Building Block Solutions – Switchers User's Guide

Introduction

The **Building Block Solutions – Switchers (BBS-SW)** board is a modular demonstration platform designed to evaluate and demonstrate the features of several Microchip Technology monolithic DC-DC switching regulators. The board consists of seven independent sub-modules, each featuring a different DC-DC converter, allowing users to easily test, compare, and integrate these solutions into their own designs.

Sub-Modules Descriptions

- **BBS1: MCP16251 Boost Regulator**
  Low Quiescent Current, PFM/PWM Synchronous Boost Regulator with True Output Disconnect or Input/Output Bypass Option
  Ideal for battery-powered applications that require efficient voltage boosting from low input levels.
- **BBS2: MCP16311 Buck Regulator**
  30V Input, 1A Output, High-Efficiency, Integrated Synchronous Switch Step-Down Regulator
  Provides high efficiency and a compact solution for stepping down voltages in portable and embedded systems.
- **BBS3: MCP16411 Boost Regulator**
  Low IQ Boost Converter with Programmable Low Battery, UVLO and Automatic Input-to-Output Bypass Operation
  Delivers a regulated 3.3V output, suitable for powering microcontrollers and sensors from lower voltage sources.
- **BBS4: MCP1663 Boost Regulator**
  High-Voltage Integrated Switch PWM Boost Regulator with UVLO
  Generates a stable 12V output, ideal for applications requiring relatively high voltage rails that are derived from low voltage sources.
- **BBS5: MCP1663 Boost Regulator**
  High-Voltage Integrated Switch PWM Boost Regulator with UVLO
  Configured for 24V output, supporting industrial and instrumentation needs.
- **BBS6: MCP1664 LED Driver**
  High-Voltage Step-Up LED Driver with UVLO and Open Load Protection
  Supplies 100 mA for driving up to 8 white LEDs (or any other type of LED strings with a combined forward voltage below 25V), suitable for lighting and indicator applications.
- **BBS7: MCP16331 Buck Regulator**
  High-Voltage Input Integrated Switch Step-Down Regulator
  Provides a regulated 5V output, commonly used for USB-powered devices and logic circuits.

Features

- Modular Design for Easy Evaluation of Each Converter
- Clearly Labeled Sub-Modules for Quick Identification
- Pre-Configured Output Voltages for Typical Use Cases

- Test Points and Connectors for Easy Measurement and Integration

Applications

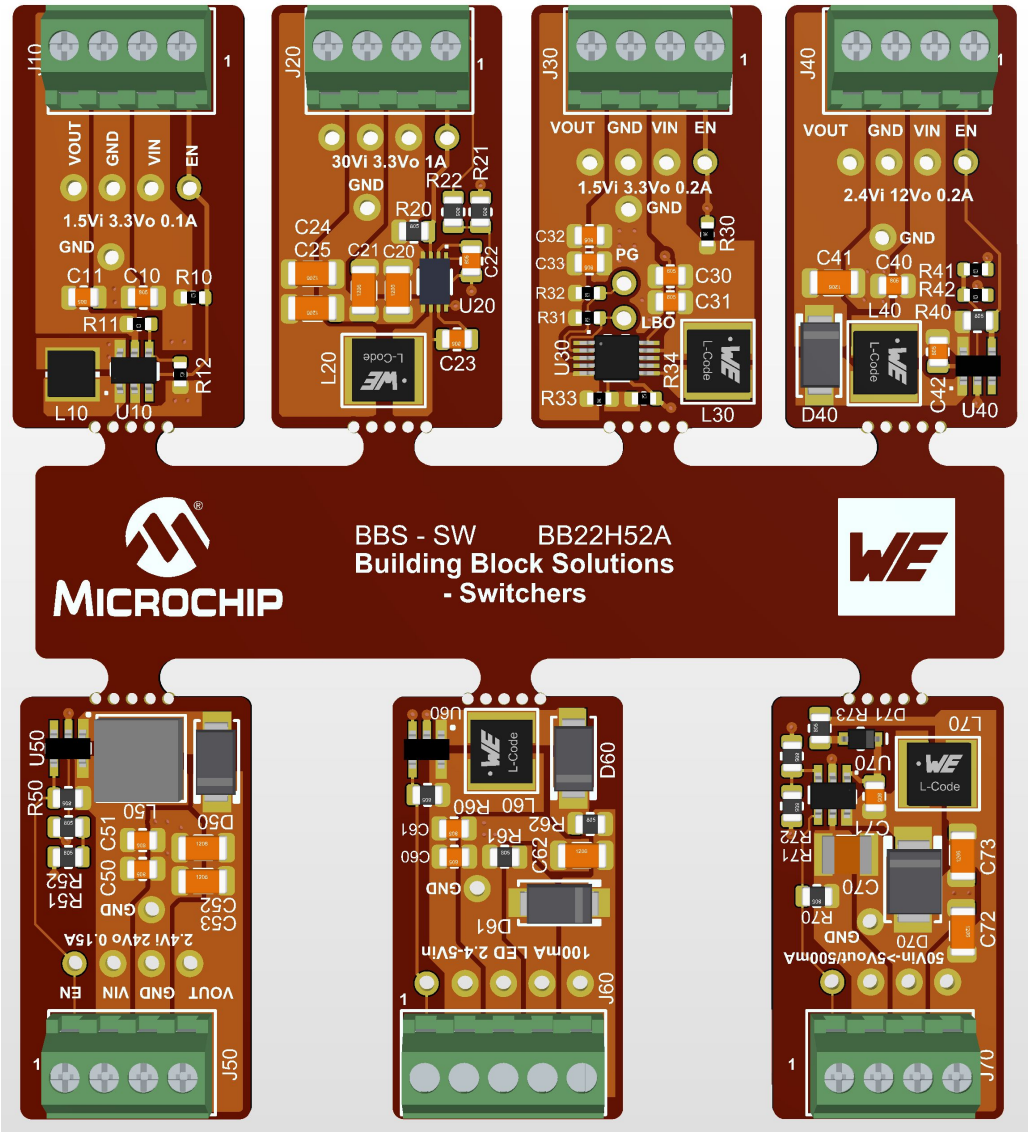
- Rapid Prototyping and Evaluation of Power Supply Solutions
- Educational Tool for Understanding Switched-Mode Power Supply Topologies
- Reference Design for Integrating Microchip Technology DC-DC Monolithic Switching Regulators into Custom Projects

Kit Contents

The Building Block Solutions – Switchers kit includes:

- Building Block Solutions – Switchers Board (BB22H52A)
- Important Information Sheet

Figure 1. Building Block Solutions – Switchers Board Overview



1. Setup and Configuration

The Building Block Solutions – Switchers Board is fully assembled and tested to evaluate and demonstrate the features of the MCP16251, MCP16311, MCP16411, MCP1663, MCP1664, and MCP16331 monolithic switching regulators. For proper evaluation, this board requires an external laboratory power supply and load (including LEDs).

Table 1-1. The Building Block Solutions – Switchers: Sub-Modules Main Parameters and Features

Module's Name	Module's input voltage range	Module's output voltage	Module's maximum output current	Special features
BBS1: MCP16251 Boost Regulator	1.5V (nominal)	3.3V	100 mA	•True Load Disconnect Option •No Load Input Current: 14 µA (typical)
BBS2: MCP16311 Buck Regulator	4.5V – 30V	3.3V	1A	•Automatic PFM/PWM Operation •Synchronous Rectification
BBS3: MCP16411 Boost Regulator	1.5V (nominal)	3.3V	200 mA	•Automatic Input-to-Output Bypass Operation while in regulation •Programmable Undervoltage Lockout (UVLO) •Programmable Low Battery Output (LBO) •Power Good and Die Overtemperature output (PG/PGT)
BBS4: MCP1663 Boost Regulator	2.4V – 5.5V	12V	200 mA	•No Load Input Current: 250 µA (typical) •Undervoltage Lockout (UVLO)
BBS5: MCP1663 Boost Regulator	2.4V – 5.5V	24V	150 mA	•No Load Input Current: 250 µA (typical) •Undervoltage Lockout (UVLO)
BBS6: MCP1664 LED Driver	2.4V – 5.5V	<25V	100 mA	•Open Load Protection (OLP) •Undervoltage Lockout (UVLO)
BBS7: MCP16331 Buck Regulator	6V – 50V	5V	500 mA	•Minimum 500 mA Output Current Over All Input Voltage Ranges •Internal Pull-up on EN

1.1. Powering the Building Block Solutions – Switchers Board

The Building Block Solutions – Switchers Board provides typical circuit applications for various output voltages and is used to evaluate the performance of the MCP16251, MCP16311, MCP16411, MCP1663, MCP1664, and MCP16331 products. The switch peak current limit ensures a safe maximum current value. The maximum output current for each converter will vary depending on

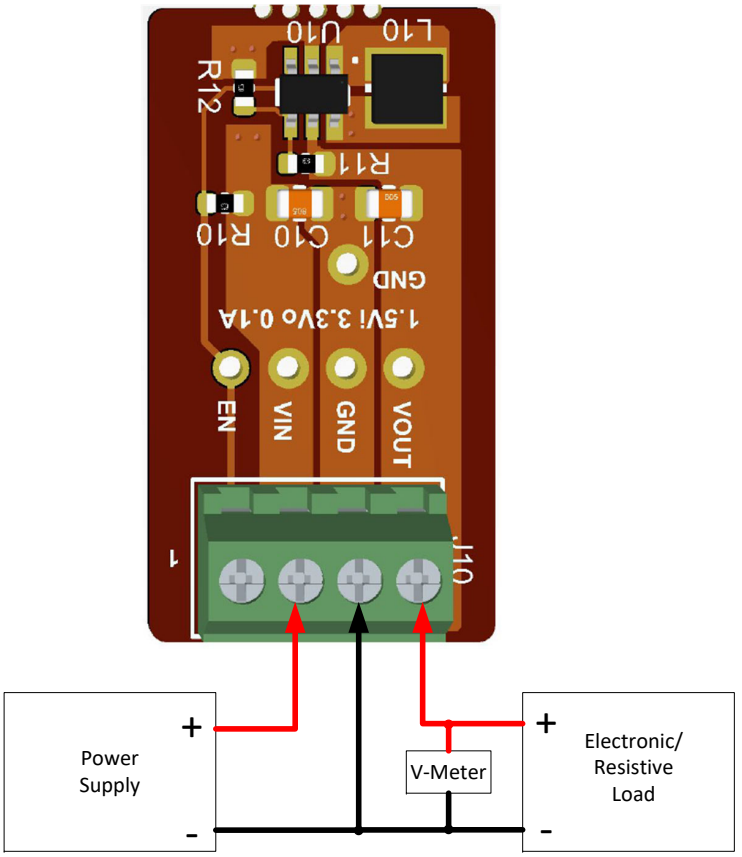
the input and output voltages. Refer to the MCP16251, MCP16311, MCP16411, MCP1663, MCP1664, and MCP16331 Data Sheets for more information on the maximum output current.

1.1.1. Boost Regulators Sub-Modules Power-up Procedure

The following procedure applies for the BBS1: MCP16251 Boost Regulator, BBS3: MCP16411 Boost Regulator, BBS4: MCP1663 Boost Regulator, and BBS5: MCP1663 Boost Regulator. To power up each board, follow these steps:

1. Connect the power supply to the input terminals of the BBS sub-module (see Figure 1-1). The input voltage should be lower than the output voltage (for more information, refer to Table 1-1).
2. Connect the load to the VOUT and GND terminals; connect the (+) side of the load to the VOUT terminal and the (-) side of the load to the GND terminal of the board (see Figure 1-1). The maximum load varies with the input and output voltage (refer to the Data Sheet for more information on the maximum load). By default, the EN pin is pulled high through a resistor.
3. When the power supply is turned on, a voltmeter can be used to monitor VOUT. The measured output voltage should be very close to the nominal value, with a variation of ±5% in PFM mode and ±2% in PWM mode. Adjusting the input voltage and load should not cause the output to vary more than a few mV over the operating range of the converter.

Figure 1-1. BBS1: MCP16251 Boost Regulator Test Setup Example

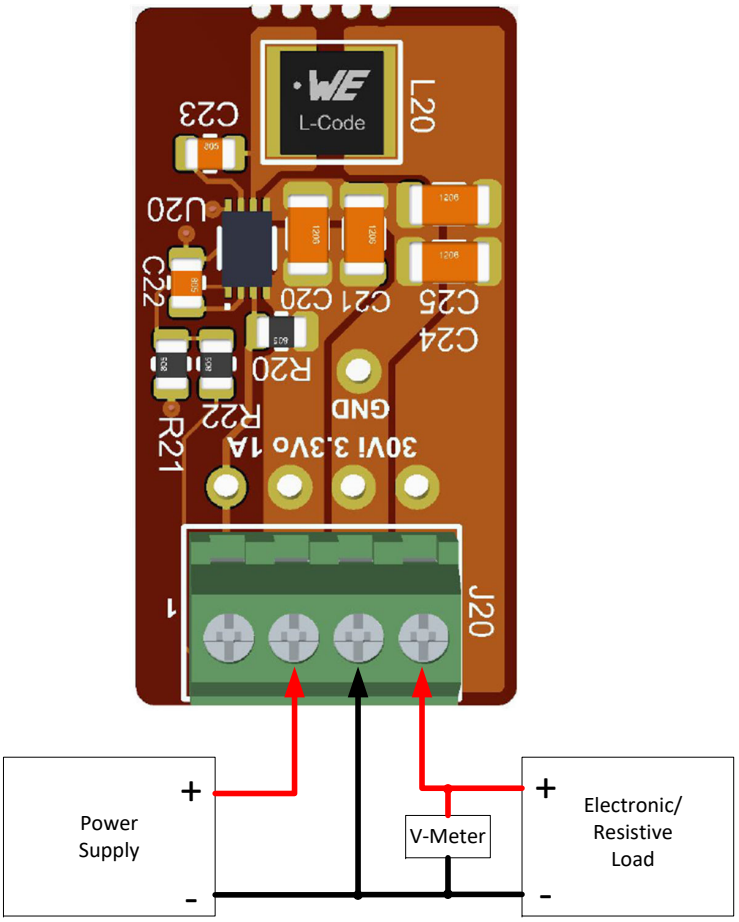


1.1.2. Buck Regulators Sub-Modules Power-up Procedure

The following procedure applies for BBS2: MCP16311 Buck Regulator and BBS7: MCP16331 Buck Regulator. To power-up each board follow these steps:

1. Connect the power supply to the input terminals of the BBS sub-module (see Figure 1-2). The input voltage should be higher than the output voltage (for more information, refer to Table 1-1).
2. Connect the load to the VOUT and GND terminals; connect the (+) side of the load to the VOUT terminal and the (-) side of the load to the GND terminal of the board (see Figure 1-2). The maximum load varies with the input and output voltage (refer to the Data Sheet for more information on the maximum load). By default, the EN pin is pulled high through a resistor.
3. When the power supply is turned on, a voltmeter can be used to monitor VOUT. The measured output voltage should be very close to the nominal value, with a variation of ±5% in PFM mode and ±2% in PWM mode. Adjusting the input voltage and load should not cause the output to vary more than a few mV over the operating range of the converter.

Figure 1-2. BBS2: MCP16311 Buck Regulator Test Setup Example

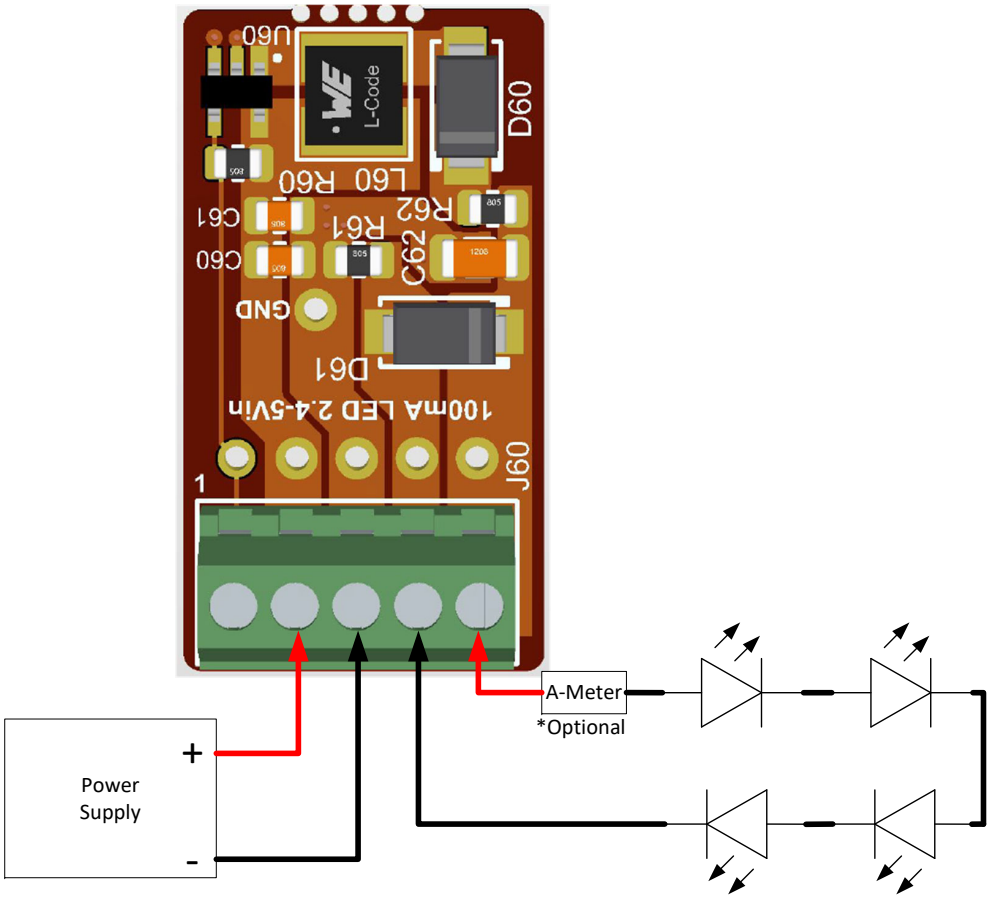


1.1.3. BBS6: MCP1664 LED Driver Sub-Module Power-up Procedure

For the power-up procedure, follow these steps:

1. Connect the power supply to the input terminals of the BBS6: MCP1664 LED Driver (see Figure 1-3). The input voltage should be lower than the combined forward voltage of the LEDs (for more information, refer to Table 1-1). The driver can supply up to 8 white series-connected LEDs (or any other type of LED strings with a combined forward voltage below 25V).
2. Connect the Anode (+) of the LED string to the L+ terminal of the board and the Cathode (-) of the LED string to the L- terminal of the board (see Figure 1-3). The maximum load varies with the input and output voltage (refer to the MCP1664 Data Sheet for more information on the maximum load). By default, the DIM terminal (EN pin) is pulled high through a resistor. By applying a low-voltage rectangular signal to this pin, the light intensity of the LED string can be adjusted. For further details, please refer to the MCP1664 Data Sheet.
3. Before turning on the power supply, an ammeter can be connected in series with the LED string to monitor the output current. The measured output current should be 100 mA (±10 mA). Adjusting the input voltage should not cause the output current to vary more than a few mA over the operating range of the converter.

Figure 1-3. BBS6: MCP1664 LED Driver Test Setup



2. Board Design

This chapter contains the following schematics and layouts for the Building Block Solutions – Switchers Board:

- BBS1: MCP16251 Boost Regulator Schematic
- BBS2: MCP16311 Buck Regulator Schematic
- BBS3: MCP16411 Boost Regulator Schematic
- BBS4: MCP1663 Boost Regulator Schematic
- BBS5: MCP1663 Boost Regulator Schematic
- BBS6: MCP1664 LED Driver Schematic
- BBS7: MCP16331 Buck Regulator Schematic
- Board – Top Silk
- Board – Top Copper and Silk
- Board – Top Copper
- Board – Inner Layer 1
- Board – Inner Layer 2
- Board – Bottom Copper
- Board – Bottom Copper and Silk
- Board – Bottom Silk

2.1. Schematics

Figure 2-1. BBS1: MCP16251 Boost Regulator Schematic

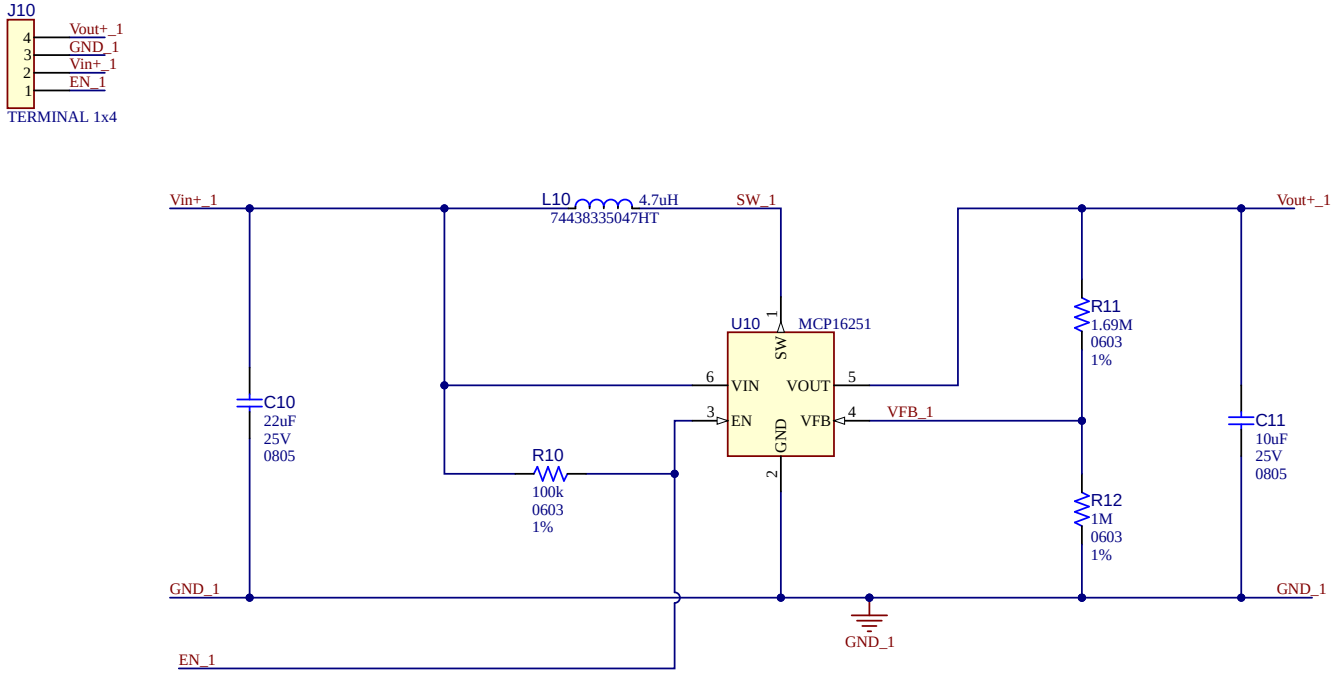


Figure 2-2. BBS2: MCP16311 Buck Regulator Schematic

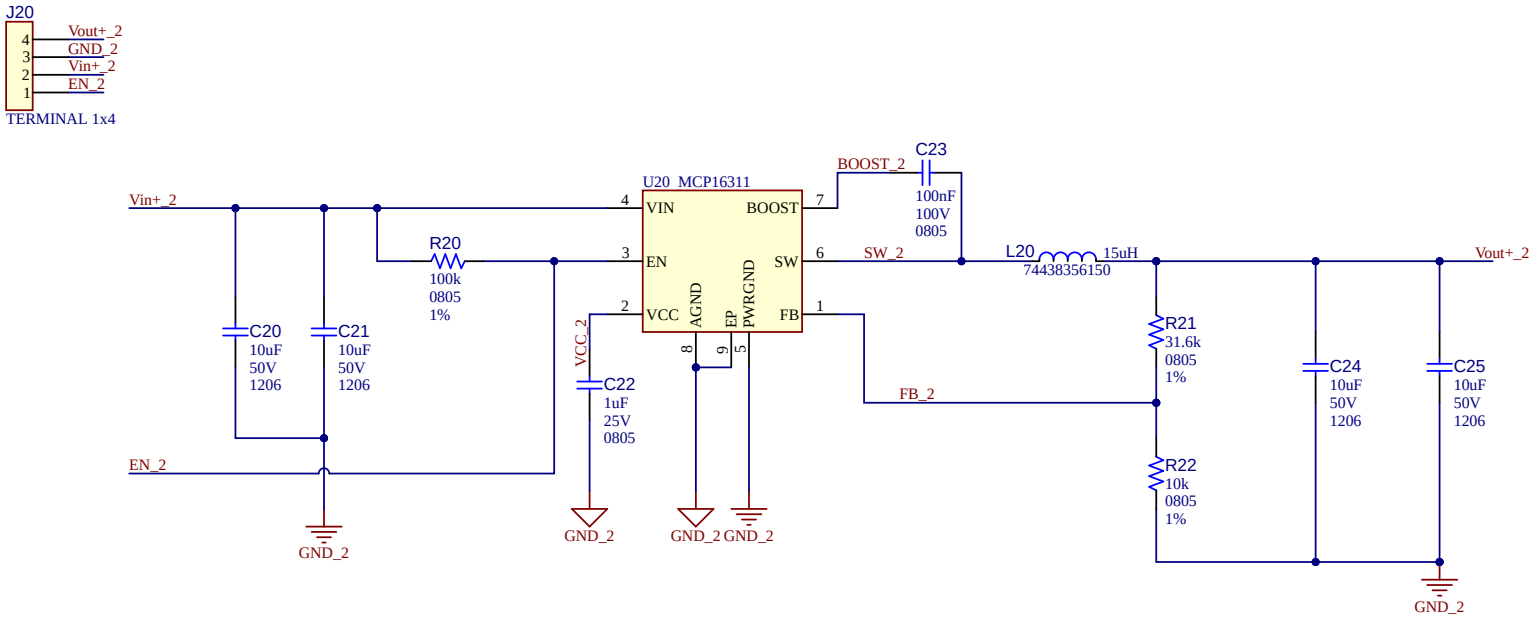


Figure 2-3. BBS3: MCP16411 Boost Regulator Schematic

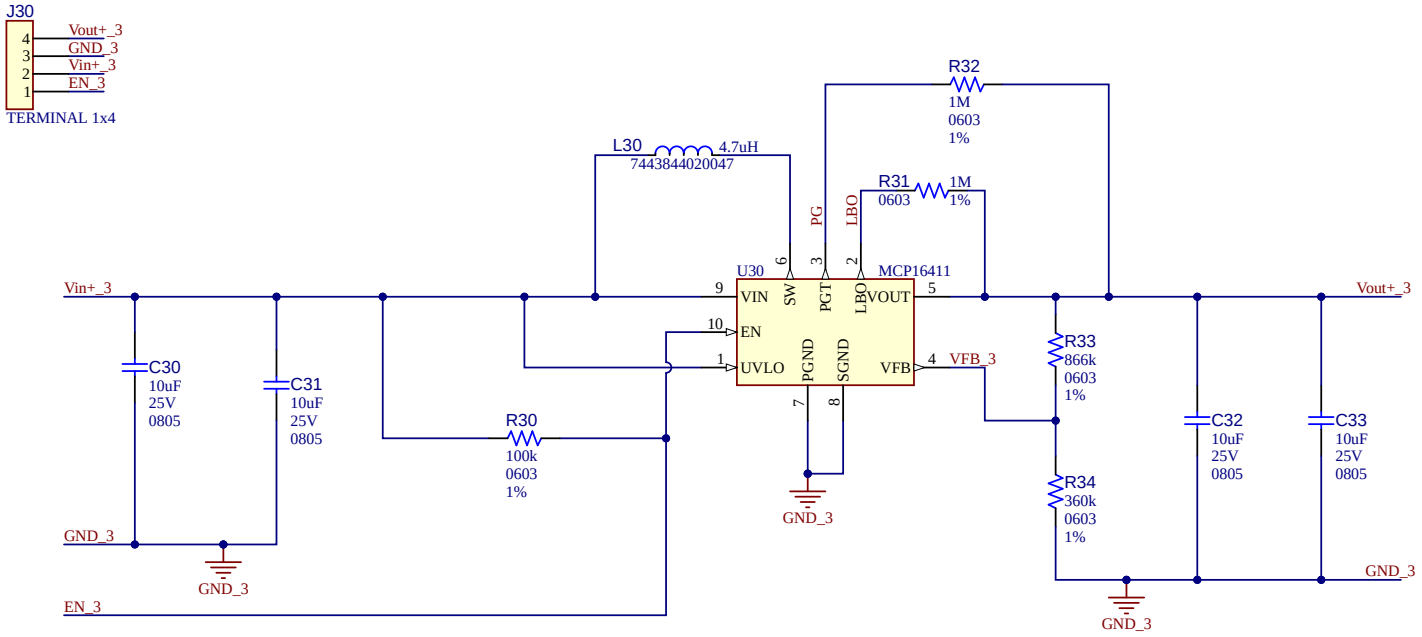


Figure 2-4. BBS4: MCP1663 Boost Regulator Schematic

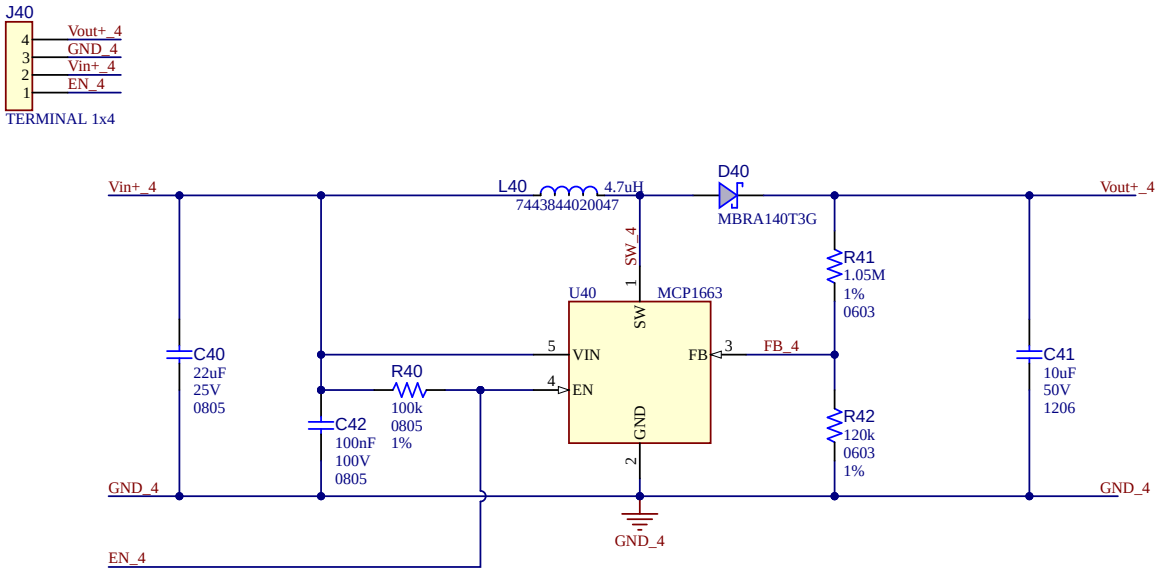


Figure 2-5. BBS5: MCP1663 Boost Regulator Schematic

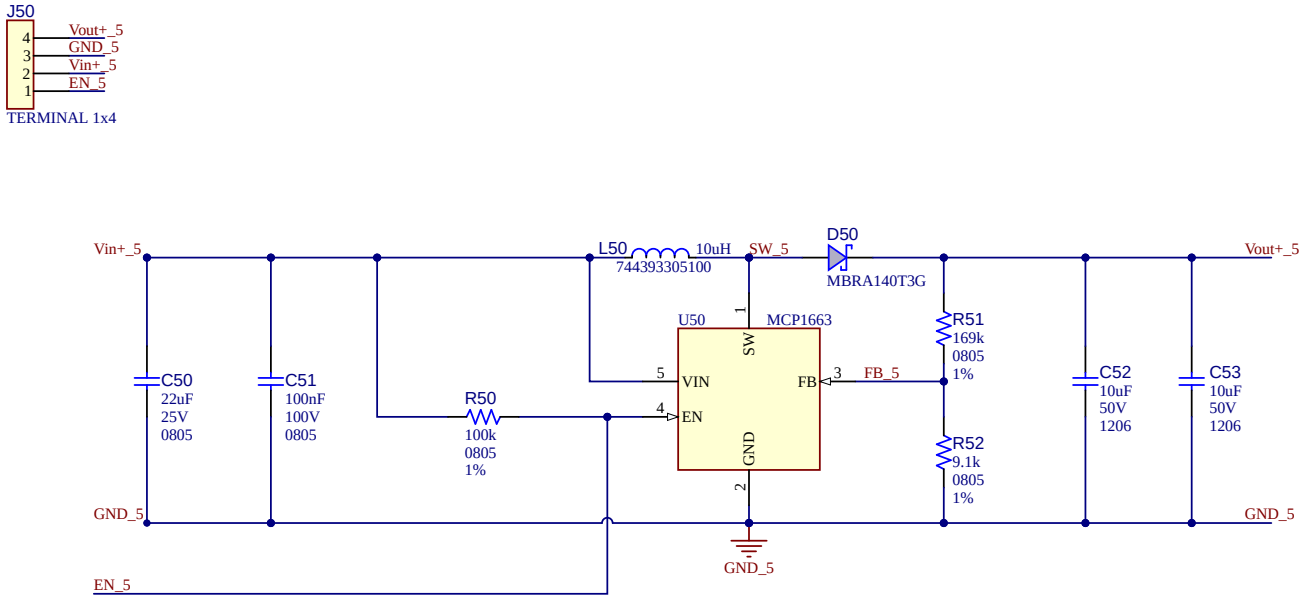


Figure 2-6. BBS6: MCP1664 LED Driver Schematic

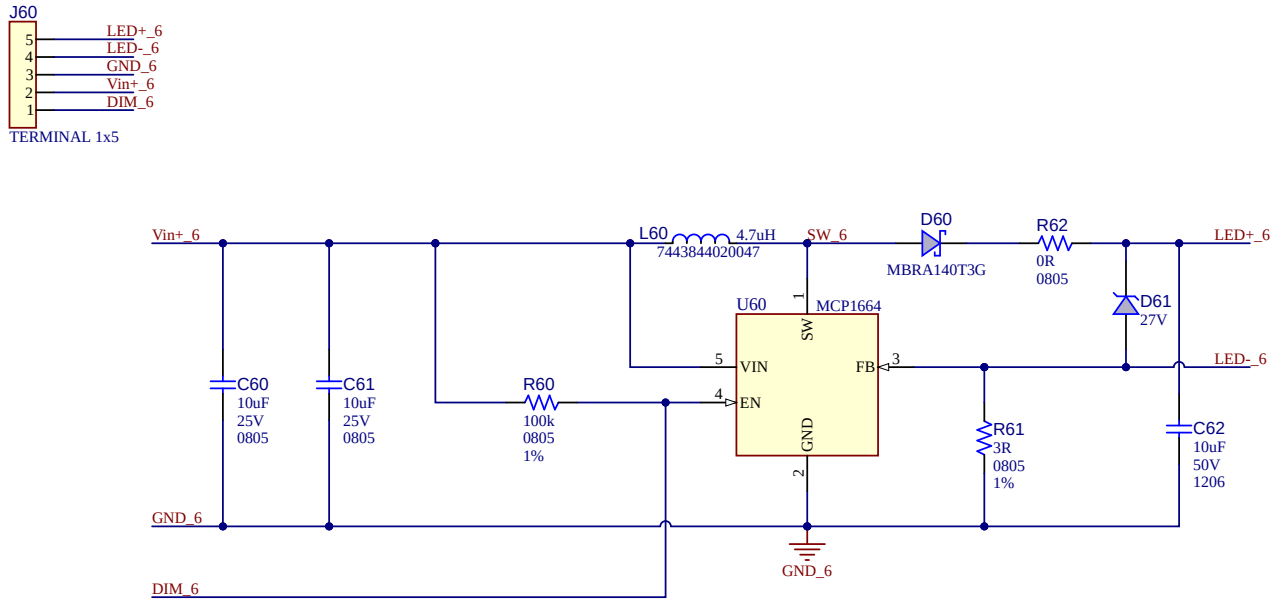
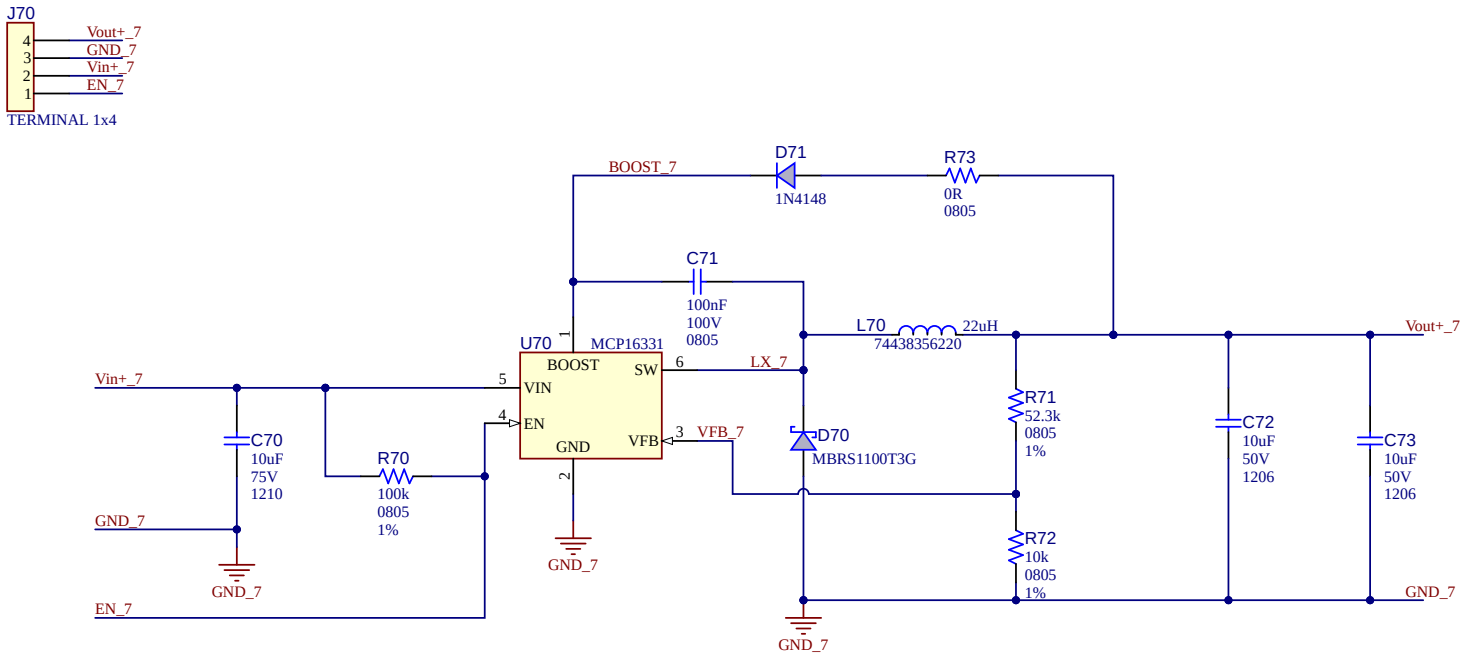


Figure 2-7. BBS7: MCP16331 Buck Regulator Schematic



2.2. Layouts

Figure 2-8. Top Silk

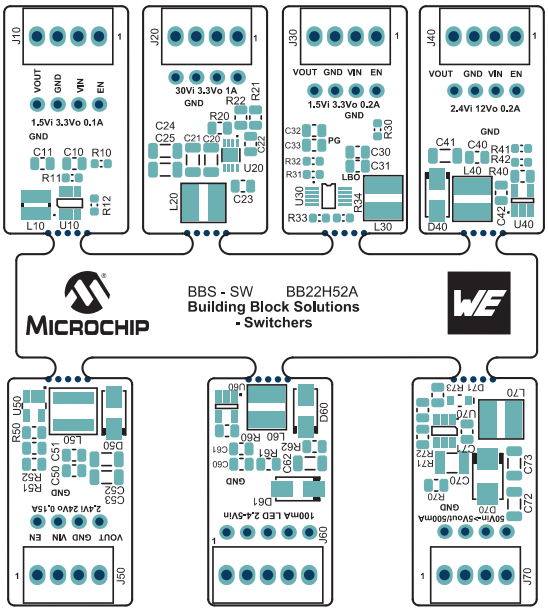


Figure 2-9. Top Copper and Silk

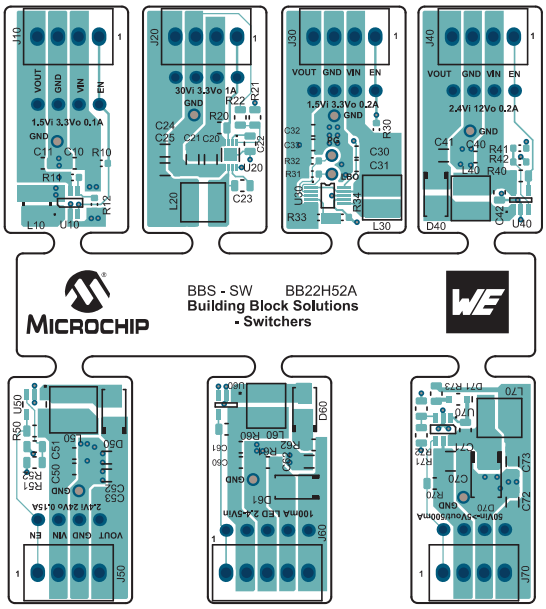


Figure 2-10. Top Copper

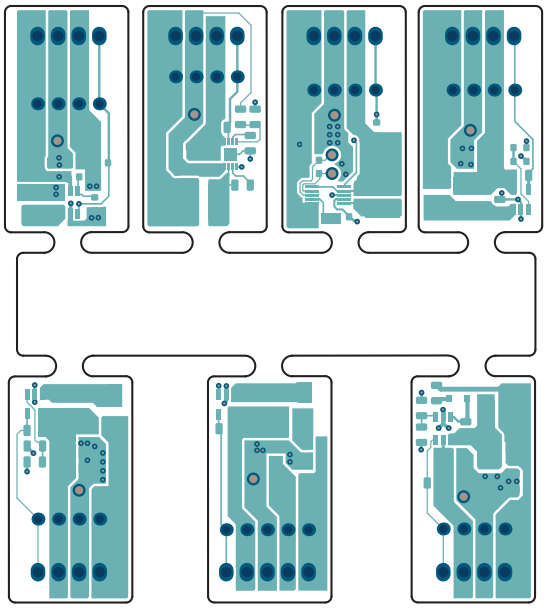


Figure 2-11. Inner Layer 1

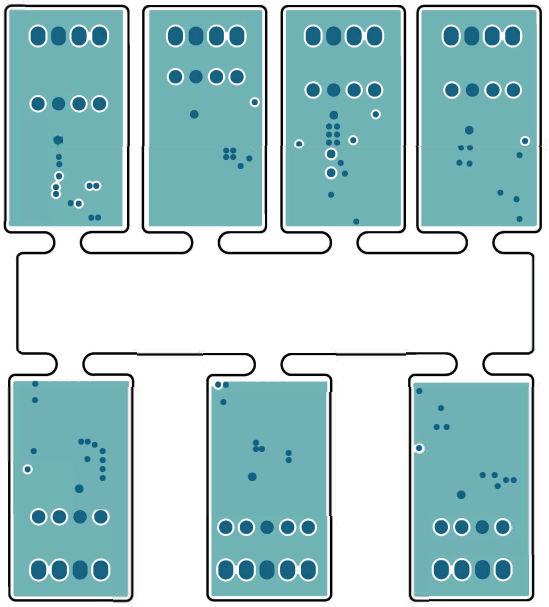


Figure 2-12. Inner Layer 2

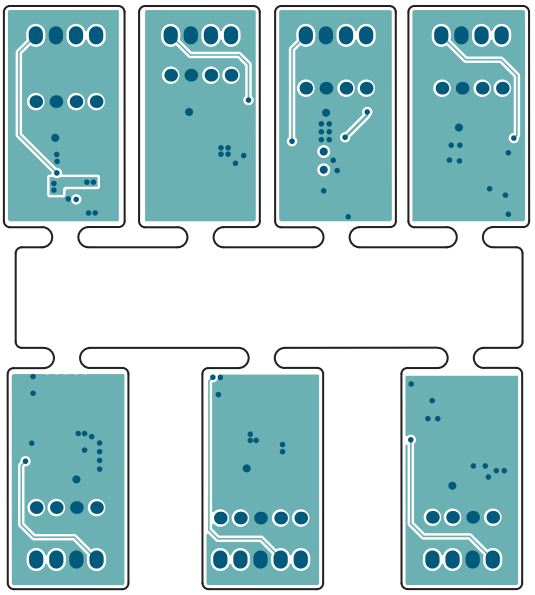


Figure 2-13. Bottom Copper

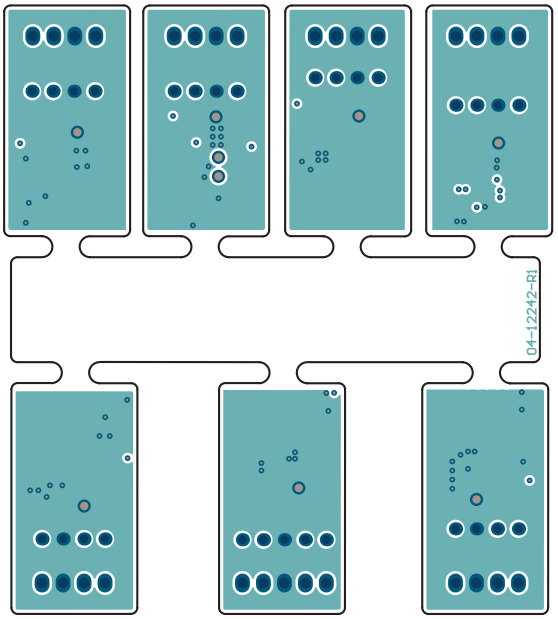


Figure 2-14. Bottom Copper and Silk

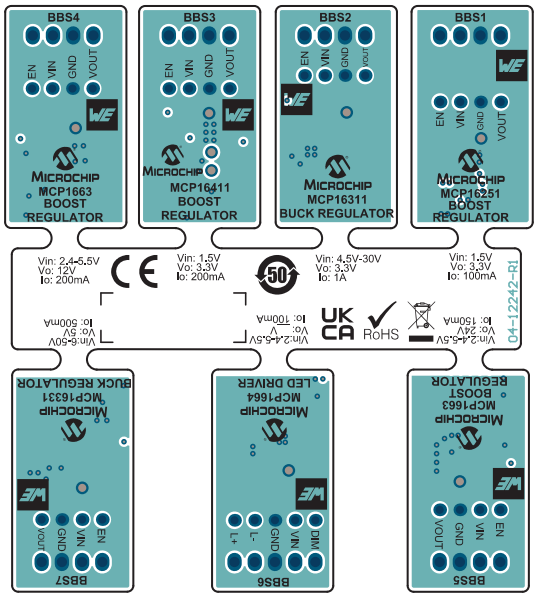
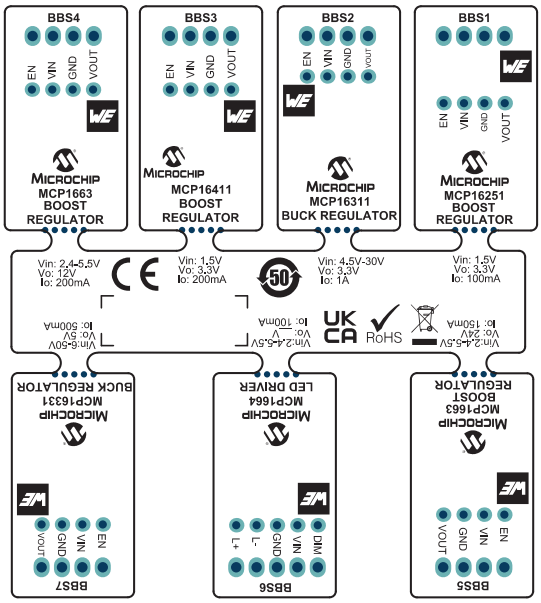


Figure 2-15. Bottom Silk



3. Bill of Materials (BOM)

Table 3-1. Bill of Materials (BOM)

Qty	Reference	Description	Manufacturer	Part Number
3	C10, C40, C50	Capacitor, Ceramic, 22 µF, 25V, 20%, X5R, SMD, 0805	Wurth Elektronik	885012107019
7	C11, C30, C31, C32, C33, C60, C61	Capacitor, Ceramic, 10 µF, 25V, 10%, X5R, SMD, 0805	Wurth Elektronik	885012107027
10	C20, C21, C24, C25, C41, C52, C53, C62, C72, C73	Capacitor, Ceramic, 10 µF, 50V, 10%, X5R, SMD, 1206	Wurth Elektronik	885012108022
1	C22	Capacitor, Ceramic, 1 µF, 25V, 10%, X7R, SMD, 0805	Wurth Elektronik	885012207078
4	C23, C42, C51, C71	Capacitor, Ceramic, 10 µF, 75V, 10%, X7R, SMD, 1210	Wurth Elektronik	885012207128
1	C70	Capacitor, Ceramic, 0.1 µF, 100V, 10%, X7R, SMD, 0805	TDK Corporation	C3225X7R1N106K250AC
3	D40, D50, D60	Diode, Schottky, 505 mV, 1A, 40V, SMD, DO-214AC (SMA)	ON Semiconductor®	MBRA140T3G
1	D61	Diode, Zener, 27V, 1.5W, DO-214AC (SMA)	ON Semiconductor®	SZ1SMA5935BT3G
1	D70	Diode, Schottky, 750 mV, 1A, 100V, SMD, SMB	ON Semiconductor®	MBRS1100T3G
1	D71	Diode, Rectifier, 1N4148, 1V, 150 mA, 75V, SMD, SOD-323	Micro Commercial Components (MCC)	1N4148WX-TP
6	J10, J20, J30, J40, J50, J70	Connector, Terminal, 2.54 mm, 1x4, Female, 18-30AWG, 6A, Through Hole, R/A	Wurth Elektronik	691210910004
1	J60	Connector, Terminal, 2.54mm, 1x5, Female, 18-30AWG, 6A, Through Hole, R/A	Wurth Elektronik	691210910005
1	L10	Inductor, 4.7 µH, 2.2A, 20%, WE-MAPI, SMD	Wurth Elektronik	74438335047HT
1	L20	Inductor, 15 µH, 2.1A, 20%, WE-MAPI, SMD	Wurth Elektronik	74438356150
3	L30, L40, L60	Inductor, 4.7 µH, 5.2A, 20%, WE-MAPI, SMD, L4.1W4.1H2.1	Wurth Elektronik	7443844020047
1	L50	Inductor, 10 µH, 5A, 20%, WE-XHMI, SMD	Wurth Elektronik	744393305100
1	L70	Inductor, 22 µH, 1.7A, 20%, SMD, L4.1W4.1H2.1	Wurth Elektronik	74438356220
2	R10, R30	Resistor, TKF, 100 kΩ, 1%, 1/10W, SMD, 0603	Wurth Elektronik	560112116004
1	R11	Resistor, TKF, 1.69 MΩ, 1%, 1/10W, SMD, 0603	Vishay	CRCW06031M69FKEA
3	R12, R31, R32	Resistor, TKF, 1 MΩ, 1%, 1/10W, SMD, 0603	Wurth Elektronik	560112116074
5	R20, R40, R50, R60, R70	Resistor, TKF, 100 kΩ, 1%, 1/4W, SMD, 0805	Wurth Elektronik	560112120013
1	R21	Resistor, TKF, 31.6 kΩ, 1%, 1/8W, SMD, 0805	Panasonic	ERJ-6ENF3162V
2	R22, R72	Resistor, TKF, 10 kΩ, 1%, 1/4W, SMD, 0805	Wurth Elektronik	560112120004
1	R33	Resistor, TKF, 866 kΩ, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-07866KL
1	R34	Resistor, TKF, 360 kΩ, 1%, 1/10W, SMD, 0603	Yageo Corporation	RC0603FR-07360KL
1	R41	Resistor, TKF, 1.05 MΩ, 1%, 1/10W, SMD, 0603	Vishay	CRCW06031M05FKEA
1	R42	Resistor, TKF, 120 kΩ, 1%, 1/10W, SMD, 0603	Wurth Elektronik	560112116044
1	R51	Resistor, TKF, 169 kΩ, 1%, 1/8W, SMD, 0805	Panasonic	ERJ-6ENF1693V
1	R52	Resistor, TKF, 9.1 kΩ, 1%, 1/8W, SMD, 0805	Stackpole Electronics, Inc.	RMCF0805FT9K10
1	R61	Resistor, TKF, 3Ω, 1%, 1/8W, SMD, 0805	Vishay	CRCW08053R00FKEA
2	R62, R73	Resistor, TKF, 0Ω, 1/8W, SMD, 0805	Wurth Elektronik	560112120002

Table 3-1. Bill of Materials (BOM) (continued)

Qty	Reference	Description	Manufacturer	Part Number
1	R71	Resistor, TKF, 52.3 kΩ, 1%, 1/8W, SMD, 0805	Panasonic	ERJ-6ENF5232V
1	PCB1	Printed Circuit Board		04-12242-R1

Table 3-2. Microchip Parts

Qty	Reference	Description	Manufacturer	Part Number
1	U10	Analog Switcher, Boost, 1.8V to 5.5V, SOT-23-6	Microchip Technology Inc.	MCP16251T-I/CH
1	U20	Analog Switcher, Buck, 2V to 24V, TDFN-8	Microchip Technology Inc.	MCP16311T-E/MNY
1	U30	Analog Switcher, Boost, 1.8V to 5.25V, MSOP-10	Microchip Technology Inc.	MCP16411T-I/UN
2	U40, U50	Analog Switcher, Boost, 32V, SOT-23-5	Microchip Technology Inc.	MCP1663T-E/OT
1	U60	Analog Switcher, Boost, 32V, SOT-23-5	Microchip Technology Inc.	MCP1664T-E/OT
1	U70	Analog Switcher, Buck, 2V to 24V, SOT-23-6	Microchip Technology Inc.	MCP16331T-E/CHCT-ND

4. References

Table 4-1. Recommended Reading

Source	Document Title	Literature Number	Available
Microchip Technology, Inc.	MCP16251 Data Sheet	DS20005173	www.microchip.com/MCP16251
Microchip Technology Inc.	MCP16311 Data Sheet	DS20005255	https://www.microchip.com/MCP16311
Microchip Technology Inc.	MCP16411 Data Sheet	DS20006394	https://www.microchip.com/MCP16411
Microchip Technology Inc.	MCP1663 Data Sheet	DS20005406	https://www.microchip.com/MCP1663
Microchip Technology Inc.	MCP1664 Data Sheet	DS20005408	https://www.microchip.com/MCP1664
Microchip Technology Inc.	MCP16331 Data Sheet	DS20005308	https://www.microchip.com/MCP16331

5. Revision History

Doc. Rev.	Date	Comments
A	11/2025	Initial release of this document.

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