MICROCHIP

AN2539

DALI 2.0 Slave Stack for tinyAVR® 1-Series Microcontrollers

Features

- IEC 62386-102 Compliant
- DALI 2 Slave Extended Commands
- DALI 2 Slave Stack Implemented on Microchip tinyAVR® 1-Series Microcontrollers

Introduction

Digital Addressable Lighting Interface (DALI) is applied in lighting control systems. The DALI stack follows the DALI standard edition 2.0 of IEC 62386-102 released in 2014. The LED module is demonstrated as the device type defined in standard IEC62386-207.

This application note introduces the DALI stack for the Microchip tinyAVR 1-series microcontroller, including:

- Software Structure
- Stack Functionalities
- Stack API Routines
- Demo System Setup

Table of Contents

1. Relevant Devices

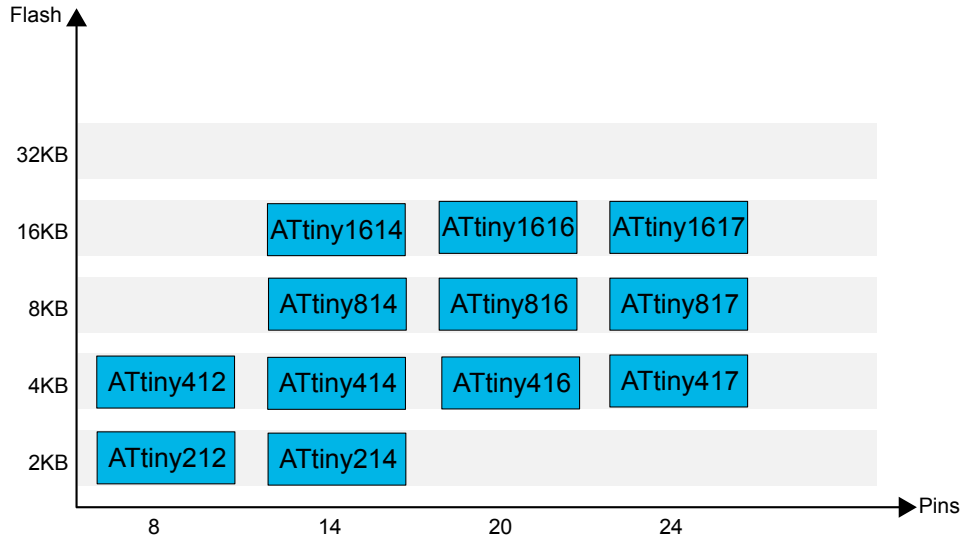
This chapter lists the relevant devices for this document.

1.1 tinyAVR 1-Series

The figure below shows the tinyAVR 1-series devices, illustrating pin count variants and memory sizes:

- Vertical migration can be done upwards without code modification, since these devices are pin compatible and provide the same or even more features. Downward migration may require code modification due to fewer available instances of some peripherals.
- Horizontal migration to the left reduces the pin count, therefore, the available features.

Figure 1-1. tinyAVR® 1-Series Device Overview



Devices with different Flash memory size typically also have different SRAM and EEPROM.

2. Recommended Reading

There are several released Microchip DALI solution documents. It is recommended to read these to get an overall idea about the DALI system.

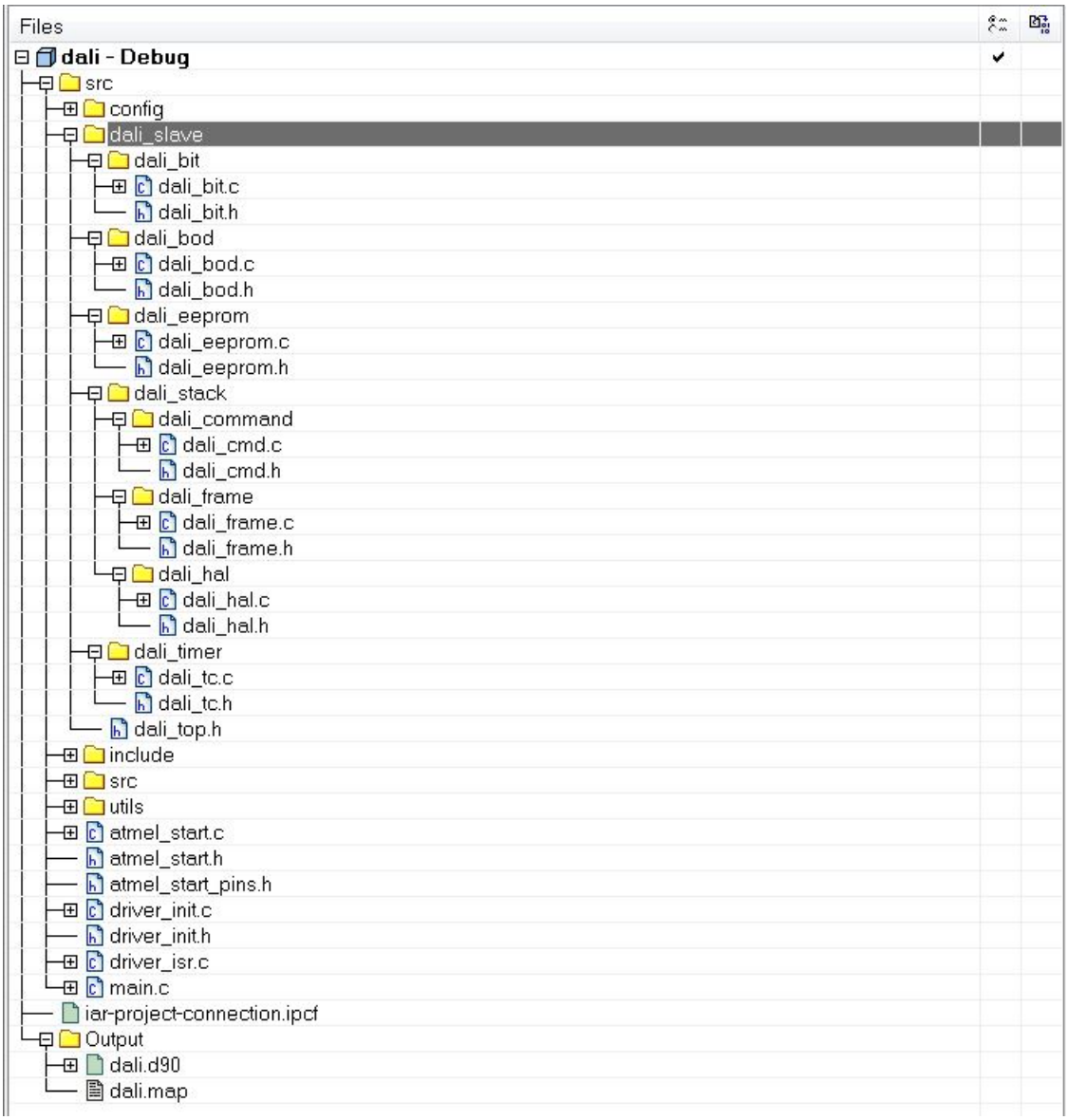
- AT03922: DALI Slave with XMEGA® E - Software User Guide (42177) - This document describes the DALI slave based on ATxmega32E5. It demonstrates the software architecture and its application programming interface (API).
- AT04022: DALI Slave with XMEGA E Hardware User Guide (42174) – This document introduces DALI slave hardware design including DALI interface, LED driver based on the ATxmega32E5 device.
- AT06409: DALI Master with ATxmega32E5 User Guide (42224) – This document demonstrates DALI master reference design based on ATxmega32E5, with the DALI bus power supply integrated. It shows the setup process of a DALI system, which is operated via PC software.
- AT01244: DALI Slave Reference Design (42071) – This document describes the DALI slave implementation based on a ATmega88PA device.
- AT10828: DALI Slave Stack for SAM D20/D21 (42386) – This document shows the DALI slave reference design for SAM D20/21 devices.

The above documents include hardware and software packages which can be downloaded from www.microchip.com. They provide hardware design files, software source code, and PC tools.

3. Software Structure

Opened with IAR Embedded Workbench®, the DALI2.0 SLAVE STACK example project tree view should look like the screen-shot in the figure below. Refer to Get Source Code from Atmel | START for more details.

Figure 3-1. DALI 2.0 Slave Project Tree



Due to the code size limitation of the MCU, an Atmel Studio package is not created.

The content of the folders are:

- dali_slave:
  Provides the DALI application and stack files.
  - dali_bit, dali_bod, dali_eeprom and dali_timer
    These folders contain the application files for the DALI stack.
    – dali_bit

DALI bits are decoded and encoded here. EXTINT (External Interrupt) peripheral is used for decoding.

  - dali_bod
    When power-down is detected, DALI slave will shut down PWM and LED to save power before Reset. The BOD interrupt deals with this detection.
  - dali_eeprom
    When the update flag rises for persistent memory, the EEPROM will update its corresponding contents. A backup page is utilized to avoid incomplete data copy during the system power-down. When the system powers on, the variables will be loaded from EEPROM to SRAM.
  - dali_timer
    System timers are provided here. They are used for DALI bit, frame, and fade timing, PWM and random address seeds.

- dali_stack
  The DALI stack is located in this folder.
  - dali_frame
    Provides the DALI frame process files.
  - dali_cmd
    Provides the DALI command implementation files.
  - dali_hal
    Hardware abstraction layer, including a complete set of APIs for using hardware resources by DALI stack that is convenient for rapid design-in and smooth integration with varied peripherals.

4. Stack Functions

For the DALI stack, the process and the flowchart are the same as in the AT03922: DALI Slave with XMEGA E - Software User's Guide (42177). Refer to chapters "*Service*" and "*Service Layer API Introduction*" in the AT03922 document for details.

5. Stack API

The input and output of the stack act through functions defined in dali_hal.h.

- `dali_hal_enable_forward_disable_backward( )`

  This function is used after the DALI slave has finished sending a backward frame. This will re-enable the DALI external input detection and disable the DALI detection timer. The detection timer will be enabled when the DALI Start bit is detected.

- `dali_hal_disable_forward_enable_backward( )`

  This function is used before the DALI slave starts to send a backward frame. This will disable DALI input detection and enable the slave sending timer. It is necessary to disable the input detection because the backward frame signal can route back to the DALI input.

- `dali_hal_get_dali_input_level( )`

  This function detects the DALI interface input voltage level used to check the interface failure state.

- `dali_hal_update_pwm_output( )`

  This function is used to update the PWM output for LED light dimming.

- `dali_hal_get_seed0_value( ), dali_hal_get_seed1_value( )`

  These two functions generate random address seeds for auto-address allocation. Two different clock sources are used to get a 32-bit random value.

- `dali_hal_save_persistent_variables( )`

  This function is called when the “SAVE PERSISTENT VARIABLES” command is executed. It should update variables in the EEPROM immediately.

- `dali_hal_identify_device ( )`

  This function executes the identification by flashing, sound, or other visual or audible means after receiving the “IDENTIFY DEVICE” command.

When the stack variables need executing outside, the below functions offer channels for outside functions to get or set them. These functions are listed in file dali_top.h.

```
/**
 *  \brief Set the DALI bytes (address and data) to stack after DALI frame decoding.
 */
void dali_set_addr_to_stack(uint8_t address);
void dali_set_data_to_stack(uint8_t data);

/**
 *  \brief Set the DALI bytes received flag to stack after decoding.
 */
void dali_set_received_flag_to_stack(bool flag);

/**
 *  \brief Set current DALI byte sent status to stack when encoding.
 */
void dali_set_sent_status_to_stack(uint8_t status);

/**
 *  \brief Get the DALI byte sent status from stack to start encoding.
 */
uint8_t dali_get_sent_status_from_stack(void);

/**
 *  \brief Get the DALI sent byte from stack when encoding.
```

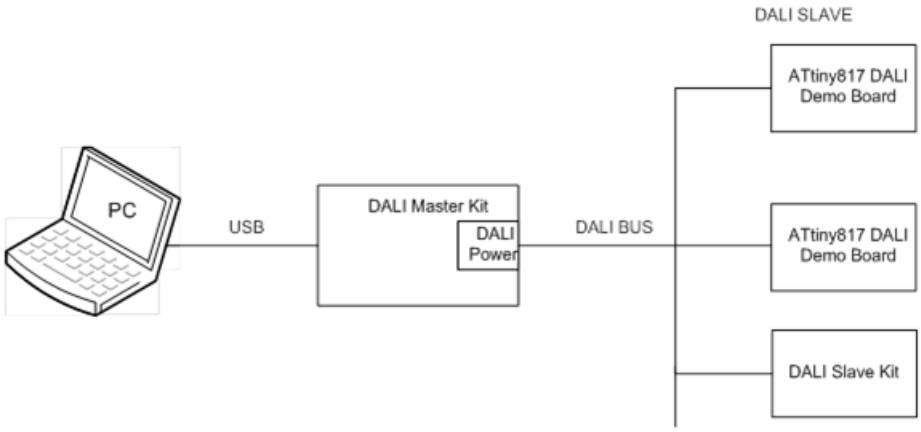
```
 */
uint8_t dali_get_sent_data_from_stack(void);

/**
 *  \brief Get the EEPROM update flag address from stack.
 */
uint8_t *dali_get_update_flag_addr_from_stack(void);

/**
 *  \brief Get the data address and size from stack for EEPROM write.
 */
uint8_t *dali_get_data_addr_from_stack(void);
uint8_t dali_get_data_size_from_stack(void);


/**
 *  \brief Set the control gear failure status to stack.
 */
void dali_set_gear_failure_status_to_stack(bool failure_status);

/**
 *  \brief Set the lamp failure status to stack.
 */
void dali_set_lamp_failure_status_to_stack(bool failure_status);
```

The above two functions should be implemented in the application layer according to the dedicated detection methods by the designer.

6. Demo System Setup

A typical DALI system contains DALI master, DALI slave, and DALI power. To set up this DALI demo system on an ATtiny817 DALI demo board, see the diagram below.

Figure 6-1. DALI Demo System



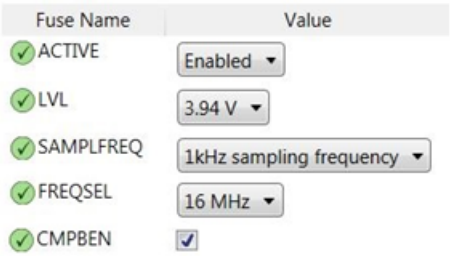
6.1 DALI Master Integrating DALI Power

Refer to the DALI master document AT06409: DALI Master with ATxmega32E5 User Guide (42224) for details. The PC software communicates with the DALI master to operate a DALI slave.

6.2 DALI Slave

The following figure shows the MCU fuse settings. BOD is enabled with threshold level 3.94V. A 16MHz internal oscillator is selected as the MCU main clock source. The Compare B output is enabled for LED dimming. The PA5 multiplexing TCDOUTB function connects with the on-board LED as lighting demo in this application.

Figure 6-2. Fuse Settings



Pins PB3 and PB4 are used for DALI decoding/encoding in file dali_bit.c. EEPROM data memory in the ATtiny817 device is required to store DALI parameters. There are a total four pages in ATtiny817, the lower three pages store parameters and the last one acts as backup.

7. DALI Slave Edition 2 Extended and Removed Commands

The following tables show extended and removed commands compared with edition 1.

Table 7-1. DALI Slave Edition 2 Extended Commands

Command name	Opcode byte/Address byte
GO TO LAST ACTIVE LEVEL	0x0A
SAVE PERSISTENT VARIABLES	0x22
SET OPERATIONG MODE(DTR0)	0x23
RESET MEMORY BANK(DTR0)	0x24
IDENTIFY DEVICE	0x25
SET EXTENDED FADE TIME(DTR0)	0x30
QUERY OPERATION MODE	0x9D
QUERY LIGNT SOURCE TYPE	0x9F
QUERY MANUFACTURER SPECIFIC MODE	0xA6
QUERY NEXT DEVICE TYPE	0xA7
QUERY EXTENDED FADE TIME	0xA8
QUERY CONTROL GEAR FAILURE	0xAA
PING	0xAD
WRITE MEMORY LOCATION - NO REPLY	0xC9

Table 7-2. DALI Slave Edition 2 Removed Command

Command name	Address byte
PHYSICAL SELECTION	0xBD

8. Get Source Code from Atmel | START

The example code is available through Atmel | START, which is a web-based tool that enables configuration of application code through a Graphical User Interface (GUI). The code can be downloaded for both Atmel Studio 7.0 and IAR Embedded Workbench® via the direct example code-link(s) below, or the *BROWSE EXAMPLES* button on the Atmel | START front page.

Atmel | START web page: http://start.atmel.com/

Example Code

AVR42793 DALI2.0 SLAVE STACK (IAR Embedded Workbench ONLY)

- http://start.atmel.com/#example/Atmel%3Aavr42793_dali2_slave%3A0.0.1%3A%3AApplication%3AAVR42793_DALI2_Slave_Stack%3A

Press *User guide* in Atmel | START for details and information about example projects. The *User guide* button can be found in the example browser, and by clicking the project name in the dashboard view within the Atmel | START project configurator.

Atmel Studio

Download the code as an .atzip file for Atmel Studio from the example browser in Atmel | START, by clicking *DOWNLOAD SELECTED EXAMPLE*. To download the file from within Atmel | START, click *EXPORT PROJECT* followed by *DOWNLOAD PACK*.

Double-click the downloaded .atzip file and the project will be imported to Atmel Studio 7.0.

IAR Embedded Workbench

For information on how to import the project in IAR Embedded Workbench, open the Atmel | START User guide, select *Using Atmel Start Output in External Tools*, and *IAR Embedded Workbench*. A link to the Atmel | START user guide can be found by clicking *About* from the Atmel | START front page or *Help And Support* within the project configurator, both located in the upper right corner of the page.

9. Revision History

Doc Rev.	Date	Comments
A	10/2017	• Converted to Microchip format. Replaced Atmel document number 42793 Rev. A with Microchip DS00002539 Rev. A. • Added "Relevant Devices" and "Get source code from Atmel START" from [COMMON] • Changed tiny817 references to tinyAVR 1-series where relevant • Added publication variables resource with direct example code links in Atmel|START
42793A	10/2016	Initial document release

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