MCP1662 LED Driver Evaluation Board User's Guide

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Object of Declaration: MCP1662 LED Driver Evaluation Board

EU Declaration of Conformity

This declaration of conformity is issued by the manufacturer.
The development/evaluation tool is designed to be used for research and development in a laboratory environment. This development/evaluation tool is not a Finished Appliance, nor is it intended for incorporation into Finished Appliances that are made commercially available as single functional units to end users under EU EMC Directive 2004/108/EC and as supported by the European Commission's Guide for the EMC Directive 2004/108/EC (8th February 2010).
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Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA

Derek Carlson
Derek Carlson
VP Development Tools

16-July-2013
Date

NOTES:

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXXXXA", where "XXXXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP1662 LED Driver Evaluation 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 MCP1662 LED Driver Evaluation Board as a development tool. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP1662 LED Driver Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with this user's guide and a description of the user's guide.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP1662 LED Driver Evaluation Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the MCP1662 LED Driver Evaluation Board.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

<table>
<tr><th>Description</th><th>Represents</th><th>Examples</th></tr>
<tr><td colspan="3">Arial font:</td></tr>
<tr><td rowspan="2">Italic characters</td><td>Referenced books</td><td>MPLAB® IDE User's Guide</td></tr>
<tr><td>Emphasized text</td><td>...is the only compiler...</td></tr>
<tr><td rowspan="3">Initial caps</td><td>A window</td><td>the Output window</td></tr>
<tr><td>A dialog</td><td>the Settings dialog</td></tr>
<tr><td>A menu selection</td><td>select Enable Programmer</td></tr>
<tr><td>Quotes</td><td>A field name in a window or dialog</td><td>"Save project before build"</td></tr>
<tr><td>Underlined, italic text with right angle bracket</td><td>A menu path</td><td><u>File>Save</u></td></tr>
<tr><td rowspan="2">Bold characters</td><td>A dialog button</td><td>Click OK</td></tr>
<tr><td>A tab</td><td>Click the Power tab</td></tr>
<tr><td>N'Rnnnn</td><td>A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.</td><td>4'b0010, 2'hF1</td></tr>
<tr><td>Text in angle brackets < ></td><td>A key on the keyboard</td><td>Press <Enter>, <F1></td></tr>
<tr><td colspan="3">Courier New font:</td></tr>
<tr><td rowspan="7">Plain Courier New</td><td>Sample source code</td><td><code>#define START</code></td></tr>
<tr><td>Filenames</td><td><code>autoexec.bat</code></td></tr>
<tr><td>File paths</td><td><code>c:\mcc18\h</code></td></tr>
<tr><td>Keywords</td><td><code>_asm, _endasm, static</code></td></tr>
<tr><td>Command-line options</td><td><code>-Opa+, -Opa-</code></td></tr>
<tr><td>Bit values</td><td><code>0, 1</code></td></tr>
<tr><td>Constants</td><td><code>0xFF, 'A'</code></td></tr>
<tr><td>Italic Courier New</td><td>A variable argument</td><td><code>file.o</code>, where <code>file</code> can be any valid filename</td></tr>
<tr><td>Square brackets [ ]</td><td>Optional arguments</td><td><code>mcc18 [options] file [options]</code></td></tr>
<tr><td>Curly brackets and pipe character: { | }</td><td>Choice of mutually exclusive arguments; an OR selection</td><td><code>errorlevel {0|1}</code></td></tr>
<tr><td rowspan="2">Ellipses...</td><td>Replaces repeated text</td><td><code>var_name [, var_name...]</code></td></tr>
<tr><td>Represents code supplied by user</td><td><code>void main (void)
{ ...
}</code></td></tr>
</table>

RECOMMENDED READING

This user's guide describes how to use MCP1662 LED Driver Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **MCP1662 Data Sheet - "*High-Voltage Step-Up LED Driver with UVLO and Open Load Protection*" (DS20005316)**
- **MCP1661 Data Sheet - "*High-Voltage Integrated Switch PWM Boost Regulator with UVLO*" (DS20005315)**

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

DOCUMENT REVISION HISTORY

Revision A (June 2014)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP1662 and covers the following topics:

- MCP1662 Short Overview
- What is the MCP1662 LED Driver Evaluation Board?
- What the MCP1662 LED Driver Evaluation Board Kit Contains

1.2 MCP1662 SHORT OVERVIEW

The MCP1662 is a compact, battery operated, fixed frequency, step-up DC/DC converter optimized as an LED constant current generator. This product provides an easy-to-use power supply solution for LEDs, with a minimum number of external components for applications powered by two-cell or three cell alkaline, NiCd or NiMH batteries, one-cell Li-Ion or Li-Polymer batteries.

The MCP1662 is a boost device with PWM-only functionality that operates at a fixed 500 kHz switching frequency. The device has an operating input voltage range from 2.4V to 5.5V (with a typical undervoltage of 2.3V to start and 1.85V to stop). Compared to its counterpart, the MCP1661, the reference voltage is only 300 mV in order to minimize the losses on the sense resistor and increase the overall efficiency of the application.

The LED can be turned on and off with a variable duty cycle applied to the EN pin for applications that require current dimming (variable lighting). Compared to its counterpart, the MCP1661, which is designed to be a voltage source, the start-up time for the MCP1662 has been decreased in order to obtain higher dimming frequencies.

The MCP1662 can supply up to 100 mA of current for a string of four white LEDs (LED forward voltage of 3.2V) from a 3V or higher input voltage source. More detailed information regarding the current capabilities of the MCP1662 are available in the data sheet.

In order to obtain a compact solution, the device is available in a small 5-Lead SOT-23 and an 8-Lead 2X3 TDFN package.

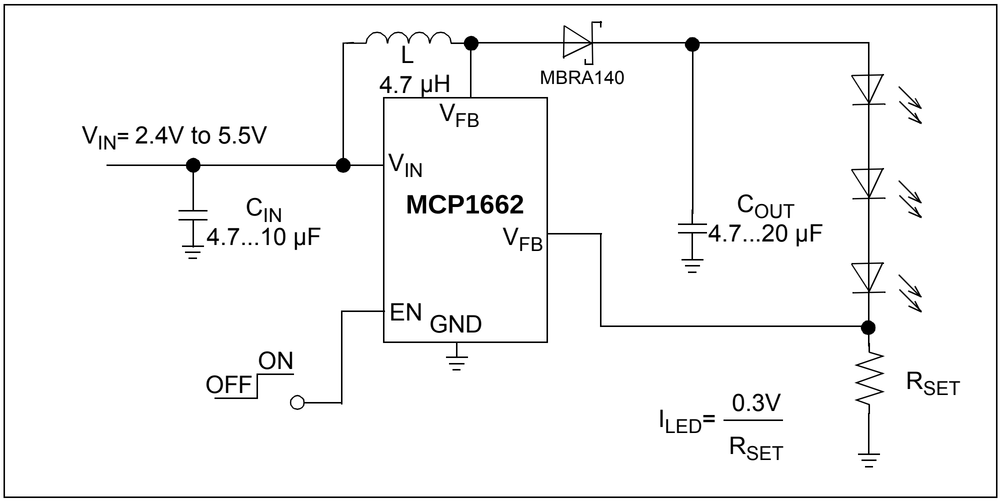


FIGURE 1-1: *Typical MCP1662 LED Driver Boost Converter Application.*

1.3 WHAT IS THE MCP1662 LED DRIVER EVALUATION BOARD?

The MCP1662 LED Driver Evaluation Board is used to evaluate and demonstrate Microchip Technology's MCP1662 product. This board demonstrates the MCP1662 in a boost-converter application supplied by two AA batteries, or from an external voltage source, which drives a string of LEDs with three selectable currents. The MCP1662 LED Driver Evaluation Board was developed to help engineers reduce the product design cycle time.

Three output currents can be selected: 30 mA, 60 mA and 90 mA. The output current can be changed with a dual switch that changes the external LED current sense equivalent resistance (R_{SET}).

An enable switch is used to enable and disable the converter. When enabled, the MCP1662 will regulate the output current; when disabled, the current consumed from the battery by the device is typically less than 20 nA.

1.4 WHAT THE MCP1662 LED DRIVER EVALUATION BOARD KIT CONTAINS

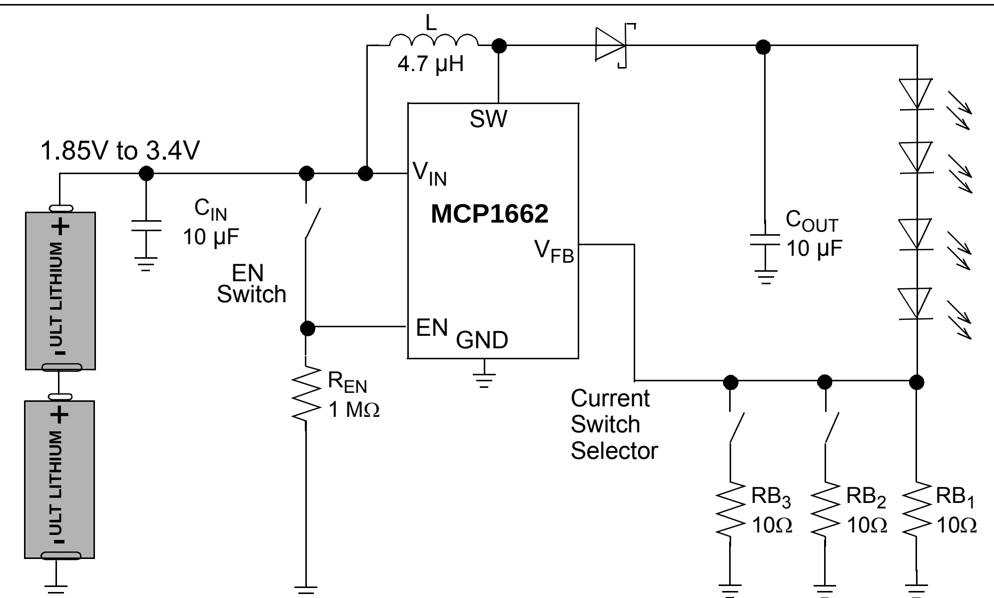
This MCP1662 LED Driver Evaluation Board kit includes:

- MCP1662 LED Driver Evaluation Board (ADM00555)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP1662 has been developed for applications that require driving a string of LEDs from a low-voltage source. Using a peak current mode control the MCP1662 offers good line and load step responses over a wide output range (up to 32V total output voltage or 10 white LEDs). The integration of compensation and protection circuitry is an important feature that minimizes the required number of additional components.



Note: The application will typically start if the voltage on the batteries is above 2.3V and will continue to operate down to 1.85V.

FIGURE 2-1: *MCP1662 Boost 30, 60, 90 mA Constant Current Application.*

2.2 FEATURES

The MCP1662 LED Driver Evaluation Board has the following features:

- It can be powered by two-cell Alkaline, NiCd, NiMH or Lithium AA cell batteries
- Input Voltage range (V_{IN}): 2.4V to 5.5V, with $V_{IN} < V_{OUT}$
- Undervoltage Lockout: 2.3V to Start; 1.85V to Stop
- Adjustable Output Current: 30 mA, 60 mA or 90 mA, selected using a dual switch on-board
- PWM Switching Frequency: 500 kHz
- Enable converter using switch on board
- 1.3A Peak Input Current Limit
- Overtemperature Protection (if the die temperature exceeds +150°C, with 15°C hysteresis)
- Open Load Protection in case of: LED fail or FB disconnected/fault

2.3 GETTING STARTED

The MCP1662 LED Driver Evaluation Board is fully assembled and tested to evaluate and demonstrate the MCP1662 product. This board requires the use of external lab supplies or two AA batteries.

2.3.1 Power Input and Output Connection

2.3.1.1 POWERING THE MCP1662 LED DRIVER EVALUATION BOARD

Soldered test points are available for input voltage connections. The maximum input voltage should not exceed 5.5V. The output current will not remain in regulation for input voltages that are greater than or equal to the forward voltage of the LEDs.

The MCP1662 LED Driver Evaluation Board was designed to help the engineer validate the MCP1662 device. The package selected for the MCP1662 LED Driver Evaluation Board is 5-Lead SOT-23.

SW1 is the enable switch, which gives the state of the converter, On or Off. A soldered test point is also available for the EN pin, that can be used for PWM dimming. The second switch is used to modify the value of the sense resistor, in order to modify the LED current and achieve analog dimming.

2.3.1.2 BOARD POWER UP PROCEDURE:

1. Connect input supply as shown in Figure 2-2 or insert two AA batteries in the battery holder on the bottom side of the board. Respect the polarity of the batteries.
2. Using the EN switch, the state of the converter is changed from On to Off.
3. Change the value of the output current using the Current Switch Selector. There are three available currents: 30 mA, 60 mA and 90 mA. When changing the positions of the Current Switch Selector, the value of the sense resistor is modified and the brightness of the LEDs change.

Additional test points are available to visualize different signals (SW, output current, FB) or to modify the output current by dimming, using the EN pin.

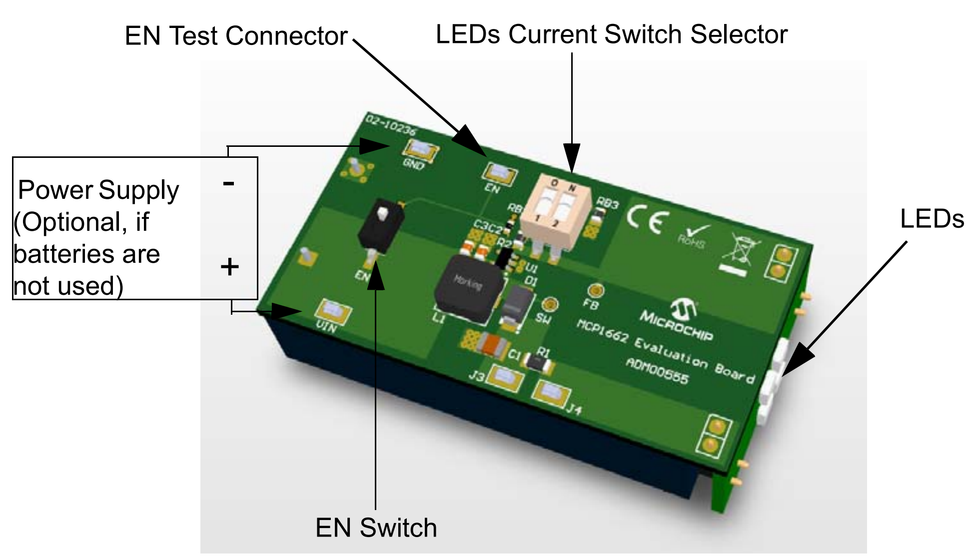


FIGURE 2-2: MCP1662 LED Driver Evaluation Board Setup.

2.3.1.3 ADJUSTABLE LED CURRENT BY RECALCULATING THE SENSE RESISTOR (ANALOG DIMMING)

The Sense Resistor (R_{SET}) is used to modify the value of the output current. The value for the resistor can be calculated using Equation 2-1:

EQUATION 2-1:

$$R_{SET} = \left[\frac{V_{FB}}{I_{LED}}\right]$$

Where: V_{FB} = 0.300V

> **Note:** If the Sense Resistor is recalculated, the Current Switch Selector will not have the same functionality, as the Sense Resistor will add a resistor in parallel with the calculated component and the value of the current will be different than the one specified in the User Guide. The Sense Resistor will be used in place of the RB_X resistors.

2.3.1.4 ADJUSTABLE LED CURRENT BY USING THE EN PIN (PWM DIMMING)

The MCP1662 allows PWM dimming by turning the LED on and off with a variable duty cycle PWM signal applied to the EN pin. The maximum frequency for dimming is limited by the start-up and the load. By varying the duty cycle of the PWM signal applied on the EN input, the LED current changes linearly. An example of PWM dimming can be observed in Figure 2-3.

By removing the 0 Ohms R1 Resistor, the soldered connectors (J3 and J4) can be used to either insert a multimeter to measure the LED current or to create a loop through which, with the help of an oscilloscope current probe, the current through the LED can be visualized.

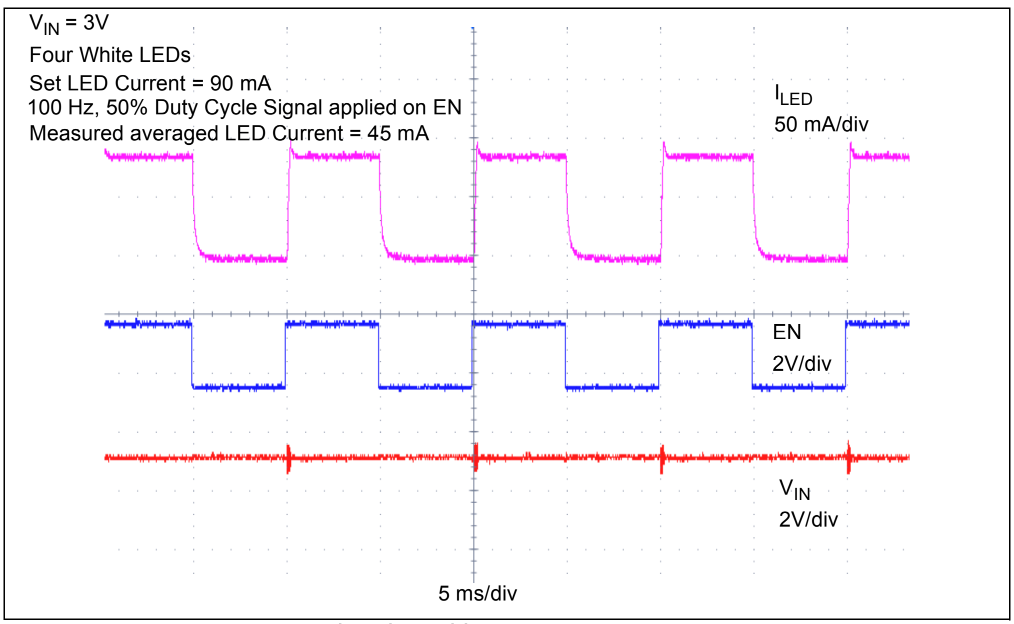


FIGURE 2-3: *PWM Dimming with MCP1662.*

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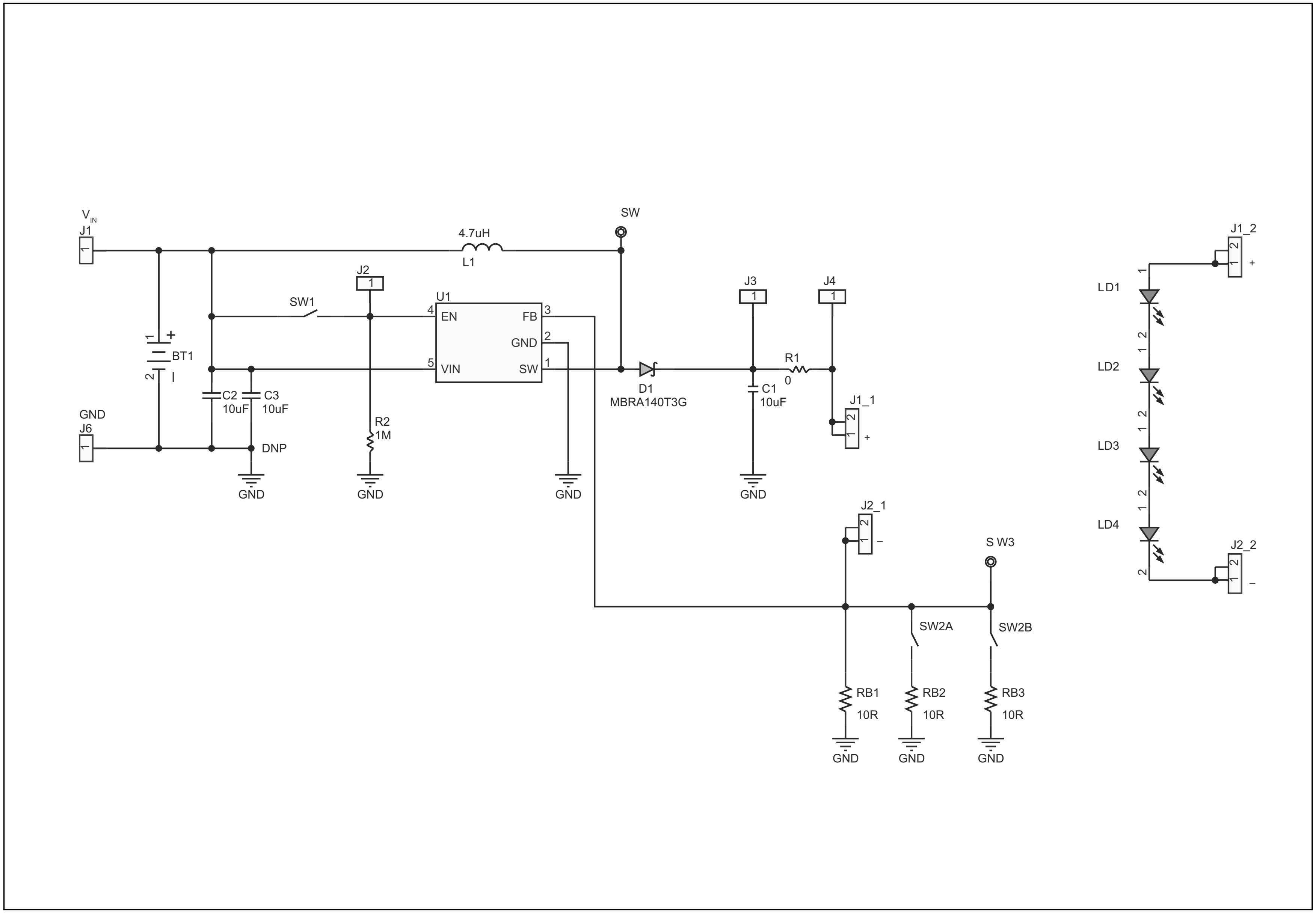
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

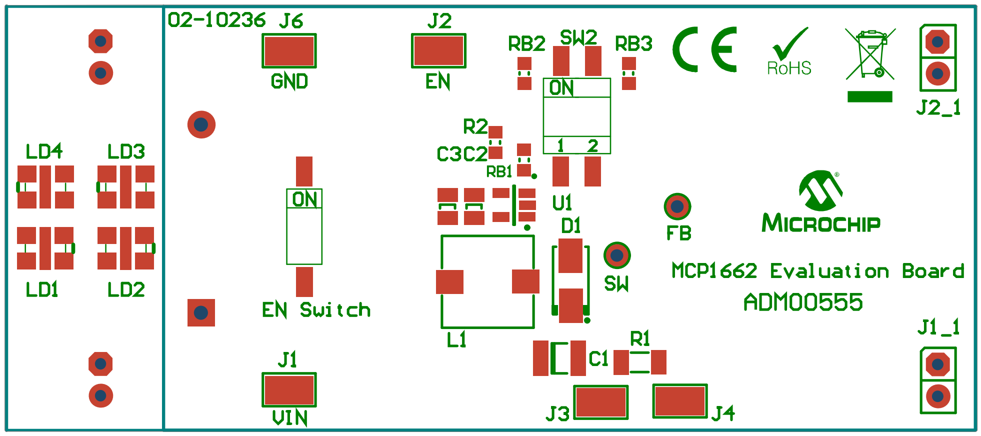
This appendix contains the following schematics and layouts for the MCP1662 LED Driver Evaluation Board:

- Board – Schematic
- Board – Top Silk
- Board – Top Silk And Copper
- Board – Bottom Copper

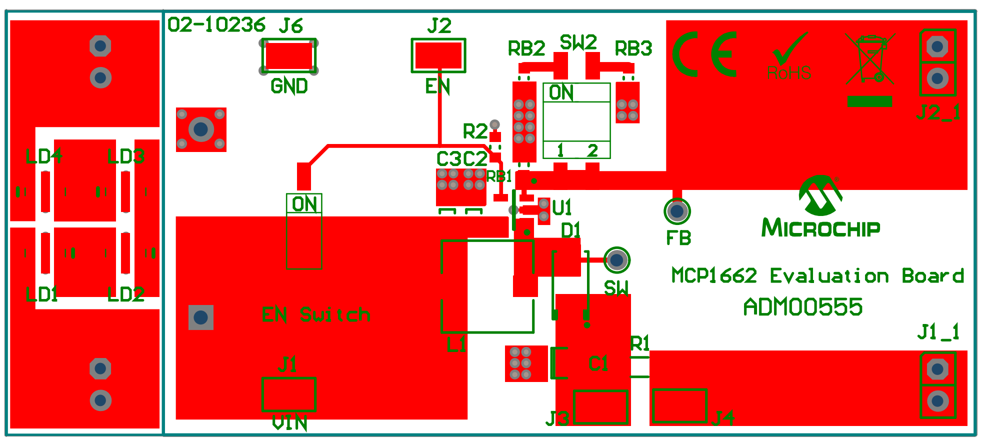
A.2 BOARD – SCHEMATIC



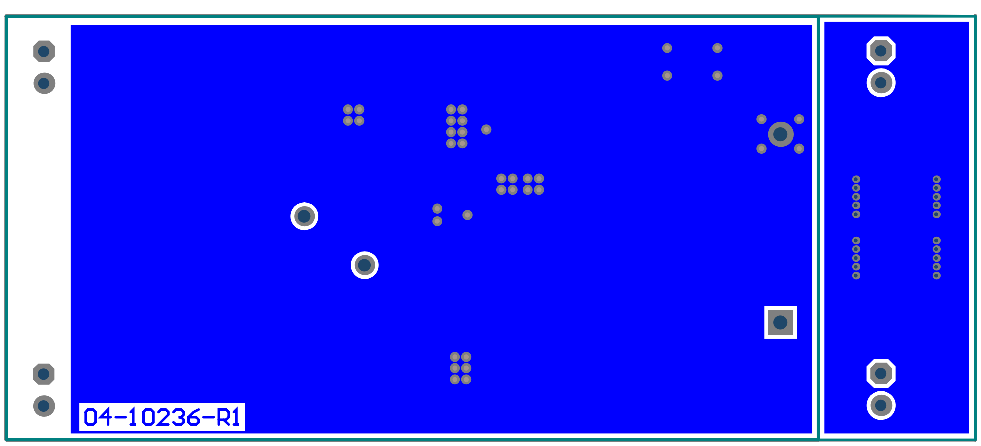
A.3 BOARD – TOP SILK



A.4 BOARD – TOP SILK AND COPPER



A.5 BOARD – BOTTOM COPPER



NOTES:

Appendix B. Bill of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
1	BT1	Battery Holder	Keystone Electronics Corp.	2462
1	C1	Cap. Ceramic 10 µF 50V X7S 1210	TDK Corporation	C3225X7S1H106M
1	C2	Cap. Ceramic 10 µF 10V 10% X7R SMD 0805	Murata Electronics®	GRM21BR71A106KE51L
1	C3	Cap. Ceramic 10 µF 10V 10% X7R SMD 0805 - **DO NOT POPULATE**	Murata Electronics®	GRM21BR71A106KE51L
1	D1	Diode Schottky 40V 1A SMA	ON Semiconductor®	MBRA140T3G
2	J1_2, J2_2	Header 2.54 mm, Pin, THT, R/A, 2-Way	Wurth Elektronik	61300211021
5	J1, J2, J3, J4, J6	Conn. TP Loop Tin SMD	Harwin Plc.	S1751-46R
1	L1	Choke, SMD, 4.7 µH	Wurth Elektronik	7447779004
4	LD1, LD2, LD3, LD4	LED, HI BRIGHT, 51.7LM, Warm White	Cree, Inc.	MLEAWT-A1-R250-0004E5
1	R1	Resistor, 1206 0R0	Welwyn Components	WCR1206-R005JI
1	R2	Resistor 1 MΩ 1/10W 1% 0603 SMD	Panasonic® - ECG	ERJ-3EKF1004V
3	RB1, RB2, RB3	Resistor TKF 10R 1% 1/10W SMD 0603	Stackpole Electronics, Inc.	RMCF0603FT10R0
1	SW1	2.54 mm SW_SMD_DIP X1	Wurth Elektronik	418121270801
1	SW2	2.54mm SW_SMD_DIP X2	Wurth Elektronik	418121270802
1	U1	Led Driver, Boost Converter	Microchip Technology Inc.	**MCP1662T-E/OT**

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

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