MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board User's Guide

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Derek Carlson
VP Development Tools

16-July-2013
Date

NOTES:

MCP1643 SYNCHRONOUS BOOST LED CONSTANT CURRENT REGULATOR EVALUATION BOARD USER'S GUIDE

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MCP1643 SYNCHRONOUS BOOST LED CONSTANT CURRENT REGULATOR EVALUATION BOARD USER'S GUIDE

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 "DSXXXXXA", where "XXXXX" 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 MCP1643 Synchronous Boost LED Constant Current Regulator 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 MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board and a description of the user's guide.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board.
- **Appendix B. "Bill of Materials"** – Lists the parts used to build the MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

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

RECOMMENDED READING

This user's guide describes how to use MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- **MCP1643 Data Sheet - *"1 MHz Low Voltage Start-up Synchronous Boost LED Constant Current Regulator"* (DS20005208)**
- **AN1311 - "*Single Cell Input Boost Converter Design*" (DS01311)**

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- Technical Support

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

DOCUMENT REVISION HISTORY

Revision A (August 2013)

- Initial Release of this Document.

NOTES:

MCP1643 SYNCHRONOUS BOOST LED CONSTANT CURRENT REGULATOR EVALUATION BOARD USER'S GUIDE

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board and covers the following topics:

- MCP1643 Short Overview
- What is the MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board?
- MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board Kit Contents

1.2 MCP1643 SHORT OVERVIEW

The MCP1643 is a compact, high-efficiency, fixed frequency, step-up DC-DC converter optimized as an LED constant current generator. This product provides an easy-to-use power supply solution, with a minimum number of external components for applications powered by one-cell, two-cell Alkaline, NiCd or NiMH batteries.

The MCP1643 is a PWM-only device that operates at a fixed 1 MHz switching frequency. The device has an operating input voltage range from 0.5V to 5V (with a 0.65V start-up voltage).

The LED can be turned ON and OFF with a variable duty cycle applied to the EN pin for applications that require dimming. The maximum dimming frequency is only limited by the internal soft-start of 240 µs.

The device is available in MSOP-8 and 2X3 TDFN-8 packages.

The scope of the MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board is to demonstrate the LED driving capabilities of the MCP1643 when supplied from one AA battery.

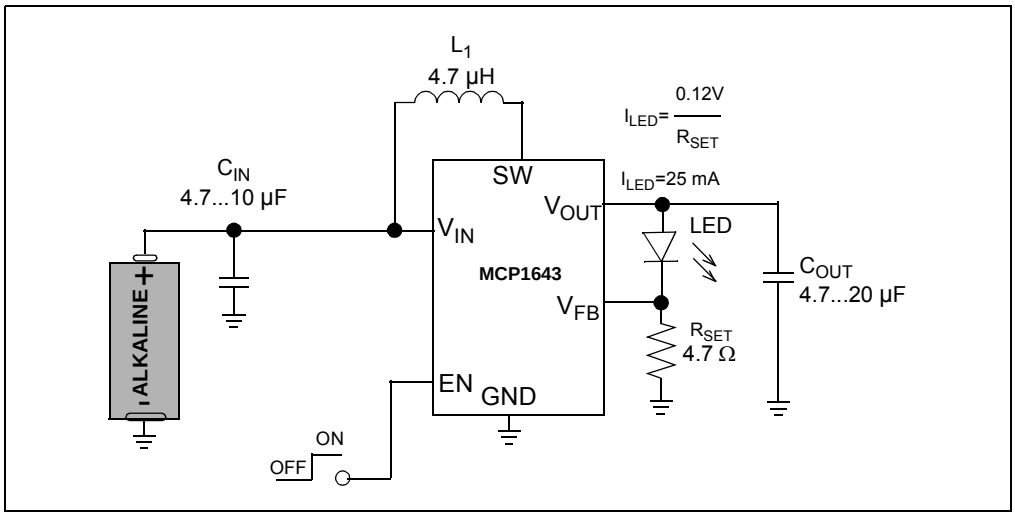


FIGURE 1-1: *Typical MCP1643 Boost Converter Single Cell Battery Input.*

1.3 WHAT IS THE MCP1643 SYNCHRONOUS BOOST LED CONSTANT CURRENT REGULATOR EVALUATION BOARD?

The MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board is used to evaluate and demonstrate Microchip Technology's MCP1643 device. This board demonstrates the MCP1643 in a boost converter application supplied by one AA battery, or from an external voltage source, which drives an LED with four selectable currents. The MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board was developed to help engineers reduce the product design cycle time.

Four output currents can be selected: 25,50,75 and 100mA. The output current can be changed with a dual switch that changes the external LED current sense equivalent resistance (for the position of the switches and output current see Table 2-1.)

An enable switch is used to enable and disable the converter. When enabled, the MCP1643 will regulate the output current; when disabled, the MCP1643 disconnects the path from input to output for "true-disconnect". In this state, the current consumed from the battery is 1.2 µA, typically.

1.4 MCP1643 SYNCHRONOUS BOOST LED CONSTANT CURRENT REGULATOR EVALUATION BOARD KIT CONTENTS

This MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board kit includes the following items:

- MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board (ADM00435)
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP1643 has been developed for applications that require driving an LED from a low-voltage source. The Microchip low-voltage technology allows the device to start up from a low 0.65V input voltage without output overshoot. At the same time, the device is capable of achieving high efficiency by integrating the low resistance N-Channel Boost switch and the synchronous P-Channel switch and by using a low voltage reference (0.120V) to reduce the power dissipation on the sensing resistor. Another important feature is that the device integrates the compensation and protection circuitry, so that the final solution will require a minimum number of additional components.

When disabled using the EN switch, the true disconnect option removes the normal boost topology path from input to output.

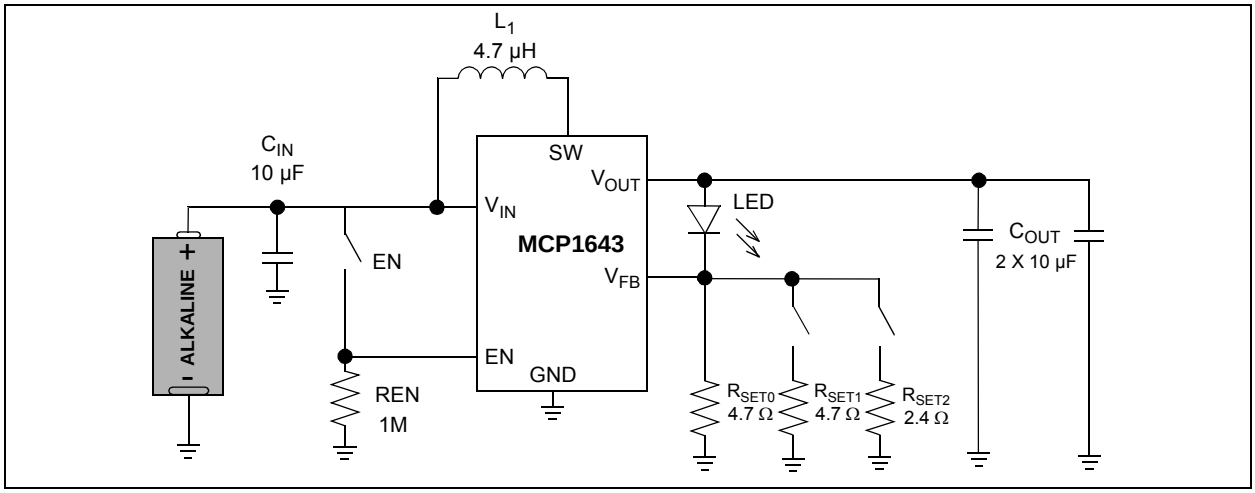


FIGURE 2-1: *Synchronous Boost 25, 50, 75, 100 mA Constant Current Application.*

2.1.1 MCP1643 Evaluation Board Features

The MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board has the following features:

- It can be powered by one-cell Alkaline, NiCd, or NiMH batteries, or by external power supply
- Input voltage range, V_{IN}: 0.5V to 2.5V, with $V_{IN} < V_{OUT}$, after start-up
- Start-up voltage: 0.65V
- Fixed output current: 25 mA, 50 mA, 75 mA or 100 mA, selected using a mini-dip switch on board
- PWM Switching Frequency: 1 MHz
- Enable state selectable using mini-dip switch on board
- 1.6A Peak Input Current Limit
- Overtemperature Protection (if the die temperature exceeds 150°C, 25°C hysteresis)
- Mechanical battery reverse polarity protection

Note: For $V_{IN} < V_{OUT}$, I_{LED} remains in regulation up to $V_{IN} = V_{LED}$ @ LED typical V_F and I_F.

2.2 GETTING STARTED

The MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board is fully assembled and tested to evaluate and demonstrate the MCP1643 product. This board requires the use of an external power supply or an AA battery.

2.2.1 Power Input and Output Connection

2.2.1.1 POWERING THE MCP1643 SYNCHRONOUS BOOST LED CONSTANT CURRENT REGULATOR EVALUATION BOARD

Soldered test points are available for input voltage connections. The maximum input voltage should not exceed 2.5V. The output current will not remain in regulation for input voltages that are greater than, or equal to, the forward voltage of the LED. White LEDs have V_F typical between 2.5 and 3.5V, depending on the LED drive current.

The MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board was designed to be used in the process of validating the device. The package selected for the MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board is the MSOP-8.

SW1 is the Enable switch, which gives the state of the converter, ON or OFF. A soldered test point that can be used for PWM dimming is also available for the EN pin. The second switch is used to modify the value of the sense resistor, in order to modify the LED current and achieve analog dimming (for the position of the switches and output current, see Table 2-1).

2.2.1.2 BOARD POWER UP PROCEDURE

1. Connect the input supply as shown in Figure 2-2 or connect an AA battery in the battery holder on the bottom of the board.
2. Use SW1 to change the state of the converter from ON to OFF.
3. Change the value of the output current using SW2. There are four available currents: 25 mA, 50 mA,75 mA and 100 mA.

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. Note: Due to the holder reverse polarity protection, the battery can only be inserted in the correct position.

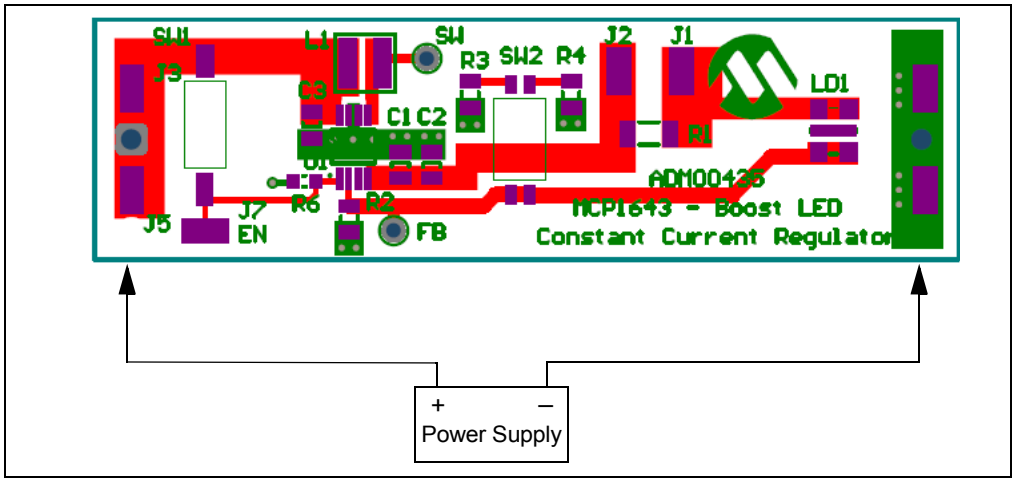


FIGURE 2-2: *MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board Setup.*

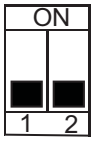
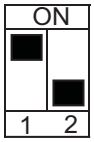
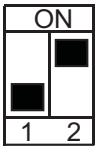
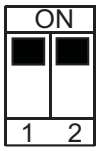
2.2.1.3 ADJUSTABLE LED CURRENT SETTING BY RECALCULATING THE SENSE RESISTOR

The Sense Resistor is used to modify the value of the output current. The value for the sense resistor can be calculated using the following equation:

$R_2 = V_{FB}/I_{LED}$

Where: $V_{FB} = 0.120V$

TABLE 2-1: LED CURRENT SELECTION

Switch Position	LED Current
	25 mA
	50 mA
	75 mA
	100 mA

Note: If the sense resistor is recalculated, the switch used for current selection will not be used, as it will add a resistor in parallel with the calculated component. When recalculating the sense resistor, check the Maximum Limits for I_{LED} in the Regulation graph available in the data-sheet.

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

The MCP1643 allows PWM dimming by turning the LED ON or OFF with a variable duty cycle PWM signal applied to the EN pin. The maximum frequency for dimming is limited by the internal soft-start of 240 µs typical. By varying the duty cycle of the PWM signal applied on EN input, the LED current is changing linearly and the light intensity changes as well.

A 0Ω R1 resistor is used for bench testing. By removing R1, the soldered test points can be used to either insert a multimeter to measure the LED current, or create a loop and visualize the current through the LED by using an oscilloscope current probe.

NOTES:

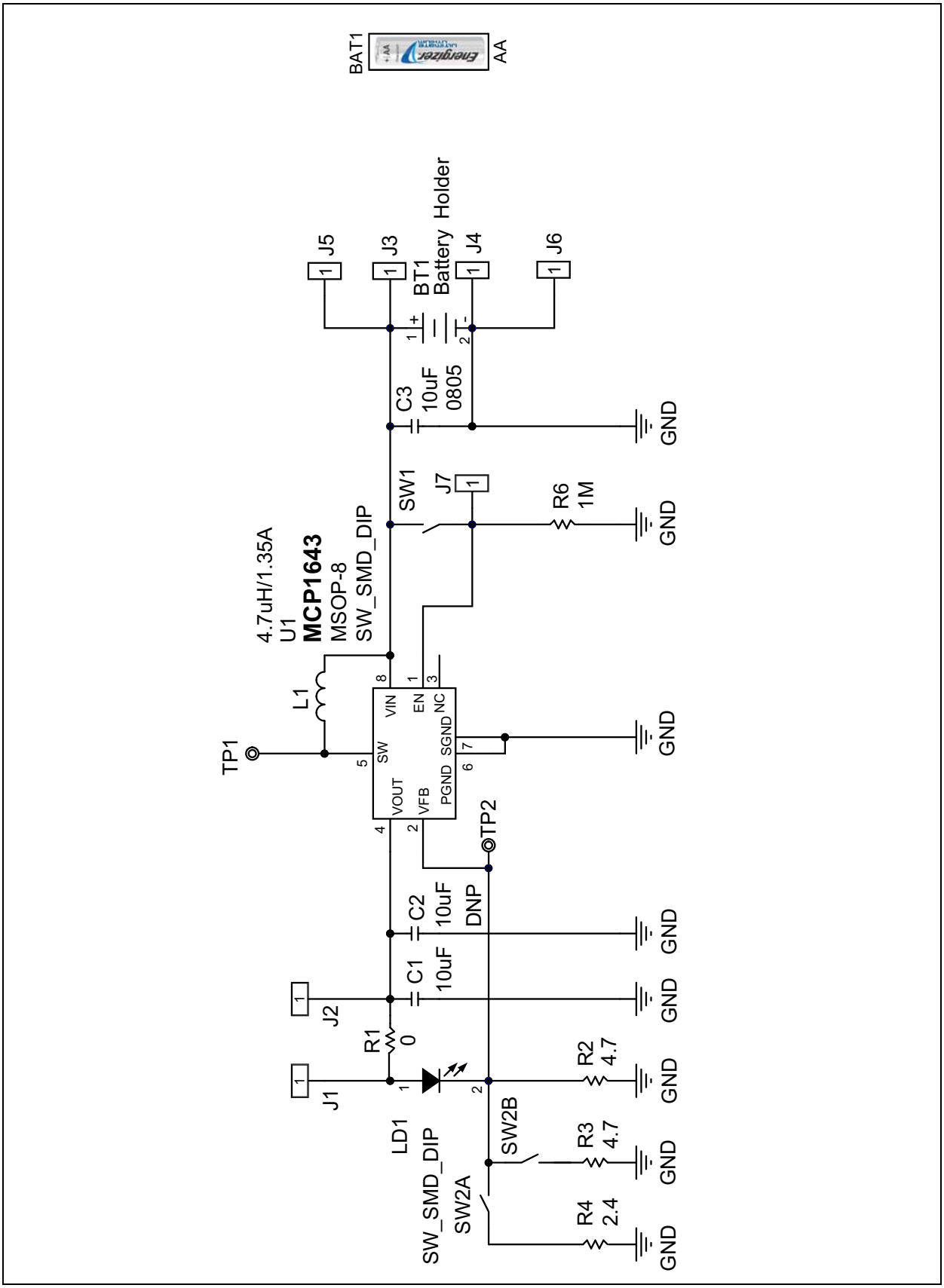
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

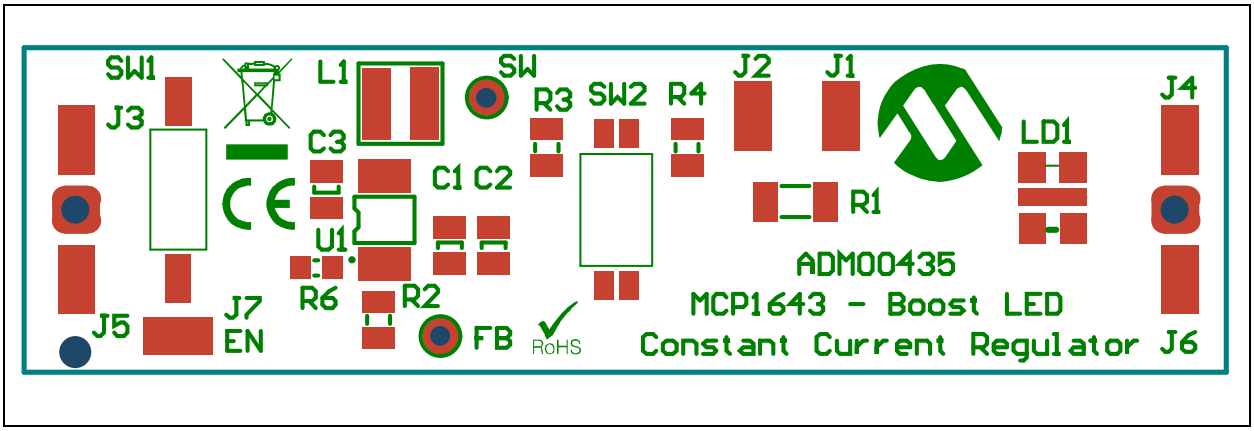
This appendix contains the following schematics and layouts for the MCP1643 Synchronous Boost LED Constant Current Regulator Evaluation Board:

- Board – Schematic
- Board – Top Silk and Pads
- Board – Top Copper
- Board – Bottom Copper

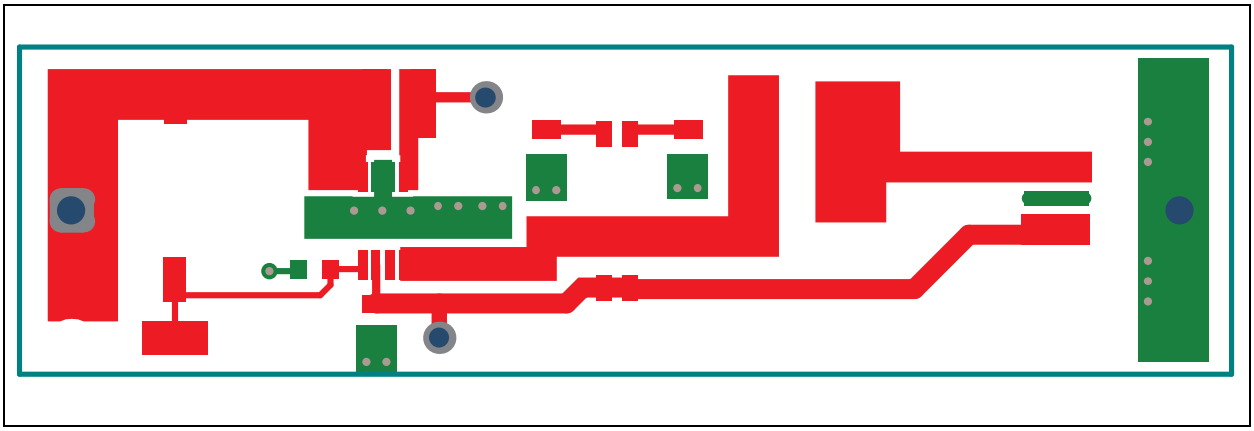
A.2 BOARD – SCHEMATIC



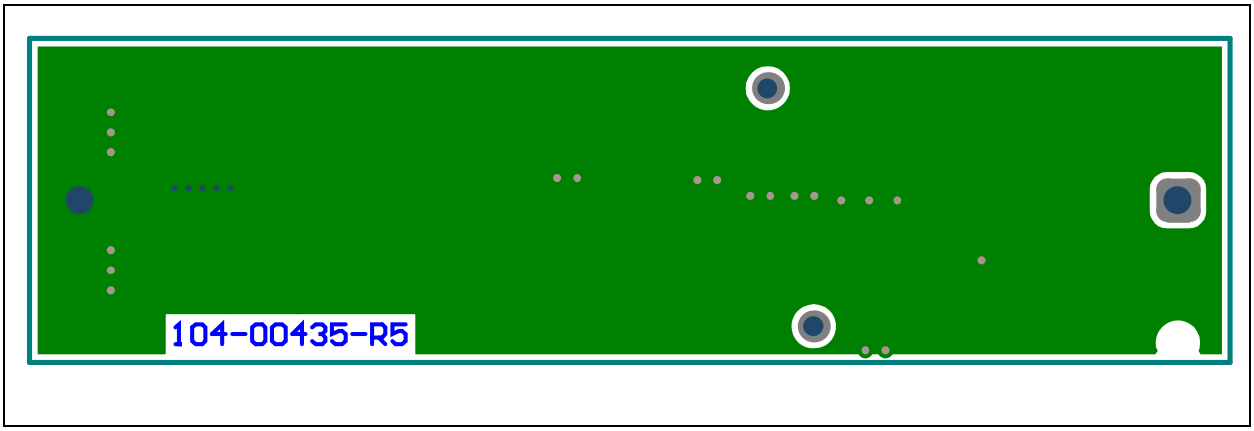
A.3 BOARD – TOP SILK AND PADS



A.4 BOARD – TOP COPPER



A.5 BOARD – BOTTOM COPPER



NOTES:

Appendix B. Bill of Materials

TABLE B-1: BILL OF MATERIALS (BOM)

Qty.	Reference	Description	Manufacturer	Part Number
1	BT1	Holder Battery AA Polar Protection	MPD (Memory Protection Devices)/Keystone	BHAA-POL
2	C1, C3	Cap. Ceramic 10 UF 10V 10% X7R 0805	Murata Electronics® North America	GRM21BR71A106KE51L
7	J1, J2, J3, J4, J5, J6, J7	PC Test Point Tin SMD	Harwin Plc.	S1751-46R
1	L1	Choke, TPC 2828, 4.7UH 20% 1.35A	Wurth Elektronik Group	744025004
1	LD1	LED, Hi Bright, 51.7LM, Warm White	Cree, Inc.	MLEAWT-A1-R250-0004E5
1	R1	Resistor, 1206 0R0	Welwyn Components	WCR1206-R005JI
3	R4	Resistor, 0805, 2R4 5%, 0.125W	Panasonic - ECG	ERJ-6RQF2R4V
1	R6	Resistor, 1M Ohm 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF1004V
1	SW1	2.54 mm SW_SMD_DIP	Wurth Elektronik Group	418121270801
1	SW2	1.27 mm SW_SMD_DIP	Wurth Elektronik Group	416131160802
2	R2, R3	Resistor, 0805, 4R7 5%, 0.125W	Panasonic - ECG	ERJ-B3BF4R7V-ND
1	U1	LED Driver, Boost Converter	Microchip Technology Inc.	MCP1643-I/MS
1	BAT1	Battery Lithium AA Cell 1.5 Volt	Energizer Battery Company	L91
1	C2	Cap. Ceramic 10uF 10V 10% X7R 0805 - **DO NOT POPULATE**	Murata Electronics® North America	GRM21BR71A106KE51L

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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Океан Электроники
Поставка электронных компонентов

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «**JONHON**», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «**FORSTAR**».

AVIC JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).

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