



## AL-DALI-HAT-I

Raspberry Pi to DALI  
Co-Processor

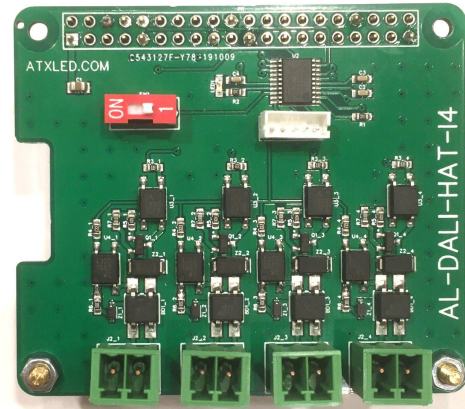
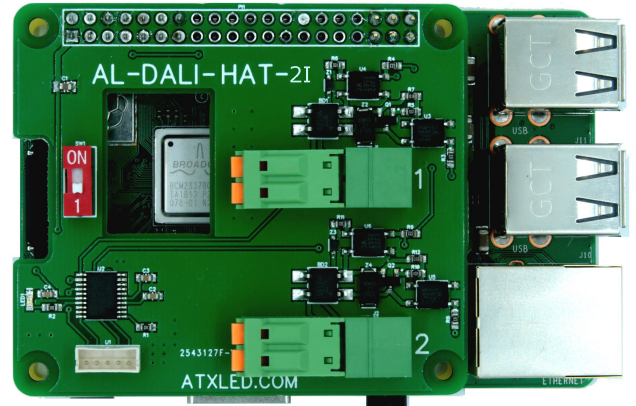
with either:

2 Isolated Busses

or

4 Isolated Busses

v14 firmware



### Product Description - AL-DALI-HAT-I2 or I4

This device interconnects a Raspberry Pi with 2 (or 4) DALI busses. Using your own software or our ZWD application (not included) – you can now control up to 256 addressable light fixtures from a Raspberry Pi.

Included in the AL-DALI-HAT-I2 (I4) are the following key functions

- DALI hardware interface
- Real Time co-processor to offload the DALI bus hardware interface
- Serial port to the Raspberry Pi
- DALI bus status reporting
- Autonomous Bus to Bus forwarding

### Overview

The Raspberry Pi uses the on-board serial port to communicate at 19200 baud to the DALI HAT-I, this rate is 16 times faster than the DALI bus – the hardware on the HAT-I2 (I4) adapts the UART serial data stream into DALI encoding. The Pi can read and write the DALI bus at it's leisure, the co-processor on the HAT-I2 (I4) handles all real-time functions.

# Wiring Connections

## Power for the AL-DALI-HAT-I

Connect the AL-DALI-HAT-I2 or AL-DALI-HAT-I4 to the Raspberry Pi. Apply power to the Raspberry Pi.

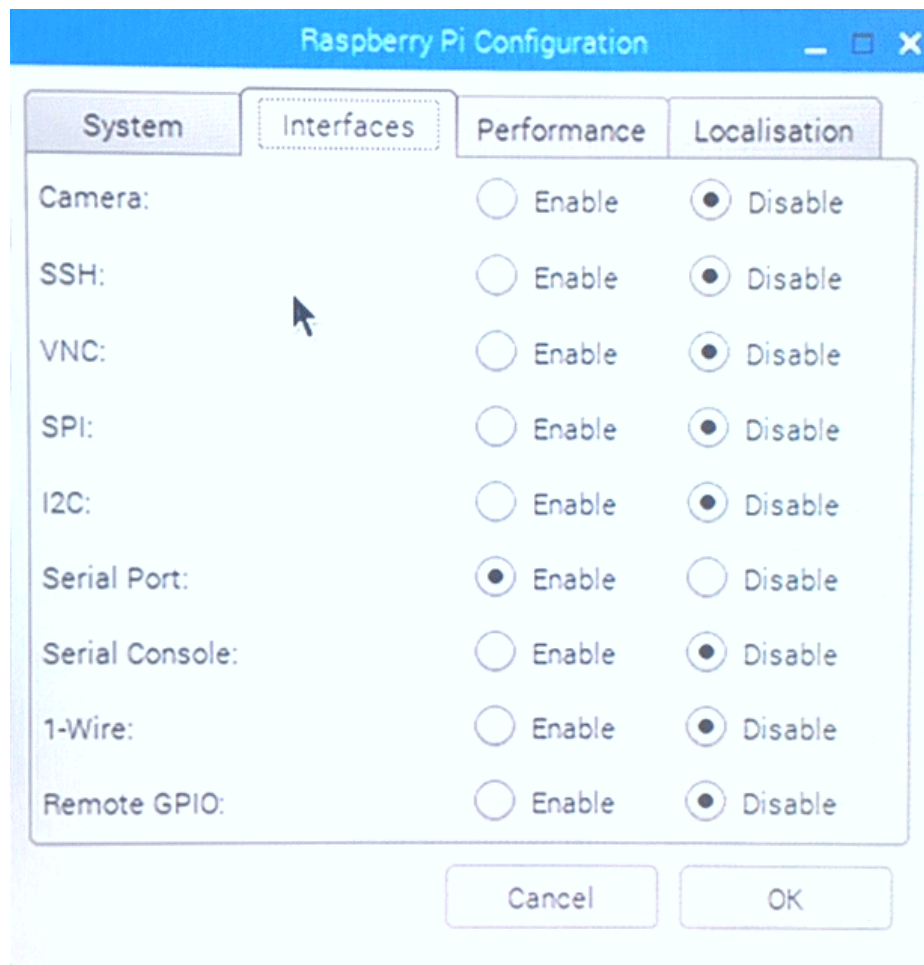
## DALI bus connection

Connect a pair of DA pins to your DALI bus. You will need an external DALI power supply. The DALI bus must have a current limit ( typically 260 mA and 16 volt max ) for normal operation. The 2 (4) busses are opto isolated from the DALI Pi itself.

## Software Switch

The HAT has an onboard switch that can be used for any software defined function. At default it is used to select the bus current at power up. This bus current control can be disabled by software. Using the Q command – the switch function can be disconnected from the DALI power calculation and become useful for any software function.

## Raspberry Serial port setup



## DALI commands from the Pi to the HAT

| Command | Length | Command type                |   |
|---------|--------|-----------------------------|---|
| h       | 4      | 16 bit DALI                 | The AL-DALI-HAT-I2 (I4) receives serial port strings from Pi and forwards them to the DALI bus. The packet is 2, 4, 6 or 8 bytes long and begins with one of these characters. We send lower case, and receive upper case: Length is the number of characters after the command |
| t       | 4      | 16 bit DALI – sent twice    |   |
| j       | 2      | 8 bit DALI                  |   |
| l       | 6      | 24 bit DALI                 |   |
| m       | 8      | 25 bit DALI                 |   |
| d       | 0      | Query DALI bus              | On receipt, the AL-DALI-HAT-I2 (I4) will wait for the DALI bus to be non busy, then will transmit the command. In the case of the t command – it will send the data twice within 100 ms.  |
| f       | 10     | Set forwarding table (v14)  |   |
| p       | 0      | Query power and switch Info |   |
| v       | 0      | Query Version               |   |
|         | 0      | Query String                |   |
| s       | < 59   | Store up to 59 characters   |   |

## Simple Serial I/O examples

See <https://atxled.com/Pi> for python code samples. Some DALI lighting control examples from Pi to Pi HAT-I2 (I4) to DALI bus are shown here

| Function                   | Decimal command | Send to HAT | Response |
|----------------------------|-----------------|-------------|----------|
| All lights on full – bus 2 | 254 254         | 1hFEFE      | None     |
| All lights off – bus 3     | 254 0           | 2hFE00      | None     |
| Initialize – bus 4         | 165 0           | 3tA500      | None     |
| Query status of #4 – bus 2 | 9 144           | 1h0990      | 6        |
| Set #5 to 200 – bus 2      | 10 200          | 1H0AC8      | None     |

See <https://atxled.com/pdf/AL-WS-DR2.pdf> for a list of commands, see the wikipedia article on DALI lighting for the addressing format for DALI.

## Bus Selection

| Bus number | DALI all On command | DALI response |
|------------|---------------------|---------------|
| 1          | HFEFE               | N             |
| 2          | 1HFEFE              | 1N            |
| 3          | 2HFEFE              | 2N            |
| 4          | 3HFEFE              | 3N            |

## Specifications

| Name      | Function                   | Description  |
|-----------|----------------------------|--|
|           | Internal Power consumption | 50 milliwatt ( plus the Pi )   |
| DA        | DALI Bus                   | 2 ( or 4 ) DALI Busses, opto isolated,   |
| Power     | Interface to Pi            | Ground ( pins 6, 9, 14, 20, 25, 30, 34, 39)<br>3.3 Volts from the Pi ( 20 mA ) ( pin 1 ) |
| Serial IP | Interface to Pi            | Serial Tx and Rx ( pins 8, 10)   |
|           | Operating Temperature      | 0°C ~ 50°C   |
|           | Size                       | 75 mm x 55 mm x 27 mm  |

## Autonomous Features

At all times – the AL-DALI-HAT-I2 (I4) is listening to the DALI bus. Some DALI bus packets will be processed internally by the Hat – others are passed to the Pi without processing.

The packets that are processed internally are

- DTR commands – those packets received that set values into the DTR will cause the Pi to not broadcast any packets for 200 ms. This allows a multi byte bus sequence to be completed without interruptions
- Inter-channel forwarding.

## Inter Channel Forwarding

The HAT has a 32 entry table of bus to bus forwarding which is handled by the Hat itself, without requiring the Pi to handle. An ARC, DALI Off, Read Level or Scene command received on a “source” bus, if matched in the table, will be forwarded to the Pi and to a destination address on a destination channel. Destination device levels will be wrong at power up and after scene recall, and are updated by ARC commands that occur on the destination bus normally.

Programming the forwarding table is done as follows, the table is stored in flash memory for use at power up:

- Send a Fxx command ( example F00) to read back the forwarding table entry 0. There are 32 entries response is Fxxssaaddaa
- Send a Fxxssaaddaa packet to create an entry with these values:
  - xx table entry # 0-31
  - ss monitored bus number 0-3, dd is destination bus number 0-3
  - aa address ( 0-63 is address, 64-79 is group 0-15, 80-95 is trigger 0-15, 208-223 is scene 0-15)
  - if the destination bus is 128 + Bus# ( 128- 131), then packets traverse in both directions.

Trigger is source DALI 0xBFxy. If y matches, then forward either a) the trigger 0-127 or b) a scene 0-15 set destination address < 128 for destination as trigger, and 208-223 for destination as a scene

## DALI monitoring – packets to the Pi

At all times – the AL-DALI-HAT-I2 (I4) is listening to the DALI bus. Any commands on the bus will be forwarded to the Pi for recording the state of the DALI bus. The packets sent to the Pi are. If there is no response after 100 ms to a packet, then a collision has occurred.

| Header to Pi            | Structure      | Xx              | yy          | cc            | zz          |
|-------------------------|----------------|-----------------|-------------|---------------|-------------|
| B Boot                  | Bxyycc         | HW Version      | FW Version  | Switch        |             |
| H DALI 16 bit           | Hxyy           | DALI byte 0     | DALI byte 1 |               |             |
| F Forwarding            | See Forwarding |                 |             |               |             |
| J DALI 8 bit            | Jxx            | DALI byte       |             |               |             |
| L DALI 24 bit           | Lxyycc         | DALI byte 0     | DALI byte 1 | DALI byte 2   |             |
| M DALI 25 bit           | Mxyycczz       | DALI byte 0     | DALI byte 1 | DALI byte 2   | DALI byte 3 |
| N No Response           | N              |                 |             |               |             |
| P Power Status          | Pxyyzz         | 0               | 0           | Switch on/off |             |
| Q Query                 | Q              | N/A             |             |               |             |
| S Key Storage           | S              | See Key storage |             |               |             |
| V Version               | Vxyycc         | HW Version      | FW Version  | Switch        |             |
| X Collision on Receive  | Xx             |                 |             |               |             |
| Z Collision on Transmit | Zxx            |                 |             |               |             |
| Other Collision         | Null response  |                 |             |               |             |

A "zDxc" packet is sent proactively by the HAT to the Pi on any change in the bus status, or in response to a 'd' query

| D                      | Z           | x  | C                         |
|------------------------|-------------|--|---------------------------|
| zDxc = status response | Channel 0-3 | DALI bus power status<br>0 = No DALI Bus power<br>1 = DALI bus short to plus<br>2 = OK | # of channels (1, 2 or 4) |

## DALI reporting sent to the Pi

At all times – the AL-DALI-HAT is listening to the DALI bus. Any commands on the bus will be forwarded to the Pi for recording the state of the DALI bus. Also status changes are sent.

The packets sent to the Pi start with a Capital Letter followed by values without commas:

- B means reboot, followed by 6 characters, HW version (2), SW version (2), channel count (2). This device has 1 channel
- D means DALI bus power supply status, 2 characters follow ( one byte with status, then one byte = one channel => 1)
- H means receipt of a 16 bit DALI packet, 4 Hex characters follow
- J means receipt of an 8 bit DALI packet, 2 Hex characters follow
- L means receipt of a 24 bit DALI packet, 6 Hex characters follow
- N means no response received – normal in most cases ( DALI NAK )
- M means receipt of a 25 bit DALI packet, 8 Hex characters follow ( fw 18 or later)
- P is for switch 0000 plus the onboard switch status, 7 characters
- S is the String stored in EEPROM ( bytes 1-30 )
- T is the String stored in EEPROM if longer than 30 bytes( bytes 31-59)
- V same values as B
- X means bus collision on Receive– normal in most cases
- Z means bus collision on Transmit– normal in most cases

The DALI power supply state is also sent proactively by the HAT if the DALI bus changes readiness

- D01 = no power on DALI , one channel
- D11 = Bus current too high – cannot drive to zero, one channel
- D21 = DALI bus OK, one channel

The HAT version status info is encoded as (Vxxyyzz) ( V is replaced by B when the HAT restarts)

- xx = Hardware Version
- yy = Firmware Version ( decimal = 32 is 32 not 50 )
- 01 = Hardware Type ( see the wiki for Hardware types )

The HAT status info is encoded as ( Pxxxyyzz)

- 000000
- z = 0 or 1 for the Switch On/Off status

Collisions on the DALI bus are expected during address search, but there are cases that are not expected. Check for lower than specified DALI bus voltages, higher currents than specified, or longer line lengths, the AL-DALI-Hat reports these errors.

- X4 = packet length error
- X3 = short bit received
- X2 = multiple packets received
- Z = Collision on transmit – normal, command should be resent
- null response = same as X Collision

## DALI Command Structure

DALI commands for simple applications are 2 byte commands with either a 1 byte response or no response. The Wikipedia article offers a good explanation.

The 2 bytes of each basic command can be of these these types

- A) Simple Direct Light Level commands
- B) Complex commands for immediate action
- C) Complex commands requiring the command to be repeated once in 100 ms for action
- D) Complex commands using previously stored information

There are 3 types of addressing methods for these commands

- 1) Broadcast – all device receive the same information
- 2) Unicast – only one device receives the information
- 3) Group – only the devices in the group receive the information.

There are 64 individual addresses, 16 group addresses, one broadcast. The individual and group addresses are shift one bit left for transmission.

The AL-DALI-HAT-I2 (I4) accepts Hex commands to pass thru to the DALI bus. So Hex 2 is address one. The commands listed in the AL-WS-DR2, AL-WS-010v, and PWS-POE-DALI are listed in Decimal – please convert to hex. In Hex – the format is

| Target     | Direct Light Control              | Complex Commands  |
|------------|-----------------------------------|---|
| Broadcast  | FExx where xx is the light level  | FFxx where xx is the command 0 thru 255   |
| Individual | 00 thru 7E ( address times 2 )    | yyxx where yy is 01 thru 7F ( addr x 2 + 1 )<br>xx is a command from 0 thru 255 |
| Group      | 80 thru 9E ( group times 2 + 128) | yyxx where yy is 81 thru 9F (group x 2 + 1)<br>xx is a command from 0 thru 255  |
| Broadcast  |                                   | A1xx thru BFxx – commands 256 thru 271<br>xx is the data to the device          |
| Broadcast  |                                   | C1xx thru DFxx – commands 272 thru 287<br>xx is the data to the device          |

The DALI devices have up to 3 internal registers called DTR, DTR1 and DTR2.

Many complex commands require that the DTR register be written first, then the command is given. For example – setting the Maximum dimming level requires first a number be stored in DTR, then the DTR is stored into the device. AL-DALI-HAT-I2 (I4) accepts Hex commands to pass thru to the DALI bus. For example, setting device 5 to max level 240 ( the range is 0 thru 254) the commands are

- a) A3F0 – save 240 into the DTR in all devices ( broadcast)
- b) 0B2A – save DTR as max value only to device address 5 ( times 2 plus 1 == B)

So Hex 0A is address five direct control and 0B is address five complex commands. The commands listed in the AL-WS-DR2, AL-WS-010v, and PWS-POE-DALI are listed in decimal – please convert to hex.

# ATX LED ZWD Application

The ZWD package for the Raspberry Pi creates a complete DALI master with all features needed for configuration and management of a DALI system. It includes interfaces to Alexa, Google, Hue, Homebridge, Smarthings, Siri and so on.

**Status**  
ZPDS version: 0285-4fb2aeef  
Channels: 1  
HW type: AL-DALI-HAT v2 with DALI power  
HW version: 02  
FW version: 24  
Local IP Address: 192.168.5.39  
MAC Address: b827ebefa86a

**Site Name**  
Staging (a86a-KVM 3)   
Enter your email address to register  
murray@atbled.com   
**Set up dataplicity**  
Dataplicity already installed.

Enable cloud backups and local redirection   
*If checked, we will periodically back up your ATX-LED user data (such as light names and scheduled actions) to the cloud. Additionally, the local redirection service will be enabled, so that following <https://mg.atbled.com> will open the ATX-LED control panel from within the local network.*

**Provisioning**

**Schedule**   No file selected.

**New Entry**

▼ DR2F Warm

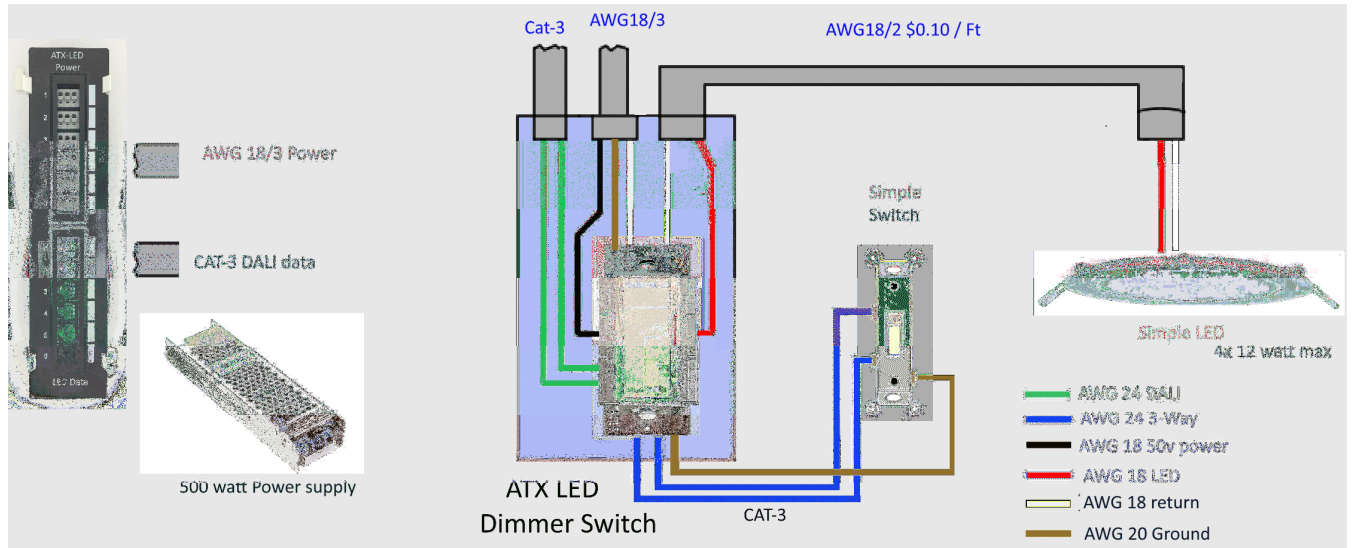
Edit name: DR2F Warm  
When? Sunset  
Offset: 60 minutes before  
On weekdays: M Tu W Th F Sa Su  
Actions:   
Set light color temperature to 4994K

► DR2F cool   
90 minutes after sunrise: set color of all lights to 4994K

► New Entry   
At sunrise: set all lights to level 0



# DALI bus products from ATX LED Consultants



## Low Voltage house lighting product line

