

XC800 Family

AP08114

DALI Control Device using XC836

Application Note

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Previous Version(s):

Page	Subjects (major changes since last revision)
–	This is the first release ...

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1 Overview

Digital Addressable Lighting Interface (DALI) is a communication protocol for lighting control in buildings. The interface was first described in Annex E, IEC60929 standard for fluorescent lamp ballast. Subsequently, it was updated to the new standard IEC-62386, to include other lighting devices, such as LED, HID, and so on. The complete standard for control interface of electronic control gears was published in June 2009. The standard for lighting control devices is scheduled to be published in 2012.

DALI requires only a pair of wires to form the bus for communication to all devices on a single DALI network. Each piece of operating equipment with a DALI interface can be communicated with, over DALI, individually. Using a bi-directional data exchange, a DALI controller can query and set the status of each connected lighting device. As a standalone system, DALI can be operated with a maximum of 64 devices. Alternatively, DALI can be used as a subsystem via DALI gateways for connection to building management systems.

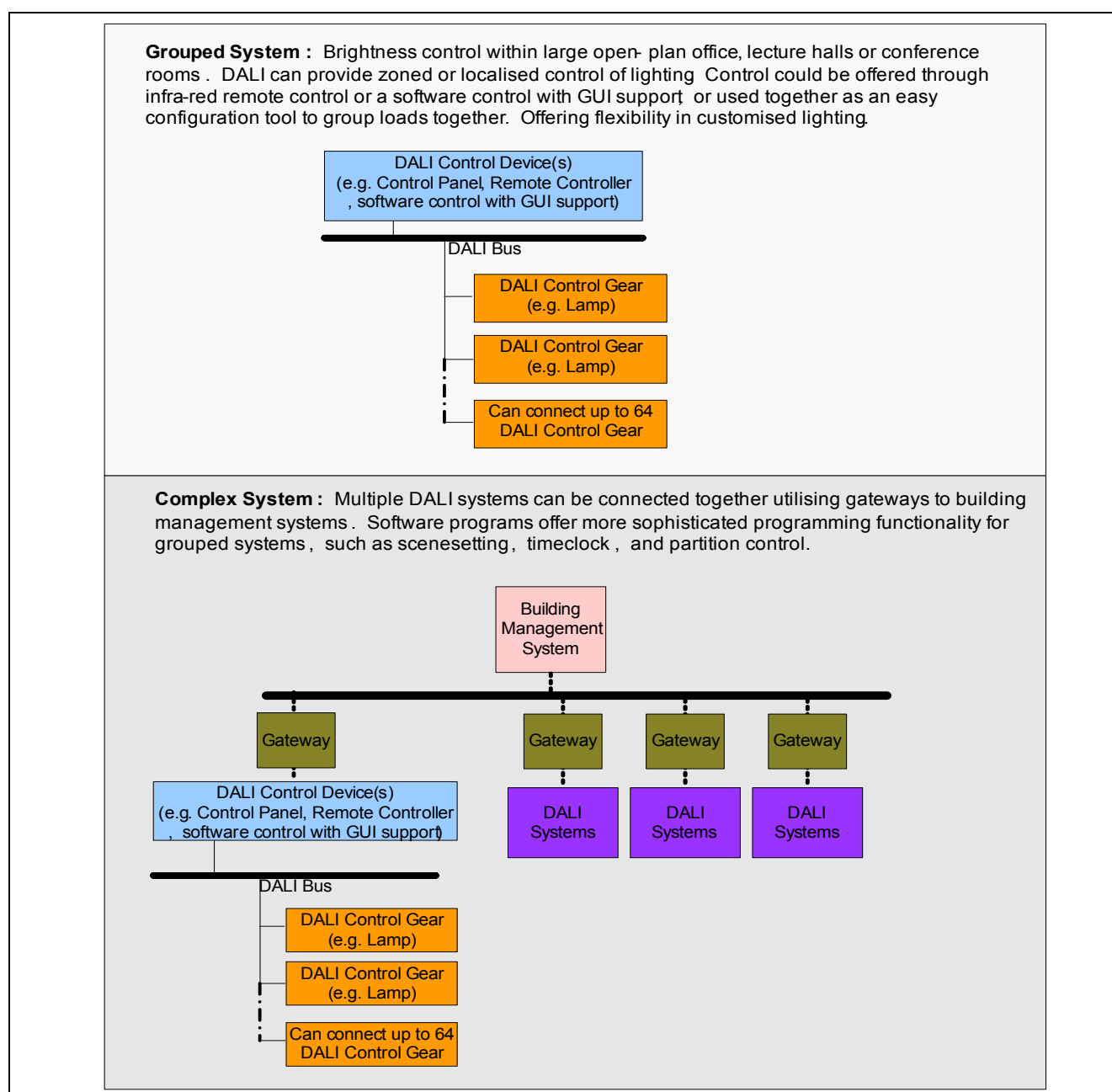


Figure 1 DALI system types

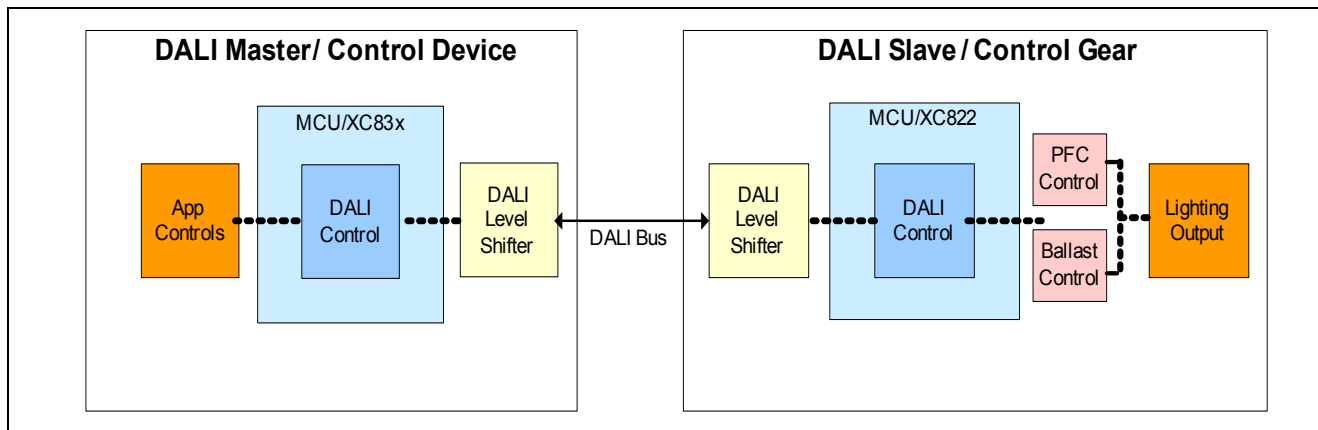


Figure 2 Block Diagram for DALI Control Device and Control Gear

An example solution for a DALI control device¹⁾ has been created using the Infineon XC836 Easy Kit. This solution makes use of the available touch pads and 7 segment display on the XC836 Easy Kit to send user commands and display the responses received from the connected DALI control gear. The solution also allows the user to send DALI commands automatically after a defined time period.

This document describes how the DALI control device software has been constructed and demonstrates the supported software functions.

The following items are required for use with this application note:

- 1 set of XC822 Easy Kit including DALI Control Gear Software Stack (AP08102), and,
- 1 set of XC836 Easy Kit.

1) IEC-62386 Part 300 for Control Devices is scheduled to be published in 2012. This application example is targeted at providing a method for the user to send out DALI commands frames.

2 Hardware Setup

This section describes the hardware setup required for this example application. The control device, which makes use of the XC836 Easy kit, has 12 built-in touch pads used for user command entries, and 4x 7-segment displays that are used to detail the commands and responses.

Details on the DALI control gear software and setup can be found in AP08102 DALI Control Gear Software Stack.

Figure 3, **Figure 4** and **Figure 5** show respectively the hardware overview, the physical connections between the control device and control gear, and the board modification required.

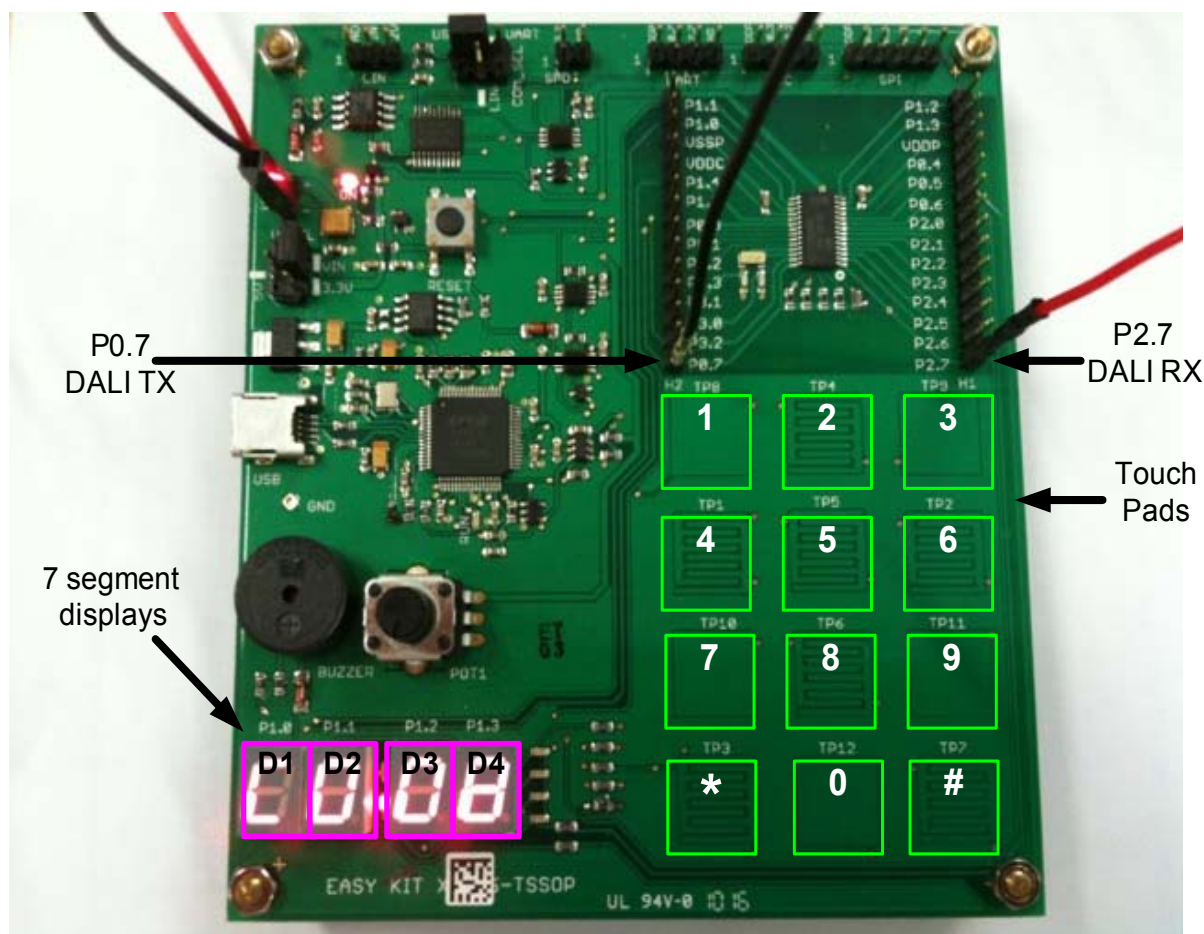


Figure 3 Control Device functions overview

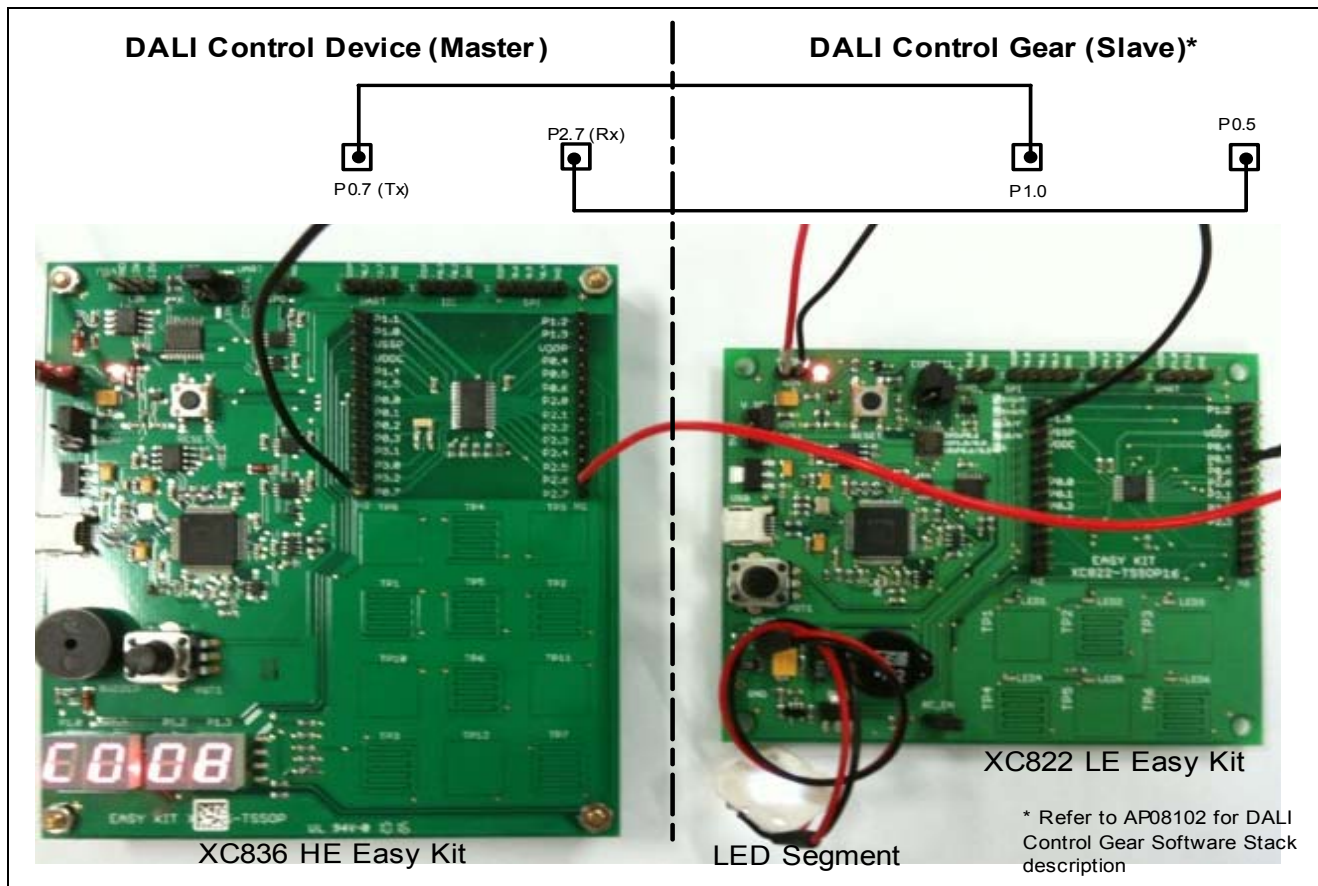


Figure 4 DALI Control Device connection to a DALI Control Gear

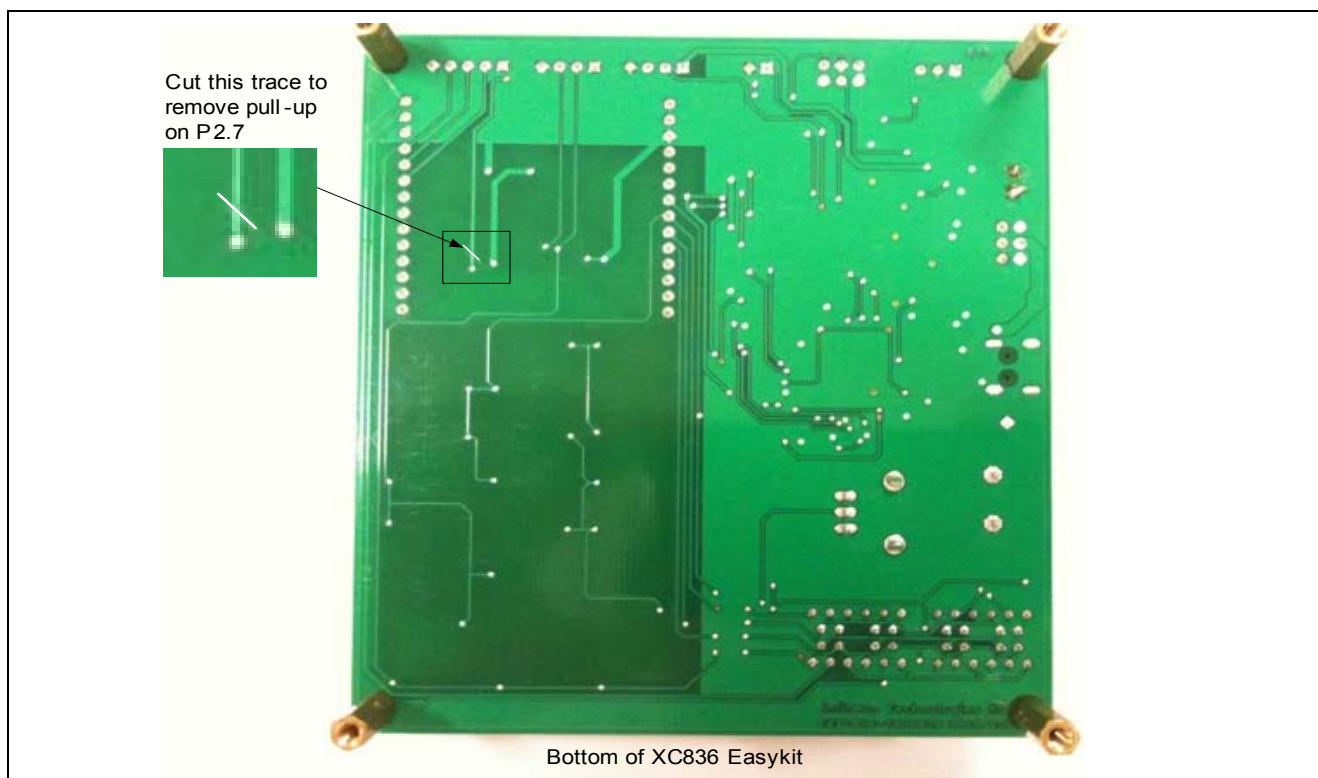


Figure 5 XC836 Easy Kit Modification: Remove connection by cutting trace

3 DALI Control Device Software

This section describes the program operational flow and the software structure used for developing this example solution. In terms of usage, the software is partitioned into 2 distinct operation phases; Phase 1: Command Entry and Phase 2: Command Execution. This operation is presented in **Figure 6**.

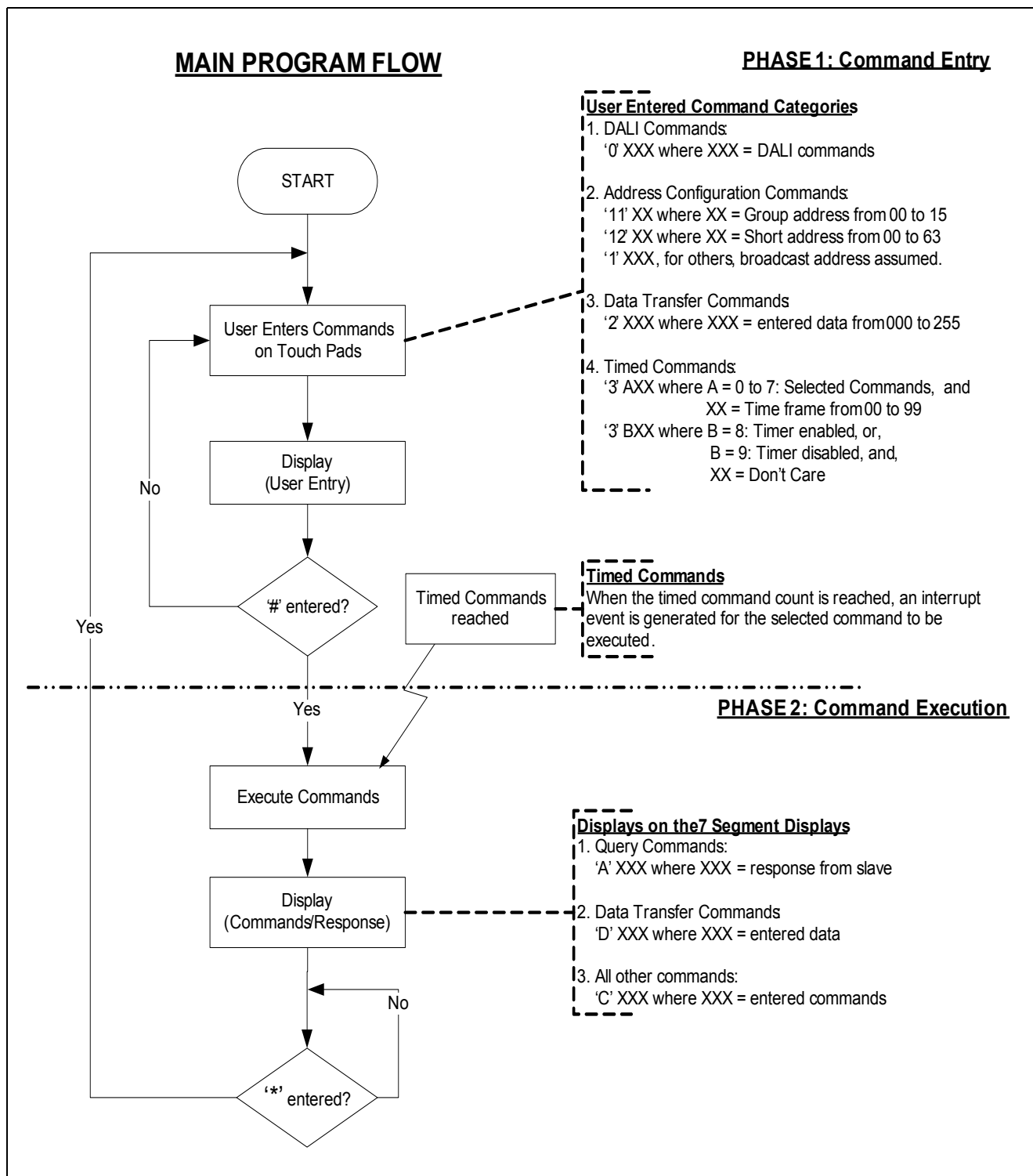


Figure 6 Main Program Flow

For code implementation, we have divided the software into two main layers:

- **DALI protocol layer**
 - Supports the translation of user commands into the desired DALI format to be sent through the DALI bus.
- **Application code layer**
 - Provides the user commands through the touch pads and 7-segment displays on the XC836 Easy Kit board.

The following XC83x device modules are required for the implementation:

- Real-Time Clock (RTC)
- Timer 0
- Timer 2
- LED and Touch Sense Control Unit (LEDTSCU)
- LEDTS ROM library.

Note: The configuration settings are done via Infineon's Technologies' free tool DAVE, which will generate the skeleton code based on the configurations set. The screen shots that follow are taken from DAVE.

3.1 DALI Protocol Layer

In the control device, the DALI protocol layer provides the translation of user commands into the desired DALI format to be sent and received through the DALI bus. For our example, the DALI bus chosen is P2.7 (Rxd) and P0.7 (Txd).

3.1.1 Timer 0

Timer 0 module is used to send DALI command frames. Mode 1: 16 bit timer is selected for this purpose (see [Figure 7](#)).

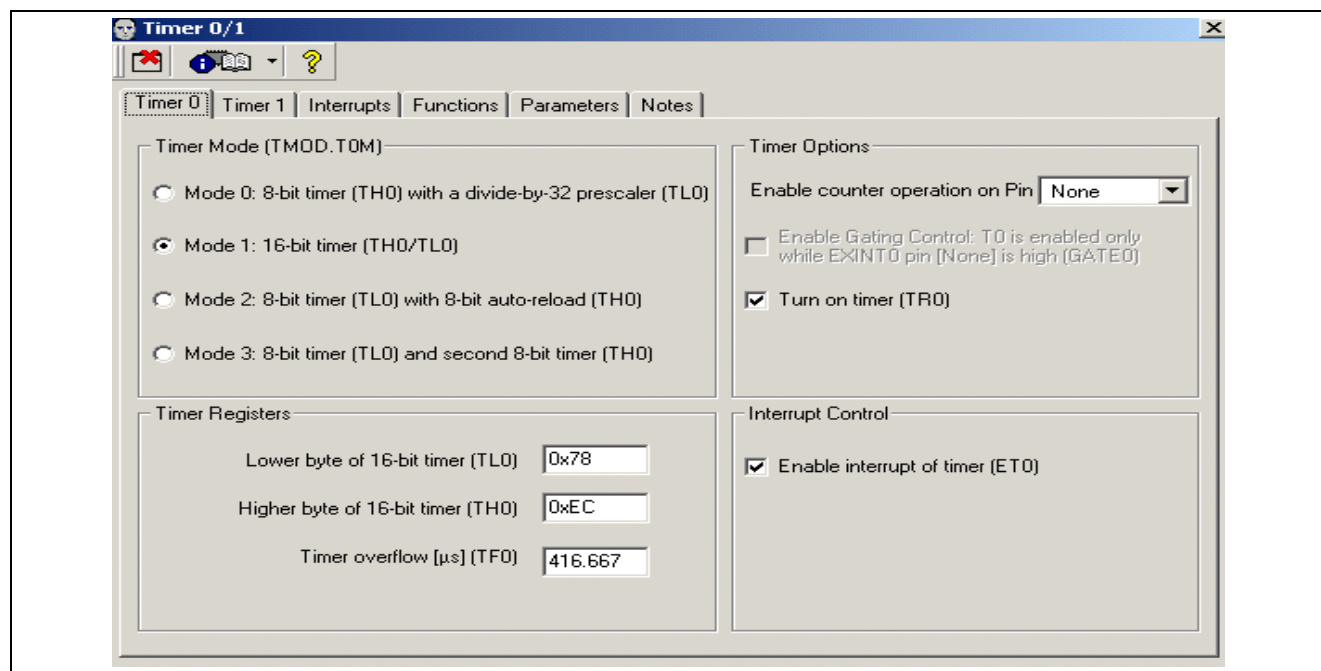


Figure 7 Timer 0 DAVE Configurations

3.1.2 Timer 2

Timer 2 module is selected for reception of DALI command frames. The 16 bit timer function capture mode is selected. Timer 2 is started on a falling edge on T2EX input. (See [Figure 8](#) to [Figure 9](#))

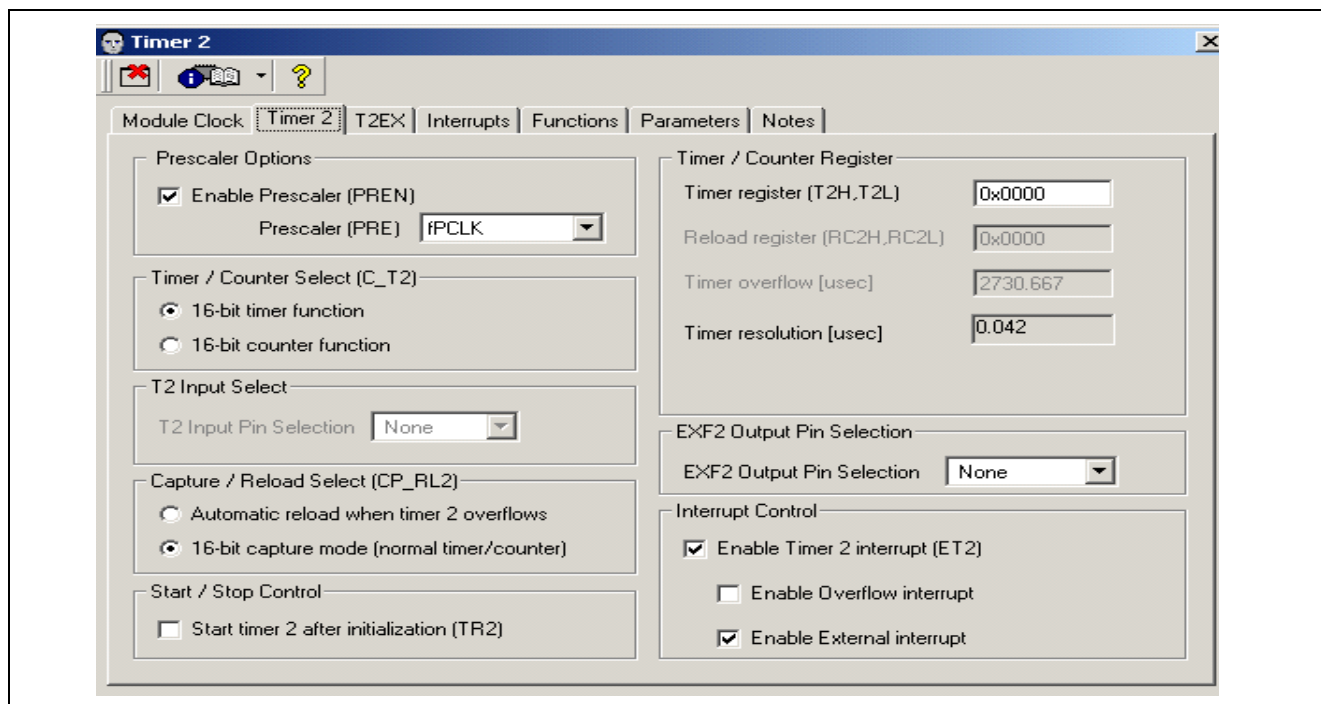


Figure 8 Timer 2 DAVE Configurations

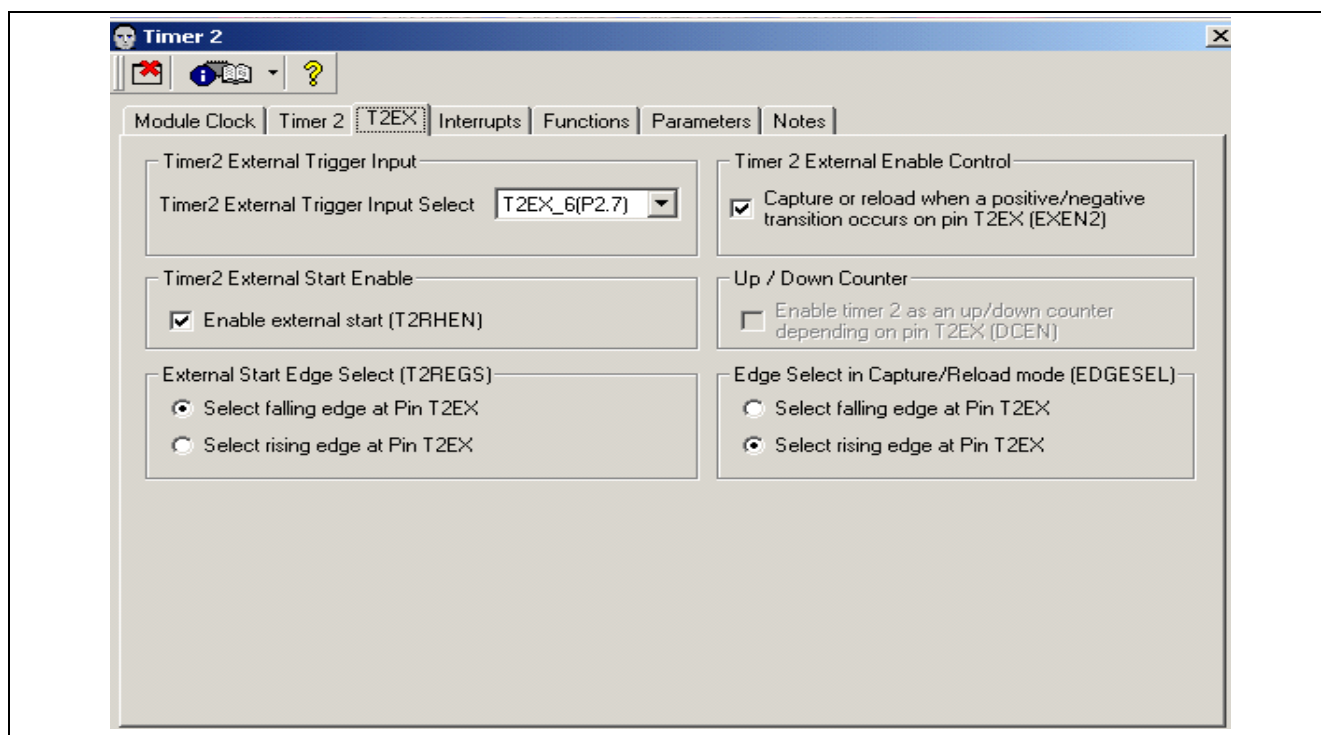


Figure 9 T2EX DAVE Configurations

3.2 Application Protocol Layer

The application layer provides the user interface control through the touch pads for user commands, displaying the returned responses on the 7-segment displays. By making use of the real-time clock, the application allows DALI commands to be sent after a user defined time period.

3.2.1 Real-Time Clock (RTC)

The RTC module is used to support sending DALI commands after a user defined time period. For this purpose, "Mode 1: Periodic wake-up mode with 75KHz oscillator clock" is selected for the RTC.

Interrupt on compare counter match (ECRTC) is enabled, where a timer match of 1's is selected. This is used as a time base for tracking the user requested period for sending the DALI commands. The user can also configure the time base towards minute, hour or day timer matches (see [Figure 10](#)).

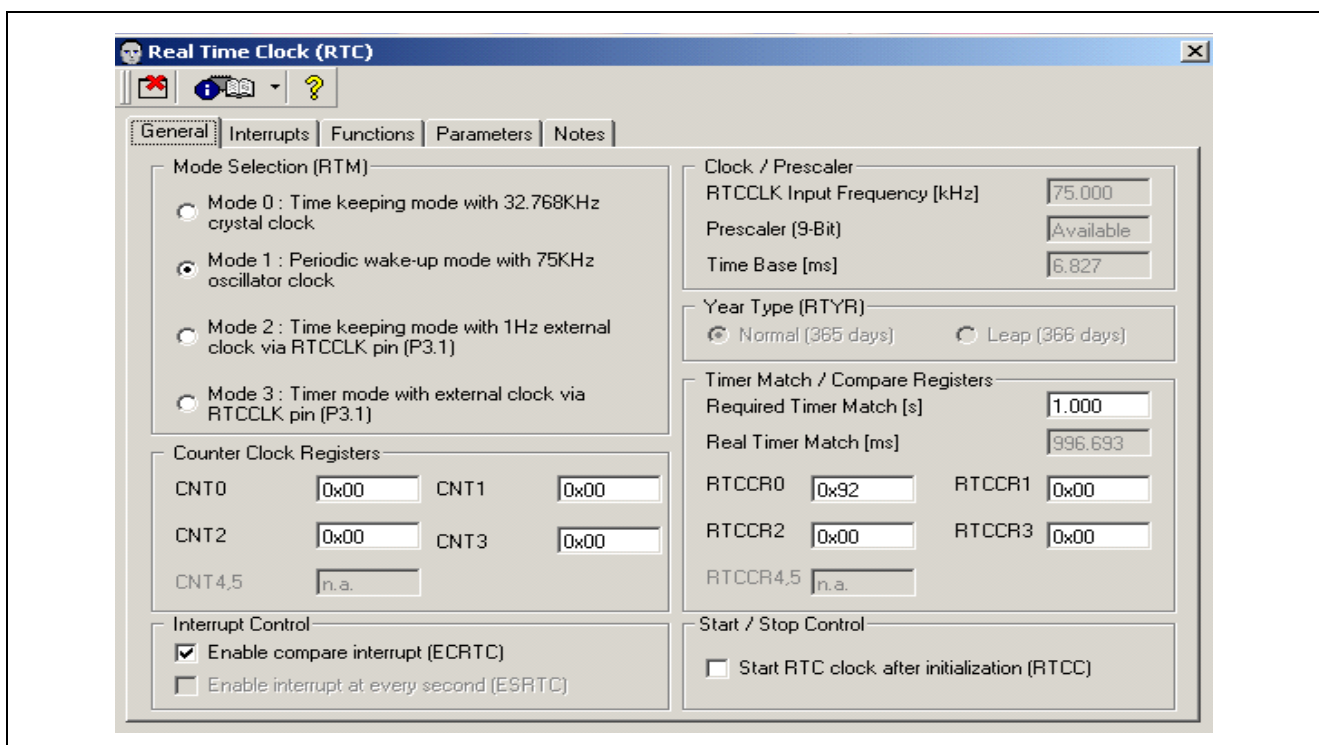


Figure 10 RTC DAVE Configurations

3.2.2 LED and Touch Sense Control Unit (LEDTSU) and LEDTS ROM Library

This module is used for the user command entry and 7-segment displays for this application.

For the LEDTSU module pin control:

- P0.0-P0.4 are selected as touch sense pins
- P0.0-P0.6 are selected for LED line pins
- P1.0-P1.4 are selected for LED column pins

The LEDTS ROM library is enabled (see [Figure 12](#)). The brightness of the LEDs can be adjusted by setting the COMPARE parameter under the LED box. For the touch sense, fixed trip point and oscillation window are selected for all 5 touch pads. Error detection is also enabled to have a long touch/press function for the application.

Note: The touch pad sensitivity may vary for different touch-sense application. Calibration may be required for different touch sense applications. Please refer to Application Note AP08100: Configuration for Capacitive Touch-Sensing Application, for further calibration and methodology details.

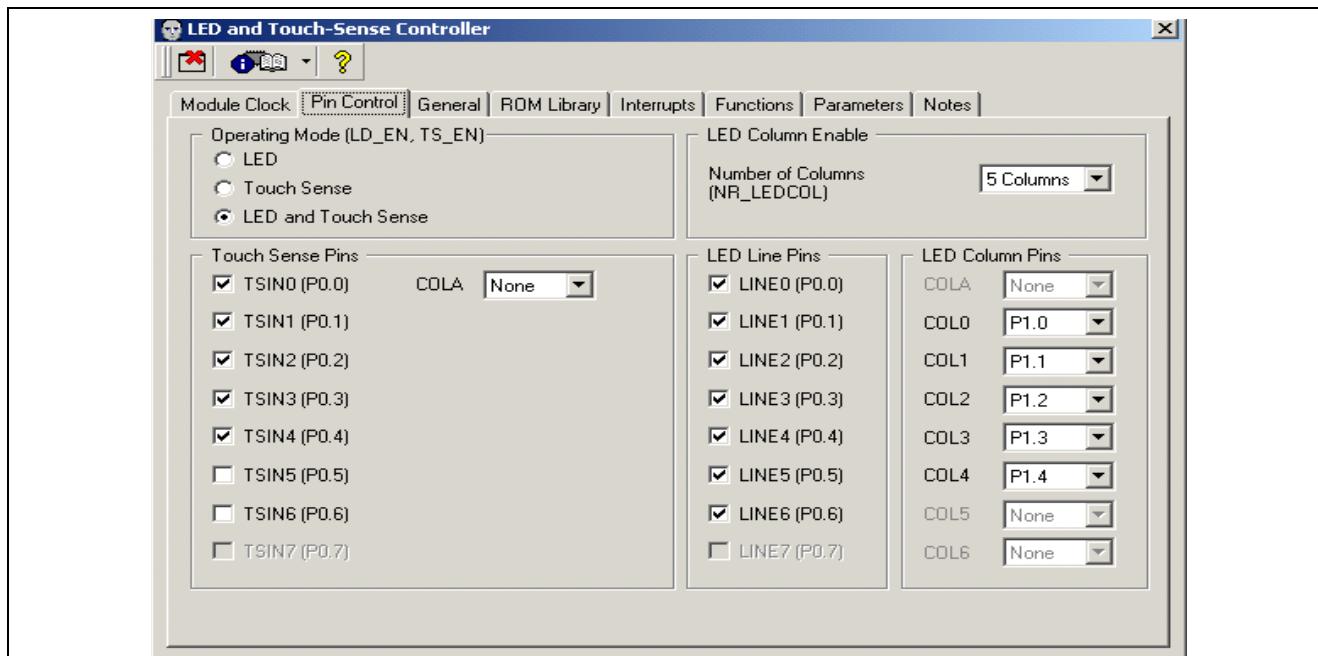


Figure 11 LEDTSCU DAVE Configurations for Pin Control

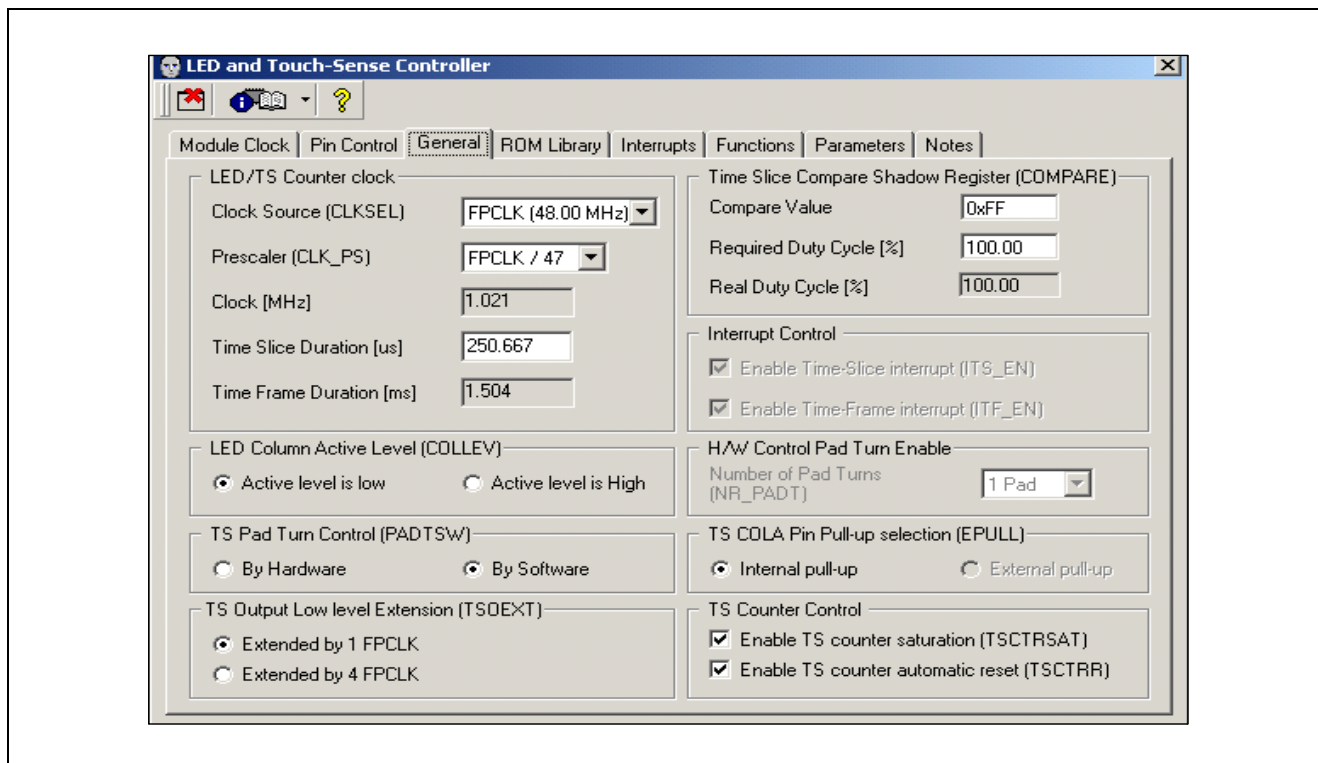


Figure 12 LEDTSCU DAVE Configurations for General Control

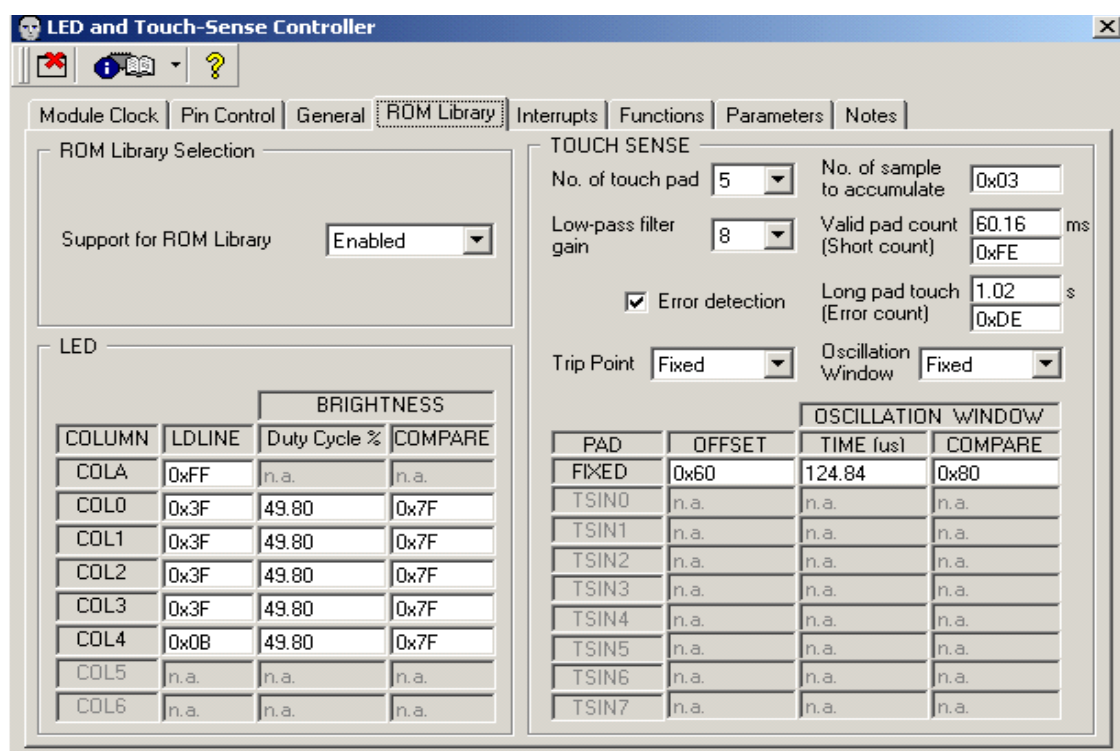


Figure 13 LEDTS ROM Library DAVE Configuration

4 Getting Started

This section provides an overview on the program flow and how the user can use this application. Information on the software package contents and customization details are also included.

4.1 Supported Commands

This section describes the commands supported and their operation with this application example.

This application example is designed for the XC836 Easy kit, which has 12 built-in touch pads used for user command entry, and 4x 7-segment displays used to display the entered commands and returned responses. **Table 1** shows the supported command category list used with this application.

Table 1 Commands Category List

Touch Pad Inputs	Category Description
0XXX	DALI Commands
1XXX	Address Configurations
2XXX	Data Transfers
3XXX	Timed Commands
4XXX to 9XXX	Not supported; reserved for future use

4.2 DALI Commands

Table 2 and **Table 3** show the supported DALI commands and recommended command sequence, together with the expected response to be observed.

Table 2 Category DALI Command

Touch Pad Inputs		
D1	D2/D3/D4	Description of DALI commands supported
0	XXX	DALI Commands are sent where XXX represents the DALI command numbers. Supported DALI commands are the following. <ul style="list-style-type: none"> Indirect Arc Power Commands: 000 to 008, 016 to 031 Configuration Commands: 032 to 033, 042 to 047, 064 to 128 Query Commands: 144 to 157, 160 to 165, 176 to 197 All other commands not supported.

Table 3 Command Sequence for DALI commands

Step	Description of Activity	Display on 7 Segment
1	User enters command through touch pad.	'0XXX', where XXX is entered DALI command
2	User enters '#' to execute command.	-
3A	If this is a Query Command, response is sent to 7 segment display.	'AXXX', where XXX is the returned response from Control Gear.
3B	Else this command does not require a response. The command will be displayed to 7 segment display.	'CXXX', where XXX is entered DALI command
4	User enters '*' to exit to command entry screen.	'_XXX', where XXX is blank.

4.3 Address Configuration Commands

This configures the address of the subsequent DALI commands. [Table 4](#) and [Table 5](#) show the supported address configuration, the recommended command sequence and the expected response to be observed.

Table 4 Category Address Configuration

Touch Pad Inputs		
D1	D2/D3/D4	Description of address configuration supported
1	1XX	Group Address where XX represents 00 to 15; otherwise broadcast address assumed.
	2XX	Short Address where XX represents 00 to 63; otherwise broadcast address assumed.
	0XX, 3XX to 9XX	Broadcast Address assumed.

Table 5 Command Sequence for Address Configuration commands

Step	Description of Activity	Display on 7 Segment
1	User enters command through touch pad.	'1XXX', where XXX represents Group/Short/Broadcast address.
2	User enters '#' to execute command.	-
3	Response is sent to 7 segment display.	'AXXX', where XXX is the address entered by user
4	User enters '*' to exit to command entry screen.	'_XXX, where XXX is blank.

4.4 Data Transfer Commands

[Table 6](#) and [Table 7](#) show the format where the data transfer is supported, the recommended command sequence and the expected response to be observed.

Table 6 Category Data Transfer

Touch Pad Inputs		
D1	D2/D3/D4	Description of data transfer supported
2	XXX	Transfer of user specified content to Data Transfer Register (DTR) where XXX represent 000 to 255. If a value greater than 255 is entered, 255 will be sent to the DTR. Configuration commands that require the use of DTR are: <ul style="list-style-type: none"> Arc power parameter settings: 042 to 47, 64 to 79 System parameter settings: 128

Table 7 Command Sequence for Data Transfer commands

Step	Description of Activity	Display on 7 Segment
1	User enters command through touch pad.	'2XXX', where XXX represents the user data entered.
2	User enters '#' to execute command.	-
3	Response is sent to 7 segment display.	'dXXX', where XXX is the data entered by user.
4	User enters '*' to exit to command entry screen.	'_XXX, where XXX is blank.

4.5 Timed Commands

Table 8 shows the format where the timed commands are supported. The user is required to select the commands to be executed after a defined time period. Up to a maximum of eight pre-defined commands are supported. Once the options are entered, the user can start the timer and the commands will be executed when the correct time is reached.

Table 9 shows the recommended command sequence and the expected response to be observed. The time-base for the timer can be configured (see [Chapter 3.2.1](#)). The default-time base is 1 second.

Table 8 Category Timed Command

Touch Pad Inputs			
D1	D2	D3/D4	Description
3	0 to 7	XX	D2: User defined commands from 0 to 7. D3/D4: time duration where XX is from 00 to 99. The current supported time-base is 1 second.
	8	XX	Enables the clock function for automated command sending. This will start the execution of timed commands selected by the user.
	9	XX	Reset the user selection and disables the clock function for automated command sending.

Table 9 Command Sequence for Timed commands

Step	Description of Activity	Display on 7 Segment
1	User enters command through touch pad.	'3XXX', where XXX represents the user defined command and timing selected.
2	User enters '#' to execute command.	-
3	Response is sent to 7 segment display.	'CXXX', where XXX is the command and timing entered by user.
4	User enters '*' to exit to command entry screen.	'_XXX, where XXX is blank.

4.5.1 Customising Automated Commands

DALI functions are assigned to the touch pads via a user configuration file (config.h). **Table 10** shows the supported DALI commands and **Table 11** gives the customisation possibility for the timed command functions.

Table 10 Supported DALI commands

Supported Commands	Description
DALI_OFF	Turns light off
DALI_DIM_UP	Set lighting level up by 1 level
DALI_DIM_DOWN	Set lighting level down by 1 level
DALI_STEP_UP	Fades lighting level up for 200ms
DALI_STEP_DOWN	Fades lighting level down for 200ms
DALI_RECALL_MIN	Sets connected lighting device level to minimum level
DALI_RECALL_MAX	Sets connected lighting device level to maximum supported level
DALI_STEP_DOWN_OFF	Set lighting level down by 1 level. If already at minimum, turn lights off.

Table 10 Supported DALI commands

Supported Commands	Description
DALI_ON_AND_STEP_UP	Turns on connected lighting device. If already on, set the arc power level up one level.
DALI_GOTO_SCENE_XX	This is a Scene Selection commands. Choosing this enables device for user configured Scene XX, where XX represents 00 to 15.

Table 11 Customising the Timed commands

DALI Commands	Description
Customising the Timed Command list	<p>In the file: config.H, the timed command to be executed can be configured by the user at compile time. A list of supported DALI commands can be referenced from Table 10.</p> <ul style="list-style-type: none"> To support timed command: <code>#define USR_CMDX <DALI COMMAND></code> where DALI commands can be referenced from Table 10. To disable timed command: <code>#define USR_CMDX <NOTSUPPORTED></code> <p>Default command selection for file: config.H</p> <pre>#define USR_CMD0 DALI_OFF #define USR_CMD1 DALI_ON_AND_STEP_UP #define USR_CMD2 DALI_STEP_UP #define USR_CMD3 DALI_DIM_UP #define USR_CMD4 DALI_RECALL_MAX #define USR_CMD5 DALI_DIM_DOWN #define USR_CMD6 DALI_RECALL_MIN #define USR_CMD7 NOTSUPPORTED</pre>

4.6 Software Package

The file description for the software package is documented in [Table 12](#) and [Table 13](#).

Table 12 Source files description

Filename	Description
Dali_master.dav	DAvE project
Dali_master.uvproj	Uvision project
MAIN.c	Performs main program initialisation
IO.c	Performs GPIO module initialisation
RTC.c	Performs RTC module initialisation
T01.c	Performs Timer 0 module initialisation for application control functions inclusive of DALI frame transmission activities.
T2.c	Performs Timer 2 module initialisation for DALI command interpreter functions inclusive of DALI frame reception activities.
START_XC.A51	Start up code for XC8xx device. This is part of the C51 Compiler package.
LTS.c	Performs LED and Touch-Sense Controller module initialisation
BOOTROM_ADDR.A51	Library address for bootrom user routines
SHARED_INT.c	Shared interrupts; LEDTS and RTC interrupt handling sections;

Table 13 Header files description

Filename	Description
MAIN.h	SFR Header file for XC836 Microcontroller
IO.h	GPIO function prototypes and macros
RTC.h	RTC prototypes and macros
T01.h	Timer 01 function prototypes and macros
T2.h	Timer 2 function prototypes and macros
LTS.h	LED and Touch-Sense Controller function prototypes and macros
SHARED_INT.h	Shared interrupt function prototypes and macros
config.h	Definitions of DALI commands and timed command assignments

5 Connecting to a DALI network

An Infineon DALI PHY¹⁾ board can be used to support evaluation within a typical DALI network. The DALI PHY board can be used by attaching it onto either the header rows of the XC822 or XC836 Easy Kit.

Figure 14 shows the DALI PHY board and the connections required. **Figure 15** shows the connections between the DALI Control Device (using the XC836 Easy Kit) and DALI Control Gear (using XC822 Easy kit) for a DALI network.

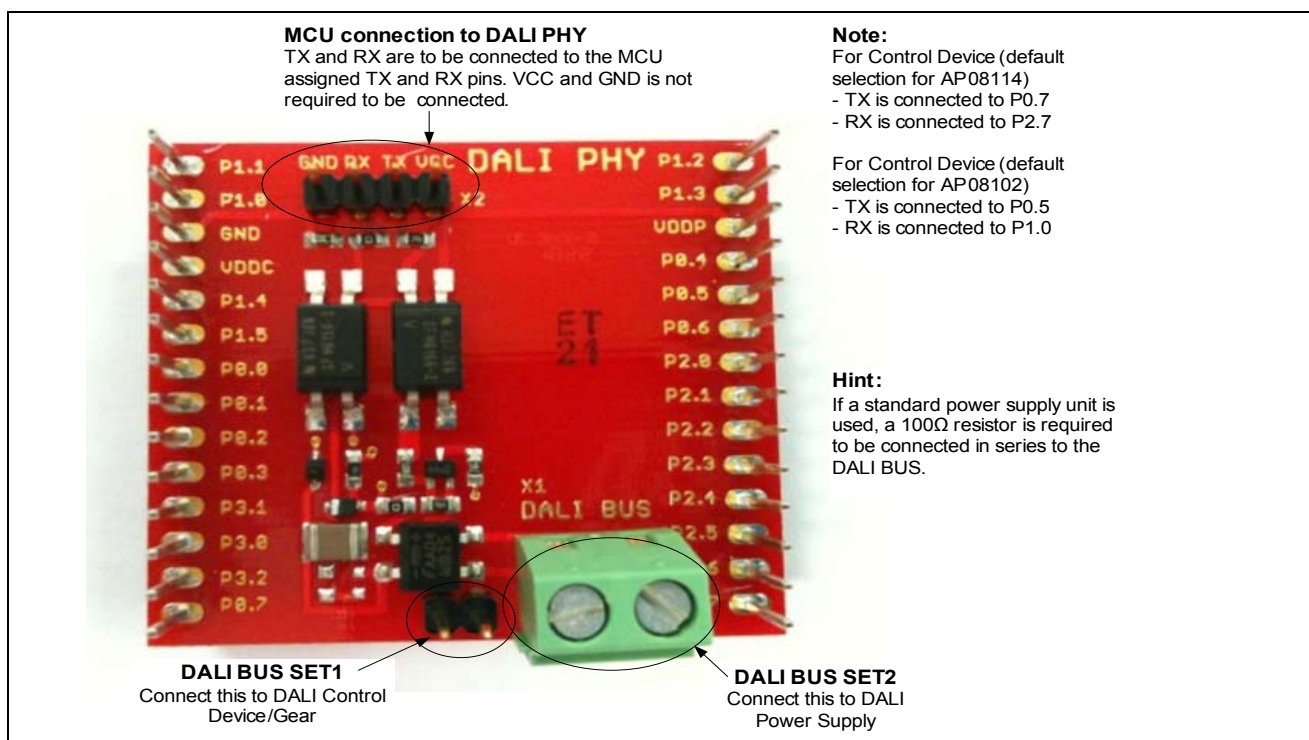


Figure 14 DALI PHY Board

1) Schematics and Bill of Materials, for the DALI PHY board can be found in *AP08104: Guide to using DALI LightNet tool, Section 4 Connecting to a DALI network.*

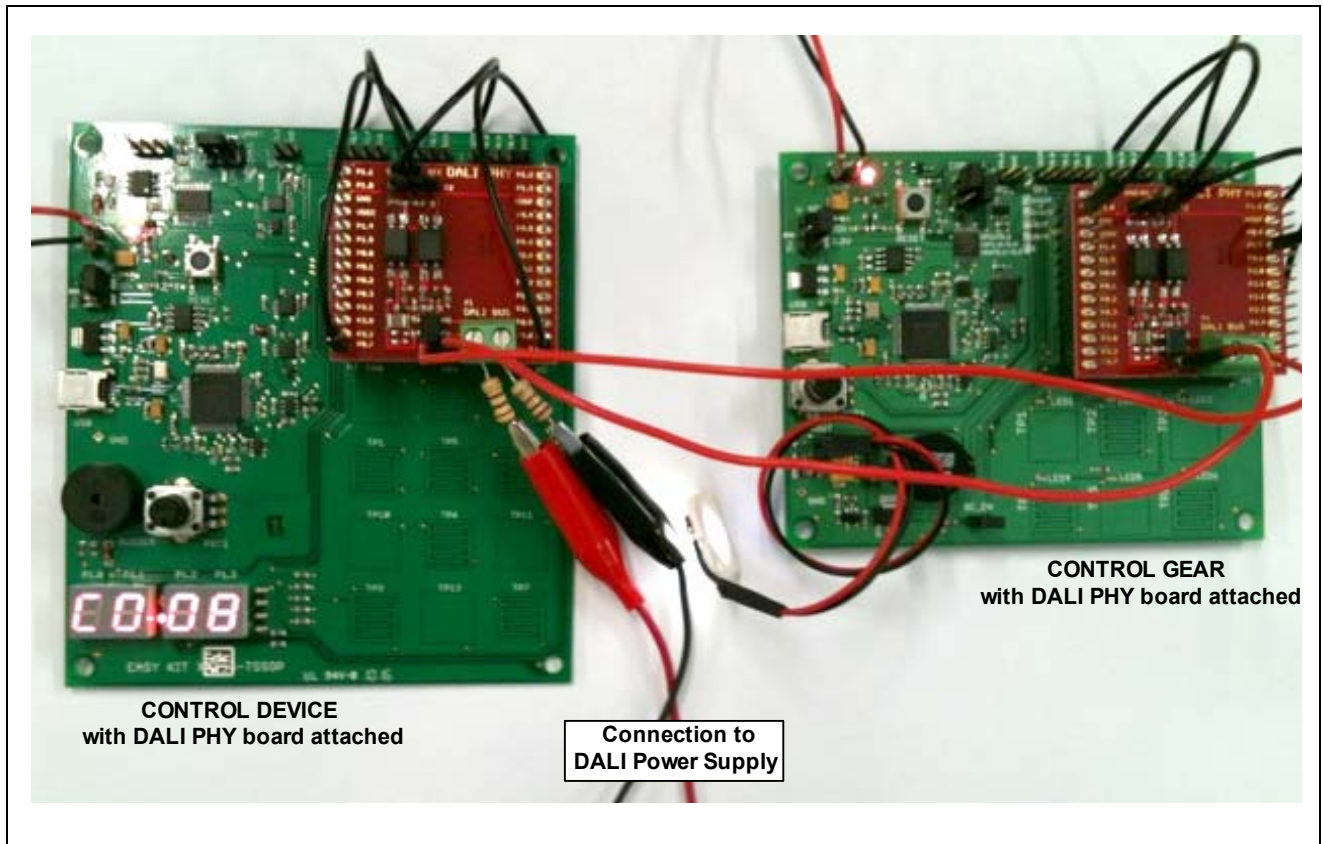


Figure 15 DALI Control Device and Control Gear with DALI PHY board connected

6 Summary

Infineon microcontrollers provides a great deal of flexibility for the creation of a wide variety of robust applications for the users. This application note demonstrates the ease of creating a DALI control device, using the touch sense module and real-time clock module in the XC836. With the given instructions, the user can customise this solution to their application with ease. Together with a DALI PHY board, this application is ready for use in any DALI network.

7 References

- [1] IEC 62386 Digital addressable lighting interface; Part 101: General requirements - System (Edition 1.0, 2009-06)
- [2] IEC 62386 Digital addressable lighting interface; Part 102: General requirements - Control gear (Edition 1.0, 2009-06)
- [3] AP08102 DALI Control Gear Software Stack
- [4] AP08100 Configuration for Capacitive Touch-Sensing Application
- [5] AP08104 Guide to using DALI LightNet tool
- [6] XC836 User Manual 1.0
- [7] Hardware Manual Easy Kit XC836-TSSOP28 board V1.0

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