byte 2 (DO2): Second byte of 2-byte command sent when light level is bright	N/A
0x94 (148)	20	Level Repeat Interval (LRI): Set number of minutes between 3-byte light level broadcasts. Zero indicates no repeat will occur (broadcast will happen on change only)	0x00

5.5 OPEN LOOP DAYLIGHT CONTROLLER BROADCAST MESSAGES

5.5.1 TWO-BYTE COMMANDS

The OLDC can be configured to send control information to other devices in two ways. First, it can directly control ballasts when enabled and appropriate 2-byte ballast commands are programmed into the controller. The 2-byte command that is sent is fully programmable (see table 7.1 above), and could correspond to a ballast command to turn a group off when unoccupied, for example. The 2-byte commands can repeat automatically at the rate specified in the DRI and BRI bytes shown above in table 7.1.

5.5.2 THREE-BYTE COMMANDS

It is also possible to broadcast a 3-byte command to other devices using sensor addressing. Such a command does not impact ballast light output directly (the ballasts ignore 3-byte commands), but another control device on the same bus can receive this information and react accordingly. This information can be sent once, on change only, or repeated automatically at the rate specified in the SRI byte shown above in table 7.1.

In the case of the 3-byte command, the controller short address is placed in the address field (see the CA parameter in Table 5.1 from NS 243-2004, Part 1-2004), with an offset of 0x40 to indicate the message is controller originated (the address byte will then range in value from 0x40 to 0x7f for controllers 0 to 63). The command field specifies the type of data being sent; and in the case of the OLDC, the command field is set to a value of 0x03, which indicates an OLDC value is being sent. The value, contained in the 3rd byte of the message, is set per table 7.2 below:

Table 7.2
THREE-BYTE OPEN LOOP DAYLIGHT CONTROLLER VALUE BROADCAST MESSAGES

Address Byte	Command Byte	Data Byte	Description
0x40 to 0x7f	0x03	0x00	Daylight Controller Value (DCV)= Level Beneath Dark Threshold
	0x03	0x01	Daylight Controller Value (DCV)= Level Between Dark and Bright Threshold
	0x03	0x02	Occupancy Sensor Value (OSV)= Level above Bright Threshold

5.5.3 CURRENT LIGHT LEVEL MESSAGES

Additionally, two messages which indicate the current light level can also be sent (always sent in pairs, low byte first). The controller short address is placed in the address field (see the CA parameter in Table 5.1 from NS 243-2004, Part 1-2004), with an offset of 0x40 to indicate the message is controller originated (the address byte will then range in value from 0x40 to 0x7f for controllers 0 to 63). The command field specifies the type of data being sent; and in the case of the OLDC Light Level, the

command field is set to a value of 0x04 (low byte) and 0x05 (high byte). The value, contained in the 3rd byte of the message, is set per Table 7.3 below:

Table 7.3
THREE-BYTE OLDC LIGHT LEVEL BROADCAST MESSAGES

Address Byte	Command Byte	Data Byte	Description
0x40 to 0x7f	0x04	0x??	OLDC Light Level byte 1 (LL1)= Light Level (Low byte)
	0x05	0x??	OLDC Light Level byte 2 (LL2)= Light Level (High byte)

5.6 OPEN LOOP DAYLIGHT CONTROLLER MESSAGES

In addition to the Common Control Commands detailed in table 5.3 of NS 243-2004, Part 1-2004, some OLDC Specific commands exist that are used to program or query the device. These commands are shown in table 7.4 below. (Note, the Query Data command, a generic command, is repeated here for completeness.)

Table 7.4
OPEN LOOP DAYLIGHT CONTROLLER MESSAGES

Command		Purpose	Comments
Dec	Hex		
0	0x00	Query Data	Used to read data specified by the 3rd byte (See table 7.1 for byte # and details). Note, PBRW must be set to the appropriate parameter bank before the read command is issued
128	0x80	Set Parameter Bank Read/Write (PBRW)	Used to select which bank to read from or write to. Note, this does not change the operating bank!
129	0x81	Set Parameter Bank Operate (PBO)	Used to select which parameter bank the controller is operating from.
130	0x82	Set Dark Repeat Interval (DRI)	Sets the DRI field in the Parameter Bank specified by PBRW (see Table 7.1)
131	0x83	Set Bright Repeat Interval (BRI)	Sets the BRI field in the Parameter Bank specified by PBRW (see Table 7.1)
132	0x84	Set Sensor Repeat Interval (SRI)	Sets the SRI field in the Parameter Bank specified by PBRW (see Table 7.1)
133	0x85	Set Sensor Scale (SS)	Sets the SS field in the Parameter Bank specified by PBRW (see Table 7.1)

134	0x86	Set Sensor Output Enable (SOE)	Sets the SOE field in the Parameter Bank specified by PBRW (see Table 7.1)
135	0x87	Set Dark Threshold byte 1 (DT1)	Sets the DT1 field in the Parameter Bank specified by PBRW (see Table 7.1)
136	0x88	Set Dark Threshold byte 2 (DT2)	Sets the DT2 field in the Parameter Bank specified by PBRW (see Table 7.1)
137	0x89	Set Bright Threshold byte 1 (BT1)	Sets the BT1 field in the Parameter Bank specified by PBRW (see Table 7.1)
138	0x8a	Set Bright Threshold byte 2 (BT2)	Sets the BT2 field in the Parameter Bank specified by PBRW (see Table 7.1)
139	0x8b	Set Dark Delay Timer (DDT)	Sets the DDT field in the Parameter Bank specified by PBRW (see Table 7.1)
140	0x8c	Set Bright Delay Timer (BDT)	Sets the BDT field in the Parameter Bank specified by PBRW (see Table 7.1)
141	0x8d	Set Tracking Occ Sensor (TOS)	Sets the TOS field in the Parameter Bank specified by PBRW (see Table 7.1)
142	0x8e	Set 2-byte Dark output, byte 1 (DO1)	Sets the DO1 field in the Parameter Bank specified by PBRW (see Table 7.1)
143	0x8f	Set 2-byte Dark output, byte 2 (DO2)	Sets the DO2 field in the Parameter Bank specified by PBRW (see Table 7.1)
144	0x90	Set 2-byte Bright output, byte 1 (BO1)	Sets the BO1 field in the Parameter Bank specified by PBRW (see Table 7.1)
145	0x91	Set 2-byte Bright output, byte 2 (BO2)	Sets the BO2 field in the Parameter Bank specified by PBRW (see Table 7.1)
146	0x92	Set Level Repeat Interval (LRI)	Sets the LRI field in the Parameter Bank specified by PBRW (see Table 7.1)

Section 6
CLOSED LOOP DAYLIGHT CONTROLLER

6.1 GENERAL

To be determined.

6.2 SPECIFIC COMMANDS

To be determined.

Section 7
SCHEDULER

7.1 GENERAL

To be determined.

7.2 SPECIFIC COMMANDS

To be determined.

Section 8
GATEWAY

8.1 GENERAL

To be determined.

8.2 SPECIFIC COMMANDS

To be determined.

Section 9
SEQUENCER

9.1 GENERAL

To be determined.

9.2 SPECIFIC COMMANDS

To be determined.

Section 10
POWER SUPPLY

10.1 GENERAL

To be determined.

10.2 SPECIFIC COMMANDS

To be determined.

Section 11
EMERGENCY LIGHTING CONTROLLER

11.1 GENERAL

To be determined.

11.2 SPECIFIC COMMANDS

To be determined.