



## AL-DALI-HAT-I

Raspberry Pi to DALI  
Co-Processor

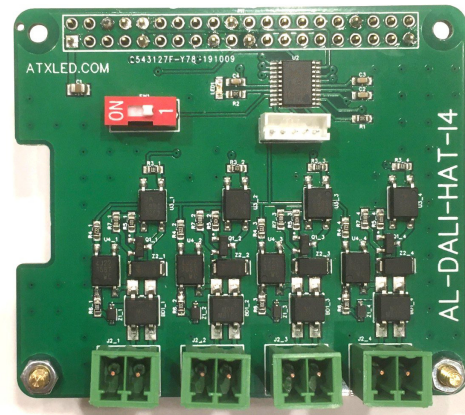
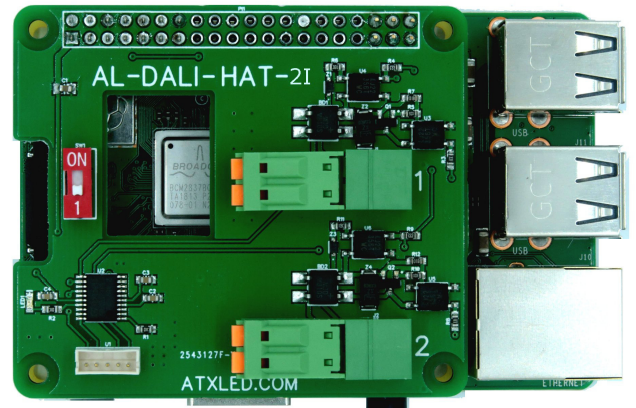
with either:

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

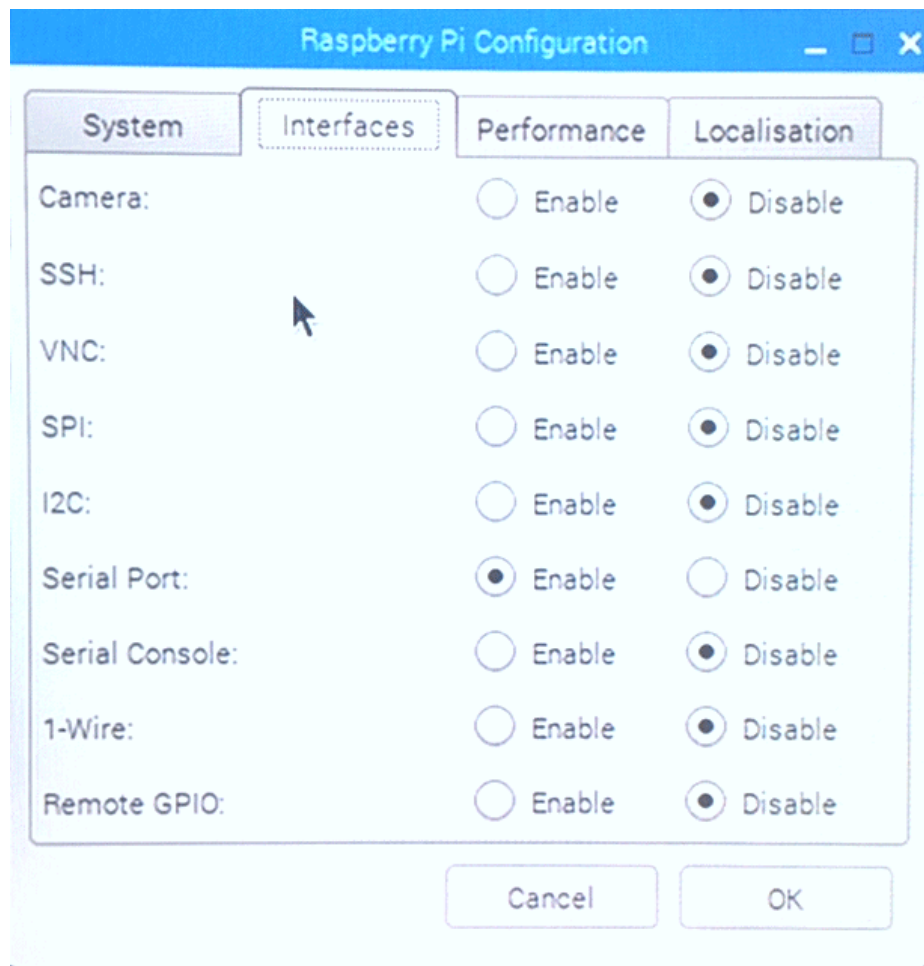
## Power for the AL-DALI-HAT-I

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.

## 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	Send to HAT	Response
All lights on full	hFEFE	None
All lights off	hFE00	None
Initialize	tA500	None
Query status of #4	h0990	6 ( all ok )
Set #5 to 200	H0AC8	None
Query level of #16	H21A0	0 to 254

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) 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

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				

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 0 = No DALI Bus power 1 = DALI bus short to plus 2 = OK	# of channels (1, 2 or 4)

## 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 ) 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) xx is a command from 0 thru 255
Broadcast		A1xx thru BFxx – commands 256 thru 271 xx is the data to the device
Broadcast		C1xx thru DFxx – commands 272 thru 287 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)

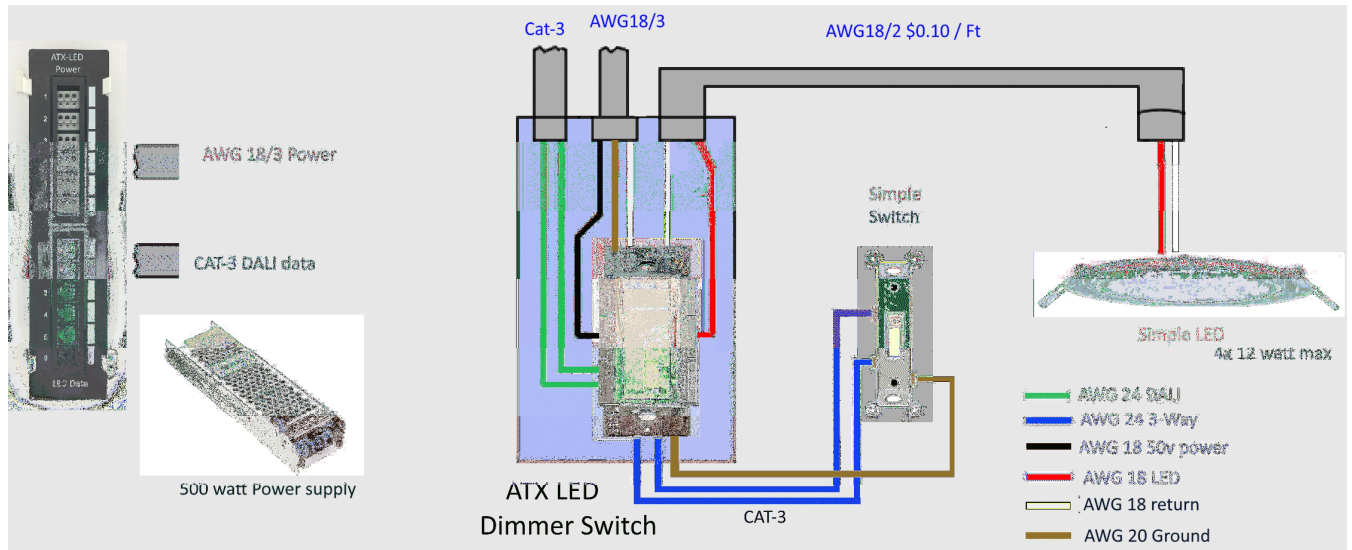
So Hex 0A is address five direct control and 0B is address five complex commands. The commands listed in the AL-WS-DR2, AL-WS-010v, and PWS-POE-DALI are listed in decimal – please convert to hex.

# 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.

The image displays three screenshots of the ATX LED ZWD application interface. The leftmost screenshot shows the 'Status' page for a DALI device, including details like ZPDS version, channels, and site name, along with a provisioning section for rescanning and assigning addresses. The middle screenshot shows the 'Query DALI Power Status' page, featuring a grid of DALI addresses (0-63) and controls for channel, address type, and manual level. The rightmost screenshot shows the 'Schedule' page, which allows for creating and editing scene entries with specific triggers and actions like setting light color temperature.

# DALI bus products from ATX LED Consultants



## Low Voltage house lighting product line

