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ISBN: 978-1-60932-623-4

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INTRODUCTION

This chapter contains general information that will be useful to know before using the Backlight LED Demo Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the Backlight LED Demo Board. The manual layout is as follows:

- Chapter 1. “Product Overview” – Important information about the Backlight LED Demo Board.
- Chapter 2. “Installation and Operation” – This chapter includes a detailed description of each function of the Backlight LED Demo Board and instructions for how to begin using the board.
- Appendix A. “Schematic and Layouts” – Shows the schematic and layout diagrams for the Backlight LED Demo Board.
- Appendix B. “Bill Of Materials (BOM)” – Lists the parts used to build the Backlight LED Demo Board.
CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

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<th>DOCUMENTATION CONVENTIONS</th>
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<td>Italic Courier New</td>
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<tr>
<td>Square brackets [ ]</td>
</tr>
<tr>
<td>Curly brackets and pipe character: {</td>
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</tbody>
</table>
| Ellipses... | Replaces repeated text | var_name [, var_name...]
| | Represents code supplied by user | void main (void) { ... }

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RECOMMENDED READING

This user’s guide describes how to use the Backlight LED Demo Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

MCP23S18 Data Sheet, “16-Bit I/O Expander with Open-Drain Outputs” (DS22103)

This data sheet provides detailed information regarding the MCP23S18 device.

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

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- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://support.microchip.com

DOCUMENT REVISION HISTORY

- Revision A (October 2010)
  - Initial Release of this Document.
Chapter 1. Product Overview

1.1 INTRODUCTION

The following name and assembly number are found on the Backlight LED Demo Board’s Printed Circuit Board (PCB):

• 102-00246

1.2 WHAT IS THE BACKLIGHT LED DEMO BOARD?

The Backlight LED Demo Board demonstrates how to use the MCP23S18 Open-Drain Output I/O Expander to control display backlight LEDs.

The Backlight LED Demo Board highlights:

- Demonstrates the use of I/O expanders to control a large number of LEDs
- High brightness with limited power source
- User selectable pattern
- User dim control
- User pattern rate control

1.3 WHAT THE BACKLIGHT LED DEMO BOARD KIT INCLUDES

This Backlight LED Demo Board Kit includes:

• The Backlight LED Demo Board
• USB cable
Chapter 2. Installation and Operation

2.1 INTRODUCTION

The Backlight LED Demo Board demonstrates how to use the MCP23S18 Open-drain Output I/O Expander to control display backlight LEDs. This solution uses the PIC18F14k50 PIC® microcontroller to control the LEDs using the I/O expander. There are two potentiometers and a switch which are used as user interface for dim control, LED blink pattern, and pattern rate control.

In addition, this demo board shows how to implement maximum brightness control using limited power source such as 100 mA USB source. This is achieved by alternating patterns between two sets of eight LEDs. Even at maximum brightness, only one set of LEDs is turned on, but with higher frequency where the blink rate would not be visually detected. Using this technique, the maximum brightness can be delivered with limited power source.

The Backlight LED Demo Board also shows how the MCP23S18 open drain output can be configured for LED applications. In this case, the LEDs are pulled up to 5V USB supply, while the rest of the circuit is powered with 3.3V source, using the MCP1703 linear regulator.

2.2 FEATURES

The Backlight LED Demo Board has the following features:
- Demonstrates the use of I/O expanders to control a large number of LEDs
- High brightness with limited power source
- User selectable pattern
- User dim control
2.3 GETTING STARTED

This section describes how to quickly configure the Backlight LED Demo Board. A simplified block diagram of the configuration is provided in Figure 2-1.

2.3.1 Hardware Setup

1. Connect the USB cable to PC.
2. Select the display pattern using the Push button switch.
3. Adjust the dim level and blink rate using the on-board potentiometers.
2.3.2 Firmware Flow Diagram

The firmware uses Timer0 to control all timings, therefore the main subroutine simply initializes all the configurations and remains in an infinite loop, waiting for the Push button to be pressed. Timer0 enables the user to multi-task for custom applications. When the Push button is pressed, different patterns are loaded into two bytes of internal data registers. When the Timer0 interrupt occurs, the Interrupt Service Routine (ISR) checks the dim control and the blink rate control potentiometers positions using the 10-bit Analog-to-Digital Converter (ADC) integrated microcontroller. The ADC output is scaled to determine the dim level and blink rate. Then, the Timer0 counter is set for the next interrupt and the LED patterns are loaded into the MCP23S18 I/O expander using the SPI interface. Figure 2-2 shows the firmware flow diagram.

![Firmware Flow Diagram](image)

The dim control feature uses a pulse-width modulation (PWM) technique to drive the LEDs. The LED's ON and OFF times are adjusted with respect to the total ON and OFF period. The period remains the same while the ON time is adjusted. Figure 2-3 shows the timing diagram.
FIGURE 2-3: Timing Diagram.

The blink rate is controlled by simply adding an additional counter to count down before updating the content of the data file register with a complement of the current content, which flips the bits. Turning the potentiometer position adjusts the counter position.

2.3.3 Current Budget Analysis

There are 16 LEDs in this demo board. In order to achieve the maximum desired brightness with the 100 mA USB source, consider the operating current for the entire circuit and the total number of LEDs to be turned on at the same time. In this application, the entire circuit consumes less than 5 mA typically (except for the LEDs), which leaves about 95 mA that can be used to power the LEDs. For this application, eight LEDs are selected to be turned on at the same time. Therefore, the maximum available current for each LED is approximately 12 mA. With 5V USB bus voltage, the potential across the LED biasing resistor when the LED is fully turned ON is 4.3V (with 0.7V diode drop). Therefore, the biasing resistor value is approximately 360Ω (4.3V/12 mA = 360Ω). This value provides adequate lighting for typical applications.
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the schematics and layouts for the Backlight LED Demo Board. Diagrams included in this appendix:

- Board – Schematic
- Board – Top Copper, Silk and Pads
- Board – Bottom Copper, Silk and Pads
- Board – Top Copper
- Board – Bottom Copper
A.3 BOARD – TOP COPPER, SILK AND PADS

A.4 BOARD – BOTTOM COPPER, SILK AND PADS
## Appendix B. Bill Of Materials (BOM)

### TABLE B-1: BILL OF MATERIALS

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<thead>
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<td>Lite-On Inc</td>
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<td>Murata Electronics North America</td>
<td>CSTCE12M0G15L99-R0</td>
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</table>
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