

# Crestron **DIN-DALI-2**

## DIN Rail 2 Channel DALI Interface

### Programming Guide



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# DIN Rail 2 Channel DALI Interface: DIN-DALI-2

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## Introduction

This guide is intended to help trained Crestron<sup>®</sup> technicians to better troubleshoot and resolve DALI related issues. It offers background information on the operation of the DIN-DALI-2, provides procedures for wiring tests and device replacement, and details the syntax and function of various advanced programming commands. Appendices offer reference materials about DALI protocol.

This guide assumes a general understanding of DALI and familiarity with Crestron Toolbox<sup>™</sup>.

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## Operation of the DIN-DALI-2

The DIN-DALI-2 consists of a DALI power supply, an Ethernet/Cresnet<sup>®</sup> controller, and two independent DALI drivers that are isolated from earth ground and from Ethernet/Cresnet. The following paragraphs provide detailed information on the power supplies, wiring, and ballast communication to assist with troubleshooting the device.

### Power Supplies

The DALI loops are not isolated from each other. Loop 1 and Loop 2 share the same common circuit.

The built-in DALI power supply provides 15 V (~14.8 V) on the DALI lines. Meter measurement shows less since data transmission reduces the average voltage.

The DALI supply uses a current limit set at 250 mA. Drawing more than 250 mA causes the output to collapse. Each loop has its own 250 mA limit. During normal operation, DALI ballasts draw ~1 mA each from the loop (2 mA max).

The DALI unit, including DALI bus power supply, can be powered from Cresnet 24 V or from PoE. If both are connected, power is drawn from Cresnet. If both are connected and Cresnet power is removed, the unit resets.

An external slide switch can be used to disable the internal power supply should an external supply be used. This is not recommended and there is no known reason to do this other than for troubleshooting. Sliding the switch to **EXT** removes power from the loops and causes all ballasts to go to their emergency levels (full).

### Communication with Ballasts

In order to communicate, devices short circuit the DALI loop. This causes 250 mA to be drawn from power supply and voltage to collapse. Devices register the voltage on the loop to represent a high or low bit. The DALI specification dictates that a logic low is when the bus voltage is less than 6.5 V while a logic high is greater than 9.5 V. Values in between are not defined. The DIN-DALI-2 uses a threshold of ~7.5 V to determine a low or high state.

Communication between DIN-DALI-2 and ballasts is two-way. Ballasts only talk when queried—when a command is sent to the ballast requesting its level or status.

The DIN-DALI-2 translates the digitals and analogs received from the control system in DALI packets. Since the communication speed on the DALI network is so slow, the DIN-DALI-2 reports a simulated (estimated) position whenever a command is received from the control system. The actual level is requested from the ballasts afterward so an accurate position can be reported to the control system.

The DIN-DALI-2 also polls all ballasts on the loop, regularly requesting their current level and status. The status of the ballast is also queried at a slower pace. This tells the DIN-DALI-2 if a lamp is out or if a ballast has just powered up. It also updates the DIN-DALI-2 internal list of connected ballasts. If a ballast is deemed not connected, it is polled at a much slower rate.

DALI ballasts do not recall their last level on power up. Instead they go to the *Power-On Level* setting, typically 100%. The DIN-DALI-2 recognizes a ballast has just powered up based on its query status response and sends the correct level to which that ballast should go.

The group information is also updated for any ballasts that power up. This is to accommodate Lutron® EcoSystem® ballasts that do not store group information in non-volatile memory.

The levels and group information are also sent out whenever the DIN-DALI-2 unit powers up.

The DIN-DALI-2 also stores a complete copy of all information that is stored in the individual ballasts, such as scene levels, groups, addresses, fade time, etc. This is used so that the DIN-DALI-2 can report simulated levels back to the control system without waiting to extract information from each ballast and is also used when replacing a failed ballast (refer to “Ballast Replacement” on page 4 for more information).

## **DALI Wiring Considerations**

The DALI protocol places few restrictions on wiring since data rate is very slow and voltage levels are high.

It is recommended that #18 fire alarm wire with shield be used. This wire size limits the maximum length of a DALI loop. The maximum length of run from the controller to the farthest ballast should not exceed 500 feet (155 meters), but the total wire on the loop can exceed 500 feet (155 meters). For example, it would be acceptable to have ten 100-foot (31-meter) runs to groups of ballasts.

Exceeding the maximum length of a loop affects communication between the ballast and the DIN-DALI-2 controller. Communication is affected in reverse direction (the ballast talking to the DIN-DALI-2) first.

## Ballast and DIN-DALI-2 Replacement

The DIN-DALI-2 keeps a record of all ballasts it has commissioned, including all ballast settings such as fade times and groups. If a ballast fails and a replacement is installed, readdressing can take place from the front of the DIN-DALI-2 unit (no laptop necessary).

### Ballast Replacement

The following process allows one or more failed DALI ballasts to be replaced with new ballasts. All addressing and programming is transferred to the new ballasts.

The DIN-DALI-2 controls two independent loops of DALI ballasts. Up to 64 ballasts can be connected to each loop. Each ballast must be assigned a unique address (0 – 63). Ballasts typically leave the factory with an “unassigned address” of 255. The ballasts store information related to addressing, group assignments, presets and fade times programmed during commissioning. When a failed ballast is replaced, all of these parameters must be reprogrammed into the new ballast for it to function correctly.

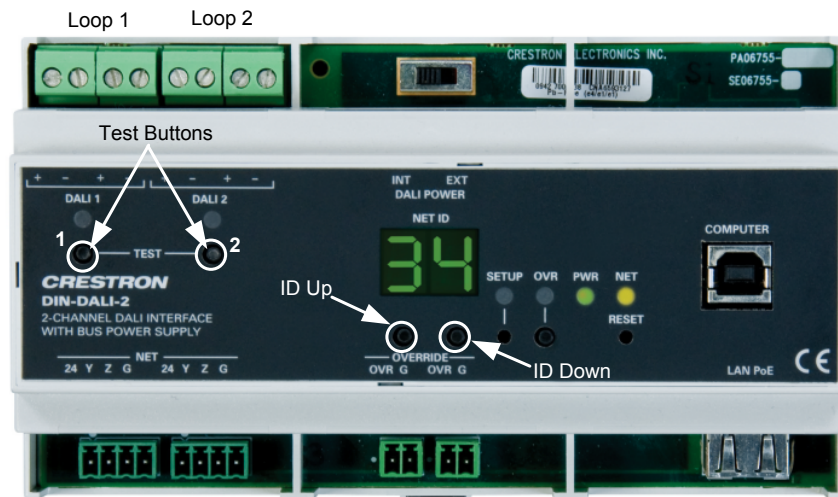
The DIN-DALI-2 simplifies the replacement process by keeping a copy of all information within its own internal memory. The DIN-DALI-2 identifies that a ballast is missing and discovers a new ballast on the DALI loop. The settings for the missing ballast are transferred to the new ballast.

If there is more than one missing ballast, the installer must select the address to assign to each new ballast. Refer to the following image for button location.

### Replacing a Single Ballast

If there is only one ballast to replace, use the following simplified method.

#### *DIN-DALI-2 TEST and ID Up Buttons*



1. Test wiring.
  - a. Replace the failed ballast.
  - b. Identify the loop (1 or 2) to which the new ballast is connected.

- c. Verify the new ballast can be controlled using the **TEST** button for the applicable loop. Tapping the **TEST** button toggles the state of all ballasts connected to that loop.
  - d. If the ballast does not respond, check the DALI wiring. Wiring must work properly before replacement process continues.
2. Initiate device discovery and replacement process.
  - a. Press and hold the **ID Up** and **ID Down** buttons until the display shows *br*, which takes approximately 5 seconds.
  - b. Within 10 seconds of entering this mode, tap the **TEST** button for the loop to which the new ballast is connected. The display blinks *br* during the device discovery process. This may take a few minutes to complete.
  - c. When discovery is complete, the display shows the address (in hex) of the missing ballast (00 – 3F) and the new ballast starts flashing.
  - d. Press and hold the applicable **TEST** button for 3 seconds to initiate reprogramming of the new ballast.
  - e. Once the new ballast has been programmed, the DIN-DALI-2 returns to normal operation and displays its Cresnet ID.

### ***Replacing Multiple Ballasts***

To replace multiple ballasts, perform the following procedure for each affected loop.

1. Test wiring.
  - a. Replace all failed ballasts.
  - b. Tap the **TEST 1** and **TEST 2** buttons to toggle the state of all ballasts connected and verify the new ballasts respond.
  - c. If a ballast does not respond, check the DALI wiring. Wiring must work properly before replacement process continues.
2. Initiate device discovery and replacement process.
  - a. Press and hold the **ID Up** and **ID Down** buttons until the display shows *br*, which takes approximately 5 seconds.
  - b. Within 10 seconds of entering this mode, tap the **TEST 1** button (for loop 1) or the **TEST 2** button (for loop 2). The display blinks *br* during the device discovery process. This may take a few minutes to complete.
  - c. When discovery is complete, the first new ballast found on the loop flashes to indicate that it has been selected for addressing.
  - d. The display shows the address (in hex) of the first missing ballast (00 – 3F).
    - a. Use the **ID Up** and **ID Down** buttons to select the address to assign to the flashing ballast. Refer to floor maps created during initial commissioning to determine correct address.
    - e. Press and hold the **TEST 1** button (for loop 1) or **TEST 2** button (for loop 2) button for 3 seconds to initiate reprogramming of the selected ballast. The display switches to show the address (in hex) of the next missing ballast and the next new ballast begins flashing.
    - f. Use the **ID Up** and **ID Down** buttons to assign an address to the flashing ballast.

- g. Press and hold the **TEST 1** button (for loop 1) or **TEST 2** button (for loop 2) button for 3 seconds to initiate reprogramming of the selected ballast.
- h. Repeat this process for each new ballast on the loop. After the final new ballast has been reprogrammed, the DIN-DALI-2 returns to normal operation and displays the Cresnet ID.

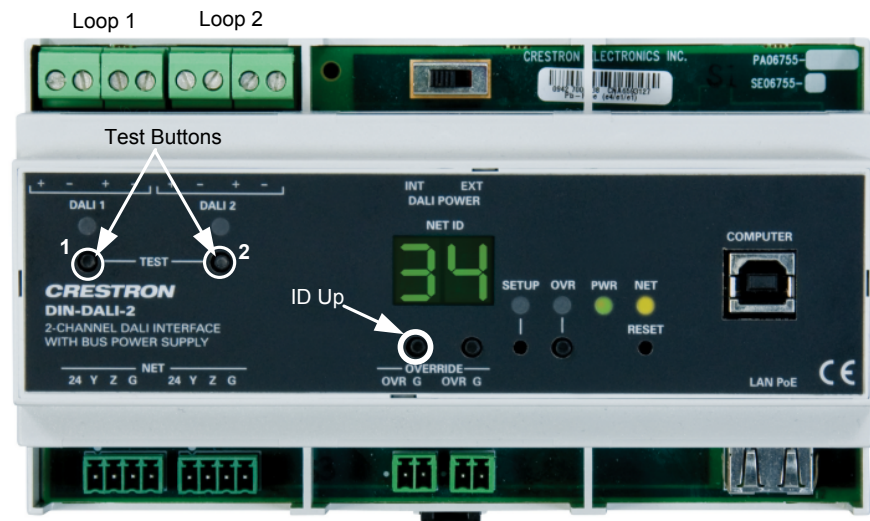
## DIN-DALI-2 Replacement

The following process allows a failed DIN-DALI-2 controller to be replaced with a new unit. The ballast addresses and settings are extracted from the network and stored in the new DIN-DALI-2 controller.

The DIN-DALI-2 controls two independent loops of DALI ballasts. Up to 64 ballasts can be connected to each loop. Each ballast must be assigned a unique address (0 – 63). Ballasts typically leave the factory with an “unassigned address” of 255. The ballasts also store information related to group assignments, presets and fade times programmed during commissioning.

The DIN-DALI-2 requires a copy of all information within its own internal memory. The following procedure causes the DIN-DALI-2 to query the network and extract all information from the existing ballasts. Information is stored within the DIN-DALI-2 permanent memory for future use.

### *DIN-DALI-2 TEST and ID Up Buttons*



To initiate read back on each loop:

1. Press and hold the **ID Up** button until the display reads *rc*, which takes approximately 5 seconds.
2. Within 10 seconds of entering this mode, tap the **TEST 1** button (for loop 1) or the **TEST 2** button (for loop 2). The display blinks *rc* while the device discovery process is running. This may take a few minutes to complete.

Once the data extraction has completed, the DIN-DALI-2 returns to normal operation and displays its Cresnet ID.



## Advanced DALI Console Commands

DALI console commands are available for almost all functions that can be executed from the DALI configuration tool. In most cases it is much simpler to use the software tool, but console commands are sometimes the only way to accomplish lower level debugging.

Console commands can be viewed using `Help debug`.

The syntax of the command generally follows:

[Command] [LOOP] [ADDRESS] [additional data]

- `LOOP` is 1 or 2.
- `ADDRESS` is a value between 0 and 63 or `ALL` if the command should go out as a broadcast to everyone. The address `UNDEFINED` may also be used for ballasts that have not been addressed.

The following sections discuss several helpful commands in detail.

### Discovering what is on the DALI Loop

The software tool does not always show the true state of what is on the loop. It may not show all devices or it may still show devices no longer present. The discovery process can be run using the `DALIDISCOVER` command.

**Recommended syntax:** `DALIDISCOVER [LOOP]`

This command triggers a search for ballasts by short address and then by random addresses on the loop specified. The short address search simply involves querying every short address 0–63 for the ballast's long (or random) address. The random address search is a binary search that queries ballasts based on the long address for its short address. The binary search finds any ballasts on the link as long as they have unique long addresses. Ballasts may only have duplicate long addresses if they are in their factory default state and no addressing has been performed (long address = `0xFFFFFFFF`). The probability of duplicate long address by random chance is essentially 0%.

`QUICK` can be included in the command to search only based on short address. This is not recommended as ballasts that have duplicate short addresses or no address assigned do not show up.

**Alternative syntax:** `DALIDISCOVER [LOOP] [QUICK]`

The discover process takes a few minutes. At the end it displays a list of short address and long addresses. The following are some of the possible results:

- *Duplicate short addresses:* Address conflicts exist and should be resolved using the software tool or using the `DALISETADDRBYRND` command.
- *Invalid short addresses of 255:* A ballast has not been addressed.
- *Invalid/duplicate long addresses of 0xFFFF:* One or more ballasts are in the factory default state and have not been addressed.
- *Total number of entries does not match the number of ballasts on the loop:* Multiple ballasts have not been addressed. They all have short addresses of 255 and long addresses of `0xFFFF` and so only show up as one entry.

Resolve this by running Setup—Addressing (of unassigned ballasts) in software tool or by using the `DALITEACHBYRND` command.

## Viewing the DIN-DALI-2's Stored Memory

The DIN-DALI-2 unit stores a copy of the information that is stored in the ballast. It also stores records related to whether a ballast is connecting and reporting on the network and whether a ballast was ever commissioned. This data is used to populate the status table in the software tool assigning ballasts as *new* or *missing*.

The data can be viewed using the `LISTBALCFG` command. Note that this only displays the data stored in the DIN-DALI-2 and not necessarily the actual data in the ballasts. Under normal operation they should match.

**Syntax:** `LISTBALCFG [LOOP] [Address] [Parameter]`

*Possible Values for [Parameter]*

VALUE	DATA DISPLAYED
POWERON	Level to which that ballast powers on
SYSFAIL	Level ballast goes to when DALI loop voltage disappears
MIN	Ballast minimum level
MAX	Ballast maximum level
PHYMIN	Ballast physical minimum level
FADETIME	Fade time (refer to DALI Fade time lookup table)
FADERATE	Fade rate (refer to DALI Faderate lookup table)
SCENE0 – SCENE15	Scene levels
GROUP*	The groups of which that ballast is a part
STATUS*	STATUS byte—contains info about lamp failure
LEVEL	Current level
CONNECTED*	Displays whether ballast is showing up on Network during normal polling
TARGET	Level to which ballast is ramping
TYPE	Ballast type – no relevance
VERSION	Version – no relevance
COMMISSIONED*	Displays whether ballast was commissioned from this unit to determine whether the data possessed is correct
RANDOM	The long address or random address of ballast (24 bits)
NAME	The name of the ballast if programmed by tool

\* Command is useful for debugging.

Refer to the following paragraphs for details on several useful commands and their proper syntax.

- `LISTBALCFG [LOOP] ALL CONNECTED`

The `CONNECTED` flag is a number from 0–5 that represents the number of consecutive polls to which the ballast has responded.

- ⇒ 5: Ballast has responded successfully to the last five poll requests and is communicating well.
- ⇒ 0: Ballast has not responded to any of the last five poll requests and is likely not connected.

⇒ 1 – 4: Intermediate values indicate some form of problem.

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**NOTE:** The values should not be read immediately after powering up the system as ballasts may not have been polled five times yet.

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- LISTBALCFG [LOOP] ALL COMMISSIONED

The COMMISSIONED flag is 0 or 1.

⇒ 1: The ballast was commissioned and the DIN-DALI-2 expects to see it on the loop. If the ballast is not physically present, the DIN-DALI-2 reports it as missing and tries to replace the address during the ballast replacement process.

⇒ 0: The ballast was not commissioned as is not expected to be on the loop. If there is a ballast found at that address, the DIN-DALI-2 reports it as new and tries to assign it an address for a missing ballast if one exists.

- LISTBALCFG [LOOP] ALL FADETIME

ALL FADETIME displays the fade time used when scenes are recalled or intensity commands (analog) are sent. The fade time is mapped into real time as shown in the following table.

*Ballast Settings and Fade Times*

BALLAST SETTING	FADE TIME
0	<0.7 s
1	0.7 s
2	1 s
3	1.4 s
4	2 s
5	2.8 s (Default)
6	4 s
7	5.6 s
8	8 s
9	11.3 s
10	16 s
11	22.6 s
12	32 s
13	45.2 s
14	64 s
15	90.5 s

- LISTBALCFG [LOOP] ALL FADERATE

ALL FADERATE displays the fade rate used when raise/lower commands (digitals) are sent. The fade rate is mapped into steps/second as shown in the table on the following page.

*Ballast Settings and Fade Rates*

BALLAST SETTING	FADE RATE
0	N/A
1	357 steps/s
2	253 steps/s
3	178 steps/s
4	126 steps/s
5	89 steps/s
6	63 steps/s
7	45 steps/s (Default)
8	32 steps/s
9	22 steps/s
10	16 steps/s
11	11 steps/s
12	8 steps/s
13	6 steps/s
14	4 steps/s
15	3 steps/s

The effective dimming range is on 128 steps so the time required to raise/lower from min to max is approximately 128/fade rate.

The default setting of 7 (45 steps/s) provides a fade rate of ~2.8 s.

- LISTBALCFG [LOOP] ALL GROUP

This displays the groups to which each ballast is assigned.

- LISTBALCFG [LOOP] ALL MIN

This displays the minimum dim level that the ballasts can dim to. Note that the DIN-DALI-2 does not allow min to be set to a value less than 128. Even though this is half the useable dimming range it corresponds to a light level of ~3% based on logarithmic curve specified by DALI standards.

- READBALCFG [LOOP] ALL  
(Read Ballast Configuration data from the ballast)

This retrieves all ballast information and overwrites internal memory. Note that this does not clear the COMMISSIONED flag. It simply reads all group levels, scene levels, fade time, and so on.

The LISTBALCFG command must be used to view the data once it has been read.

- SETBALCFG [LOOP] ALL  
(Set Ballast Configuration data within the ballast)

This sets parameters within the ballast. It should be performed through the software tool, not over the console.

## Addressing Ballasts

The addressing process can be triggered from the console using the `DALITEACHBYRND` command.

**Syntax:** `DALITEACHBYRND [LOOP] [ALL or UNASSIGNED]`

The command can be executed to address all ballasts on the loop or just those that do not have an address assigned yet. If all ballasts are not showing up during device discovery but are responding to broadcast commands then there are likely ballasts that have not been assigned an address. Running the command should expose these. Readdressing everything is often the best solution as duplicate addresses may cause problems that are difficult to discover.

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**NOTE:** Readdressing ballasts does not wipe out any grouping or scene information that may be stored in the ballasts.

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## Constructing DALI Packets

For lower level troubleshooting, the DIN-DALI-2 console allows raw DALI packets to be constructed and the responses displayed.

If the response from the ballast must be displayed on the console, the debug console must first be enabled and standard polling of ballasts must be disabled. Without polling disabled the console window fills with messages, making it difficult to see specific ballast responses.

Enter the following commands to disable polling on both loops:

1. `DALIPOLL 1 STOP`
2. `DALIPOLL 2 STOP`

Enter the following commands to enable receive and transmit debug traces.

1. `DEBUGDALI RX ON`
2. `DEBUGDALI TX ON`

Once the console has been enabled any traffic on the DALI outputs is reported. Pressing the DALI **TEST** buttons shows commands broadcasted to the ballasts.

The `SENDDALIPKT` command can now be used to communicate directly with a specific ballast or group of ballasts. The paragraphs beginning on the following page illustrate different ways to use the command.

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**NOTE:** When work is complete, the console must be disabled and polling must be re-enabled. Without polling enabled, the DIN-DALI-2 does not report levels and Ballast replacement is not possible.

To disable receive and transmit debug traces, use the commands `DEBUGDALI RX OFF` and `DEBUGDALI TX OFF`. To enable polling on both loops, use the commands `DALIPOLL 1 START` and `DALIPOLL 2 START`.

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- **Syntax:** SENDDALIPKT [LOOP] [ADDR+DATA]

The ADDR+DATA is the raw DALI packet. For more general information on DALI protocol, refer to the DALI protocol summary in Appendix A, which begins on page 16.

The ADDR portion determines whether the command is a broadcast to a group or to a single short address. It also determines whether the DATA byte is an intensity or a Special Command. Note that both ADDR and DATA are in hex. Refer to Appendix B on page 19 for ballast address to hex address translation.

*Command Types and Equivalent Addresses*

COMMAND TYPE	ADDRESS*
Broadcast	1111111S
Group	100AAAAS
Single	0AAAAAAS

\* AAAA = 0 to F (Group Address 0-15);

AAAAAA = 0 to 3F (Short Address 0-63);

S determines whether DATA byte is an intensity (S=0) or a Special Command (S=1)

- **Syntax:**

SENDDALIPKT 1 [Short address \* 2 + 1] [COMMAND]

SENDDALIPKT 1 [Group address \* 2 + 129] [COMMAND]

The following tables provide examples of the completed syntax for each command used with various addresses.

Typical commands to use are:

⇒ Go to Max (05)

⇒ Go to Min (06)

⇒ Go Off (00)

⇒ Query Status (90)

*Examples for Sending Ballast to Max Level*

ADDRESS	COMMAND
Short address 00	SENDDALIPKT 1 0105
Short address 06	SENDDALIPKT 1 0D05
Short address 63	SENDDALIPKT 1 7F05
Group address 00	SENDDALIPKT 1 8105

*Examples for Sending Ballast to Min Level*

ADDRESS	COMMAND
Short address 00	SENDDALIPKT 1 0106
Short address 06	SENDDALIPKT 1 0D06
Short address 63	SENDDALIPKT 1 7F06
Group address 01	SENDDALIPKT 1 8306

*Examples for Sending Ballast to Off*

ADDRESS	COMMAND
Short address 00	SENDDALIPKT 1 0100
Short address 06	SENDDALIPKT 1 0D00
Short address 63	SENDDALIPKT 1 7F00
Group address 15	SENDDALIPKT 1 9F00

*Examples for Querying Status*

ADDRESS	COMMAND
Short address 00	SENDDALIPKT 1 0190
Short address 06	SENDDALIPKT 1 0D90
Short address 63	SENDDALIPKT 1 7F90

- **Syntax:** SENDDALIPKT [LOOP] [ADDR] [DATA]

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**NOTE:** There is no space between the ADDR and DATA bytes.

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Refer to the following tables when generating raw DALI packets.

*Byte Equivalents for Short and Group Addresses*

SHORT ADDRESS	ADDR BYTE	SHORT ADDRESS	ADDR BYTE	SHORT ADDRESS	ADDR BYTE	SHORT ADDRESS	ADDR BYTE	GROUP ADDRESS	ADDR BYTE
0	01	16	21	32	41	48	61	0	81
1	03	17	23	33	43	49	63	1	83
2	05	18	25	34	45	50	65	2	85
3	07	19	27	35	47	51	67	3	87
4	09	20	29	36	49	52	69	4	89
5	0B	21	2B	37	4B	53	6B	5	8B
6	0D	22	2D	38	4D	54	6D	6	8D
7	0F	23	2F	39	4F	55	6F	7	8F
8	11	24	31	40	51	56	71	8	91
9	13	25	33	41	53	57	73	9	93
10	15	26	35	42	55	58	75	10	95
11	17	27	37	43	57	59	77	11	97
12	19	28	39	44	59	60	79	12	99
13	1B	29	3B	45	5B	61	7B	13	9B
14	1D	30	3D	46	5D	62	7D	14	9D
15	1F	31	3F	47	5F	63	7F	15	9F

*Commands and Equivalent DATA Bytes*

Command	DATA Byte
OFF	00
MAX	05
MIN	06
RESET	20
QUERY STATUS	90
QUERY LEVEL	A0
QUERY GROUPS 0-7	C0
QUERY GROUPS 8-15	C1

The query command results in a response from the ballast if it is present. Typically this is all that is needed to prove reliable communication back from the ballast. The byte received can also provide further information.

- *Bit 0:* Value of 0 means ballast is okay. Value should always be 0.
- *Bit 1:* Value of 0 means lamp is okay. Value of 1 means lamp is burned out. Use this to verify burned out lamps.
- *Bit 2:* Value of 0 means ballast is off.
- *Bit 3 – 6:* Ignore
- *Bit 7:* Value of 0 means power is okay. Value of 1 means power cycled since last intensity command.



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## Clearing out the DIN-DALI-2 Internal Memory

If addresses of ballasts are changed via console commands or if ballasts are removed or replaced during the commissioning phase, the internal copy of ballast settings may not match what is installed. Typically the internal memory retains the previous settings for a ballast and then shows the new settings as a new ballast. The status list shows a ballast with the previous address as missing and a ballast with the new settings as new.

If this occurs, the internal memory in the DIN-DALI-2 should be cleared and the latest settings read back in from the ballasts. Both can be achieved using the software tool.

To clear internal memory, go to the DALI Commissioning Tool in Crestron Toolbox, click **Setup**, and select **Clear Commission Settings**.

To read back ballast info (what ballasts are on the network and all their parameters), go to the DALI Commissioning Tool in Crestron Toolbox, click **Setup** and select **Replace DIN-DALI-2 settings with ballast settings**.

The DIN-DALI-2 should now show only the ballasts that are physically present.

It is important that internal memory matches what is stored in the ballasts so that future ballast replacement can take place without recommissioning the system.

## Appendix A: DALI Protocol Summary

DALI uses a Manchester encoded unidirectional serial protocol with a transmission rate of 1.2 kHz. The bit time is  $833 \mu\text{s} \pm 10\%$ .

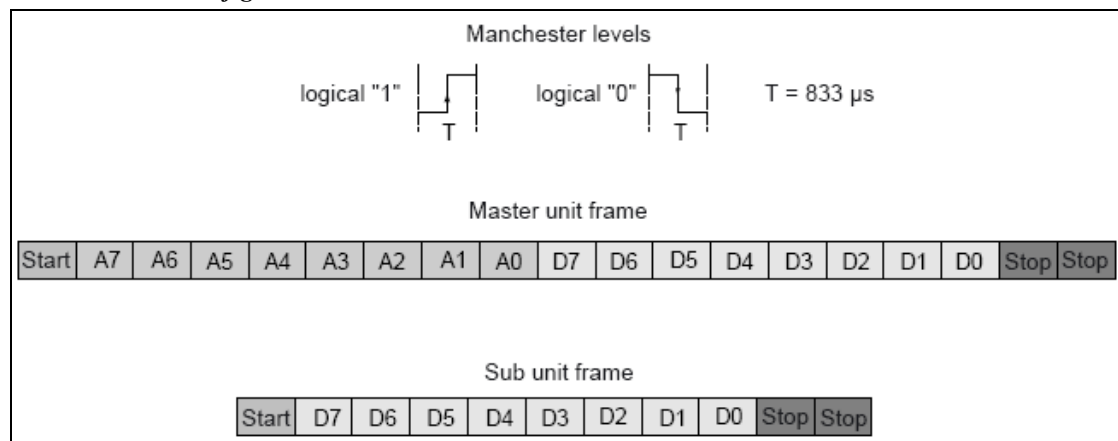
The frame of the main unit consists of 19 bits (15.9 ms):

- 1 start-bit (logical 1)
- 8 address bits
- 8 data bits
- 2 stop bits (physical high level)

The answer frame of the sub unit consists of 11 bits (9.2 ms):

- 1 start-bit (logical 1)
- 8 data bits
- 2 stop bits (physical high level)

### *DALI Protocol Configuration*



To select the devices by the different addressing modes (broadcast, group, single), use the address types shown in the following table.

### *Addresses Used for Different Command Types*

COMMAND TYPE	ADDRESS*	NOTES
Broadcast	1111111S	
Group	100AAAAS	AAAA = 0 to F (Group Address 0-15)
Single	0AAAAAAS	AAAAAA = 0 to 3F (Short Address 0-63)
Special command:	101CCCC1; 110CCCC1	CCCC = special command number

\* The S distinguishes between a direct arc power command and a DALI command. If  $S = 0$  the following data is interpreted as a power level with a value between 0x00 (off) and 0xFE (maximum power level).

Standard commands are listed in the table beginning on the following page.

*Standard Commands*

COMMAND NUMBER	ADDRESS	COMMAND/DATA	COMMAND NAME
-	YAAAAAA0	XXXX XXXX	DIRECT ARC POWER CONTROL
0	YAAAAAA1	00000000	OFF
1	YAAAAAA1	00000001	UP
2	YAAAAAA1	00000010	DOWN
3	YAAAAAA1	00000011	STEP UP
4	YAAAAAA1	00000100	STEP DOWN
5	YAAAAAA1	00000101	RECALL MAX LEVEL
6	YAAAAAA1	00000110	RECALL MIN LEVEL
7	YAAAAAA1	00000111	STEP DOWN AND OFF
8	YAAAAAA1	00001000	ON AND STEP UP
9–15	YAAAAAA1	00001XXX	RESERVED
16–31	YAAAAAA1	0001XXXX	GO TO SCENE
32	YAAAAAA1	00100000	RESET
33	YAAAAAA1	00100001	STORE ACTUAL LEVEL IN THE DTR
34–41	YAAAAAA1	0010XXXX	RESERVED
42	YAAAAAA1	00101010	STORE THE DTR AS MAX LEVEL
43	YAAAAAA1	00101011	STORE THE DTR AS MIN LEVEL
44	YAAAAAA1	00101100	STORE THE DTR AS SYSTEM FAILURE LEVEL
45	YAAAAAA1	00101101	STORE THE DTR AS POWER ON LEVEL
46	YAAAAAA1	00101110	STORE THE DTR AS FADE TIME
47	YAAAAAA1	00101111	STORE THE DTR AS FADE RATE
48–63	YAAAAAA1	0011XXXX	RESERVED
64–79	YAAAAAA1	0100XXXX	STORE THE STR AS SCENE
80–95	YAAAAAA1	0101XXXX	REMOVE FROM SCENE
96–111	YAAAAAA1	0110XXXX	ADD TO GROUP
112–127	YAAAAAA1	0111XXXX	REMOVE FROM GROUP
128	YAAAAAA1	10000000	STORE DTR AS SHORT ADDRESS
129–143	YAAAAAA1	1000XXXX	RESERVED
144	YAAAAAA1	10010000	QUERY STATUS
145	YAAAAAA1	10010001	QUERTY BALLAST
146	YAAAAAA1	10010010	QUERY LAMP FAILURE
147	YAAAAAA1	10010011	QUERY LAMP POWER ON
148	YAAAAAA1	10010100	QUERY LIMIT ERROR
149	YAAAAAA1	10010101	QUERY RESET STATE
150	YAAAAAA1	10010110	QUERY MISSING SHORT ADDRESS
151	YAAAAAA1	10010111	QUERY VERSION NUMBER
152	YAAAAAA1	10011000	QUERY CONTENT DTR
153	YAAAAAA1	10011001	QUERY DEVICE TYPE

*(Continued on following page)*

*Standard Commands (Continued)*

COMMAND NUMBER	ADDRESS	COMMAND/DATA	COMMAND NAME
154	YAAAAAA1	10011010	QUERY PHYSICAL MINIMUM LEVEL
155	YAAAAAA1	10011011	QUERY POWER FAILURE
156–159	YAAAAAA1	100111XX	RESERVED
160	YAAAAAA1	10100000	QUERY ACTUAL LEVEL
161	YAAAAAA1	10100001	QUERY MAX LEVEL
162	YAAAAAA1	10100010	QUERY MIN LEVEL
163	YAAAAAA1	10100011	QUERY POWER ON LEVEL
164	YAAAAAA1	10100100	QUERY SYSTEM FAILURE LEVEL
165	YAAAAAA1	10100101	QUERY FADE TIME / FADE RATE
166–175	YAAAAAA1	1010XXXX	RESERVED
176–191	YAAAAAA1	1011XXXX	QUERY SCENE LEVEL (SCENES 0–15)
192	YAAAAAA1	11000000	QUERY GROUPS 0–7
193	YAAAAAA1	11000001	QUERY GROUPS 8–15
194	YAAAAAA1	11000010	QUERY RANDOM ADDRESS (H)
195	YAAAAAA1	11000011	QUERY RANDOM ADDRESS (M)
196	YAAAAAA1	11001100	QUERY RANDOM ADDRESS (L)
197–223	YAAAAAA1	10XXXXXX	RESERVED

## Appendix B: Ballast Address to Hex Translation

Refer to the following table when translating ballast address to hex addresses.

*Hex and Ballast Address Conversion Table*

BALLAST ADDRESS	HEX ADDRESS	BALLAST ADDRESS	HEX ADDRESS	BALLAST ADDRESS	HEX ADDRESS	BALLAST ADDRESS	HEX ADDRESS
0	00	16	10	32	20	48	30
1	01	17	11	33	21	49	31
2	02	18	12	34	22	50	32
3	03	19	13	35	23	51	33
4	04	20	14	36	24	52	34
5	05	21	15	37	25	53	35
6	06	22	16	38	26	54	36
7	07	23	17	39	27	55	37
8	08	24	18	40	28	56	38
9	09	25	19	41	29	57	39
10	0A	26	1A	42	2A	58	3A
11	0B	27	1B	43	2B	59	3B
12	0C	28	1C	44	2C	60	3C
13	0D	29	1D	45	2D	61	3D
14	0E	30	1E	46	2E	62	3E
15	0F	31	1F	47	2F	63	3F

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## Glossary

### Binary Search

This is the method by which ballasts are found using the long address. Since the long address is 24 bits, it would take too long to query every address. Instead a binary search queries any ballasts below an address. All ballast with an address less than the value specified responds. The DIN-DALI-2 hears the response and repeats the process with a lower value (half the original). If the DIN-DALI-2 does not hear a response then it retries with a higher value (in between the last two values). This process repeats until a single ballast is found—that is, when a response is heard after querying long address 0xLLLLLL but not after querying 0xLLLLLL-1. The ballast with long address 0xLLLLLL is then assigned the next available short address and is instructed to not respond to any further binary search queries. The process starts again until another ballast is found and addressed. The process repeats until no further ballasts can be found.

### Long Address (also known as Random Address)

This is a 24-bit random number generated during the addressing phase that allows commands to be sent to ballasts that do not have short addresses. The value of 0xFFFFF is reserved for unassigned ballasts. A ballast typically leaves the factory with a long address of 0xFFFFF.

### Short Address

This is the address used under normal operation. It is a value between 0-63. A value of 255 (0xFF) is reserved for unassigned ballasts. A ballast typically leaves the factory with a short address of 255.

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Specifications subject to  
change without notice.