EVM User's Guide: LMR51635EVM

LMR51635 Buck Evaluation Module

Description

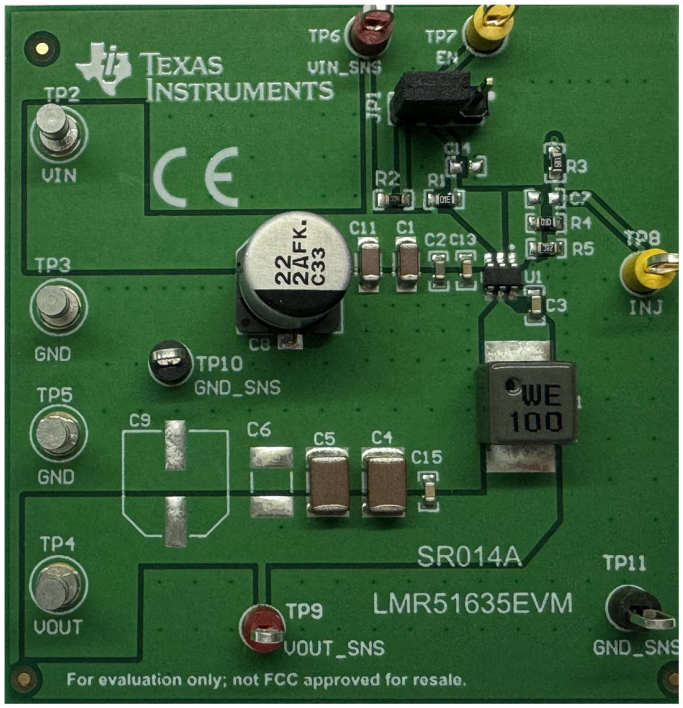
The Texas Instruments LMR51635EVM evaluation module (EVM) helps designers evaluate the operation and performance of the LMR51635 wide-input synchronous buck regulator. The LMR51635 is a wide-V_{IN}, easy-to-use synchronous buck converter. With the wide operating input voltage range of 4.3V to 60V, the device is designed for a wide range of industrial applications for power conditioning from an unregulated source. The LMR51635 operates at 400kHz and 1.1MHz switching frequency to support use of relatively small inductors for an optimized design size. The LMR51635 supports up to 3.5A continuous output current.

Features

- 4.3V to 60V input voltage range
- Default 5V output
- 3.5A continuous output current capability
- 400kHz switching frequency
- Hiccup mode short-circuit protection
- Frequency spread spectrum

Applications

- Major appliance
- PLC, DCS, and PAC
- Smart meters
- General purposes wide V_{IN} power supplies



LMR51635EVM Hardware Top View

1 Evaluation Module Overview

1.1 Introduction

The LMR51635EVM evaluation module (EVM) is a single, synchronous buck converter providing 5V at 3.5A output from 6V to 60V input. Table 1-1 shows the rated input voltage and output current ranges for the evaluation module.

Table 1-1. Input Voltage and Output Current Summary

EVM	Input Voltage (V_{IN}) RANGE	OUTPUT CURRENT (I_{OUT}) RANGE
LMR51635EVM	6V to 60V	0A to 3.5A

This user's guide contains information for the LMR51635 as well as support documentation for the LMR51635EVM evaluation module. This user's guide includes the performance specifications, schematic, and the bill of materials of the LMR51635EVM.

1.2 Kit Contents

- LMR51635EVM Circuit Board
- EVM Disclaimer Read Me
- Prototype EVM Disclaimer Read Me

1.3 Specification

A summary of the LMR51635EVM performance specifications is provided in Table 1-2. Specifications are given for an input voltage of V_{IN} = 24V and an output voltage of 5V, unless otherwise noted. The ambient temperature is 25°C for all measurement, unless otherwise noted.

Table 1-2. LMR51635EVM Performance Specifications Summary

SPECIFICATIONS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input voltage range (V_{IN})		6	24	60	V
Output voltage			5		V
Operating frequency	V_{IN} = 24V, I_{OUT} = 3.5A		400		kHz
Output current range		0		3.5	A
Output ripple voltage	V_{IN} = 24V, I_{OUT} = 3.5A		25		mV_{PP}
Efficiency	V_{IN} = 24V, I_{OUT} = 3.5A		90		%

1.4 Device Information

The purpose of LMR51635EVM is to showcase the typical application of the LMR51635 device.

2 Hardware Setup and Test Resutls

This section describes the jumpers and connectors on the EVM and how to properly connect, set up, and use the LMR51635EVM. The section also includes test results of output voltage ripple and start-up.

2.1 Setup

2.1.1 Input and Output Connector Description

- **V_{IN} — Terminal TP2** – Power input terminal for the converter. Adjacent to this terminal is the GND reference ground. Use this terminal to attach the EVM to a cable harness.
- **V_{OUT} — Terminal TP4**– Regulated output voltage for the converter. Adjacent to this terminal is the GND reference ground.
- **GND — Terminal TP3, TP5** – Ground reference for the converter. Use these terminals to attach the EVM to a cable harness.
- **Enable Setting — Jumper JP1** – Used to configure the enable circuit. Leave the pins open or short Pin2 with pin3 enables the circuit, short Pin2 to Pin1 disables the circuit. See Table 2-1 for details.

Table 2-1. EN Connections

EN Connection	Configuration
Leave all pins of JP1 open	Enable, EN connect to V_{IN} through a pullup resistor
Short Pin2 with pin3, leave Pin1 open	Enable, Programmable system UVLO by EN divider
Short Pin2 with pin1	Disable, EN connect to GND directly

- **Test point** — TP6, TP7, TP8, TP9, TP10, TP11 are test points. See Table 2-2 for details.

Table 2-2. Test Point connections

Reference Designator	Function
TP6(VIN_SNS)	Test point for V_{IN}
TP7(EN)	Test point for EN
TP8(INJ)	Test point for loop response measurement
T9(VOUT_SNS)	Test point for V_{OUT}
T10, TP11(GND_SNS)	Test point for GND

2.1.2 Adjusting the Output Voltage

To change the output voltage of the EVMs, change the value of resistor R_4 (R_{FB_TOP}) and resistor R_5 (R_{FB_BOT}). The value of R_4 and R_5 for a specific output voltage can be calculated using Equation 1.

$$V_{OUT} = 0.8 \times \left(1 + \frac{R4}{R5}\right) \quad (1)$$

2.2 Test Results

2.2.1 Output Voltage Ripple

The following images show the LMR51635EVM output voltage ripple waveforms. The output currents are as indicated.

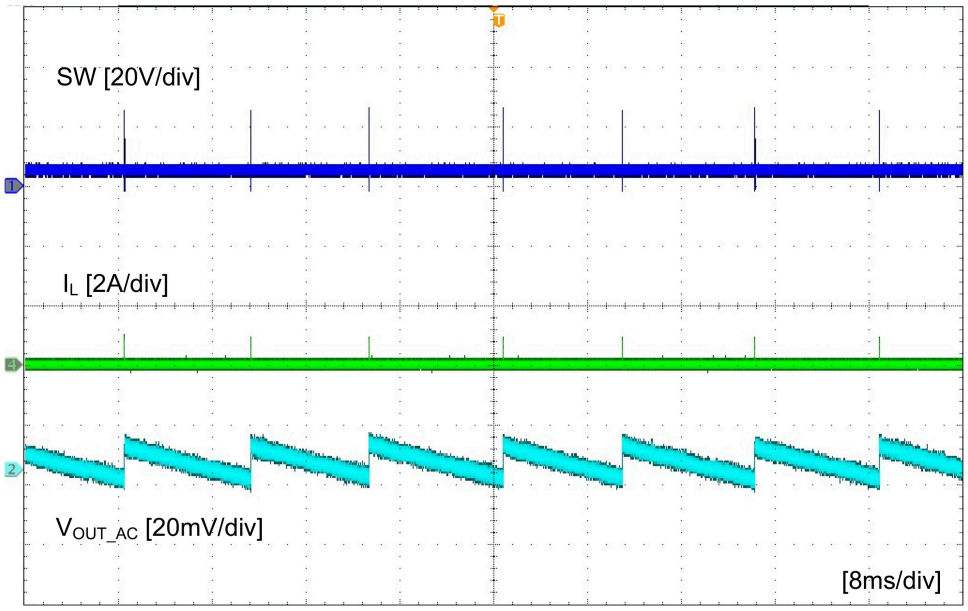


Figure 2-1. LMR51635EVM Output Voltage Ripple, V_{IN} = 24V, I_{OUT} = 0A

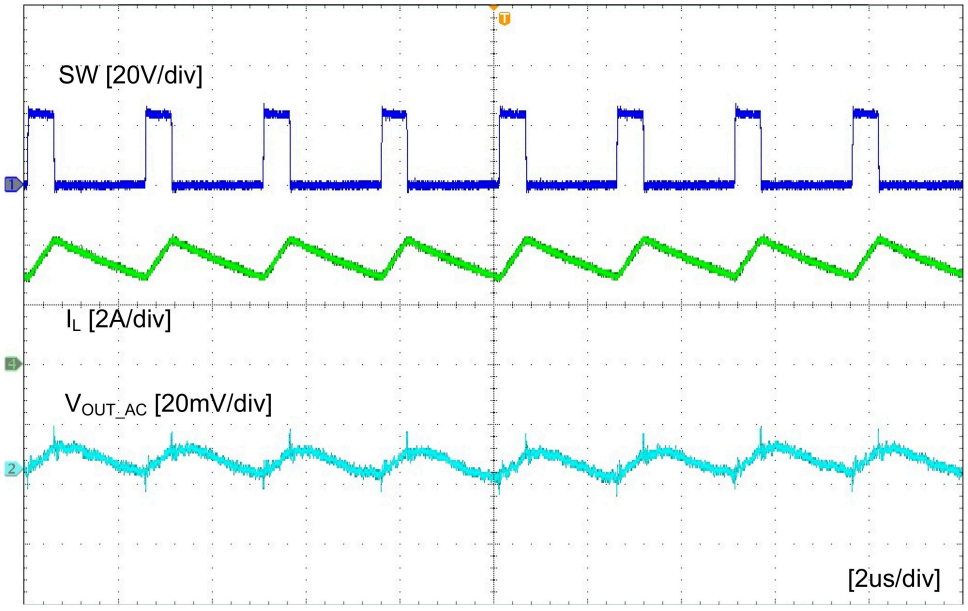


Figure 2-2. LMR51635EVM Output Voltage Ripple, V_{IN} = 24V, I_{OUT} = 3.5A

2.2.2 Start-Up Relative to V_{IN}

The following figure shows the LMR51635EVM start-up waveform relative to V_{IN}.

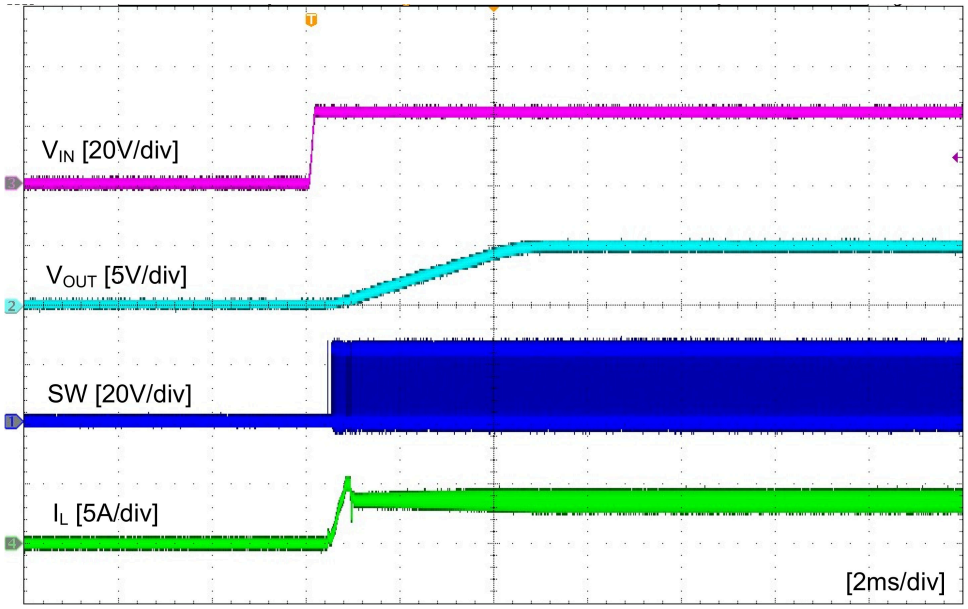


Figure 2-3. LMR51635EVM Start-Up Relative to V_{IN}, I_{OUT} = 3.5A

2.2.3 Start-Up Relative to EN

The following figure shows the LMR51635EVM start-up waveform relative to V_{IN}.

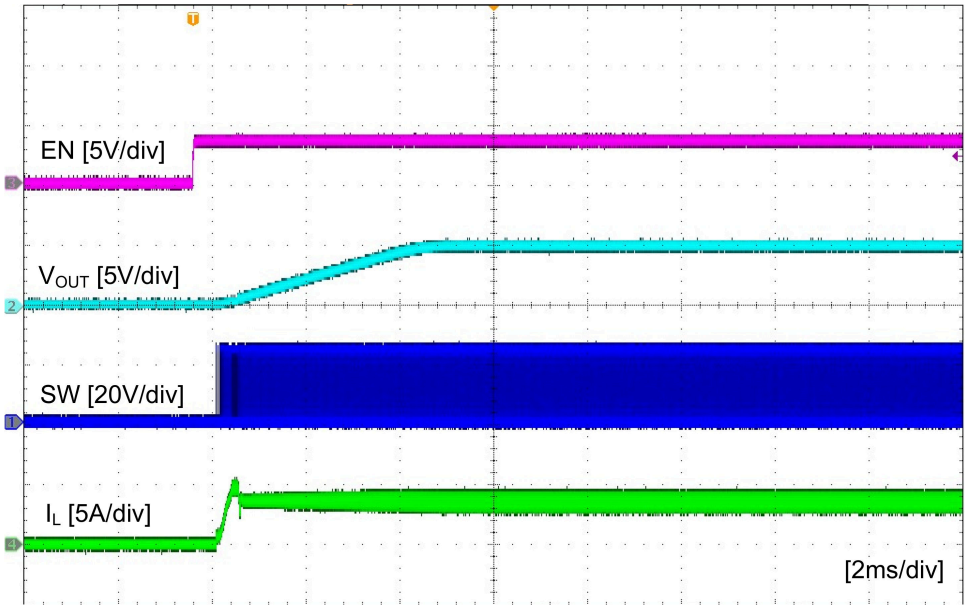


Figure 2-4. LMR51635EVM Start-Up Relative to EN, I_{OUT} = 3.5A

3 Hardware Design Files

3.1 Schematic

Figure 3-1 is the schematic for the LMR51635EVM.

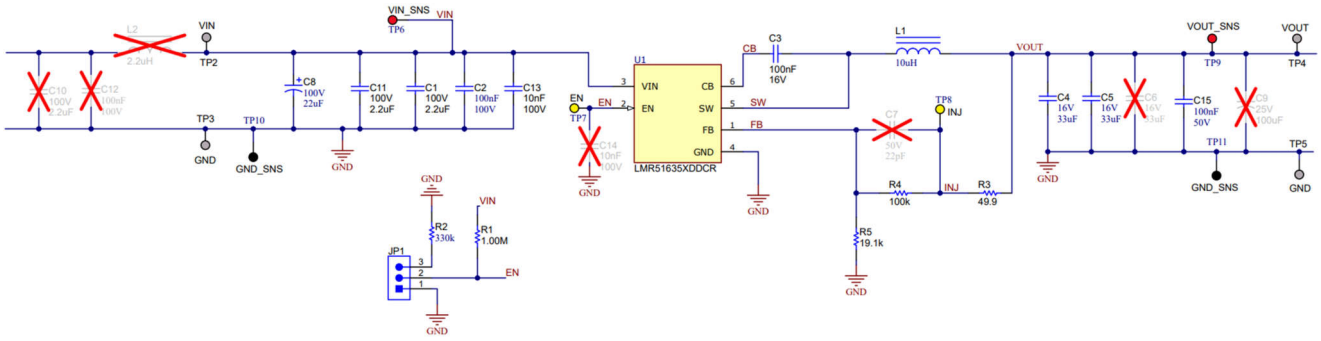


Figure 3-1. LMR51635EVM Schematic Diagram

3.2 PCB Layouts

This section provides a description of the LMR51635EVM, board layout, and layer illustrations.

The board images are shown in Figure 3-2 and Figure 3-3. The board layouts are shown in Figure 3-4 to Figure 3-7. The PCB consists of a 4-layer design. The board size is 55mm × 57mm. 2OZ copper planes are applied on top and bottom layers, 1OZ copper planes are applied on middle layers.

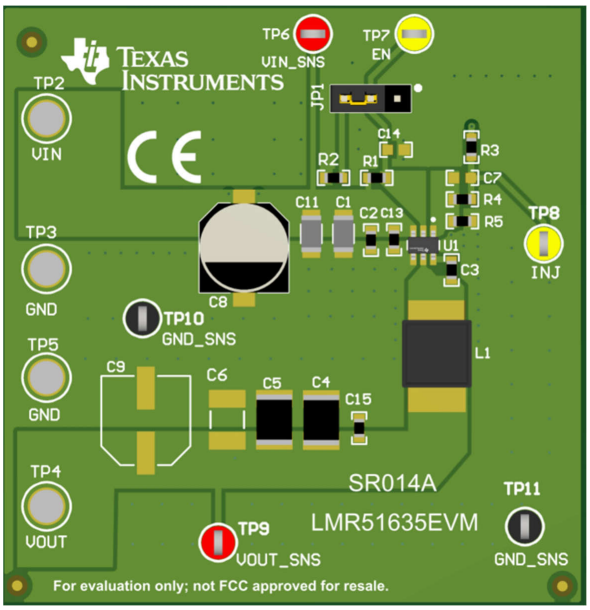


Figure 3-2. LMR51635EVM Top View

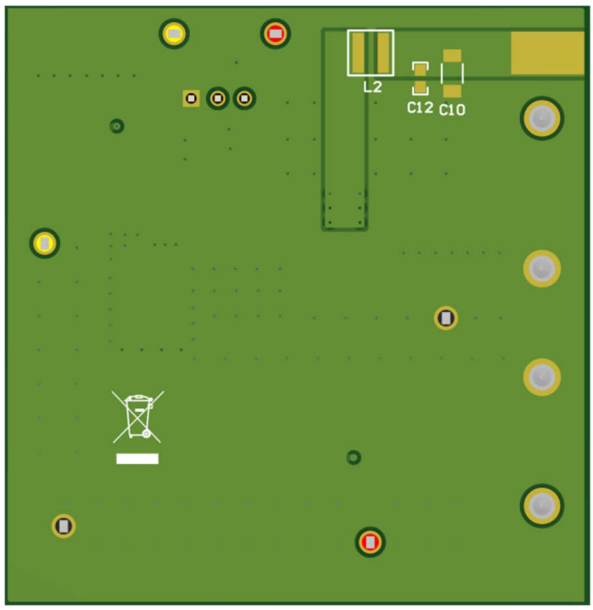


Figure 3-3. LMR51635EVM Bottom View

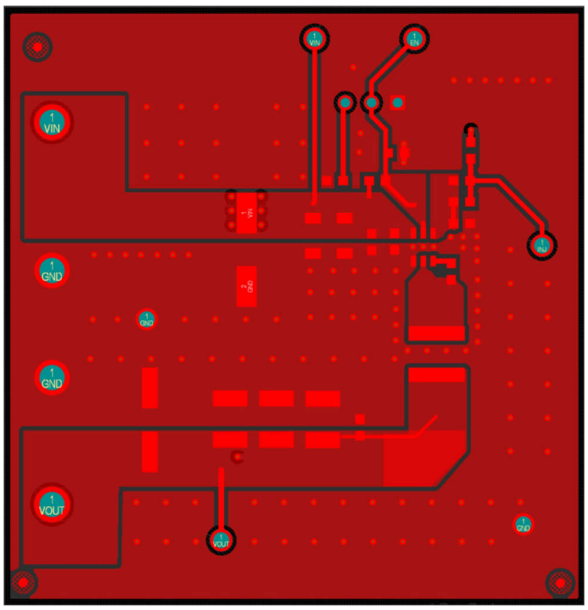


Figure 3-4. Top Layer

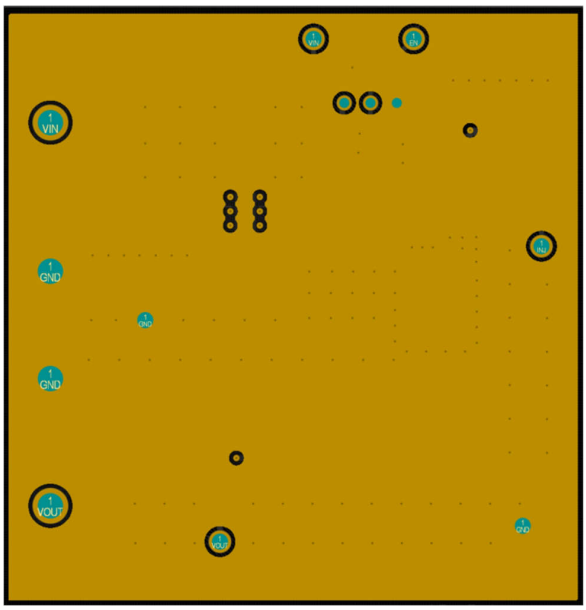


Figure 3-5. Middle Layer 1

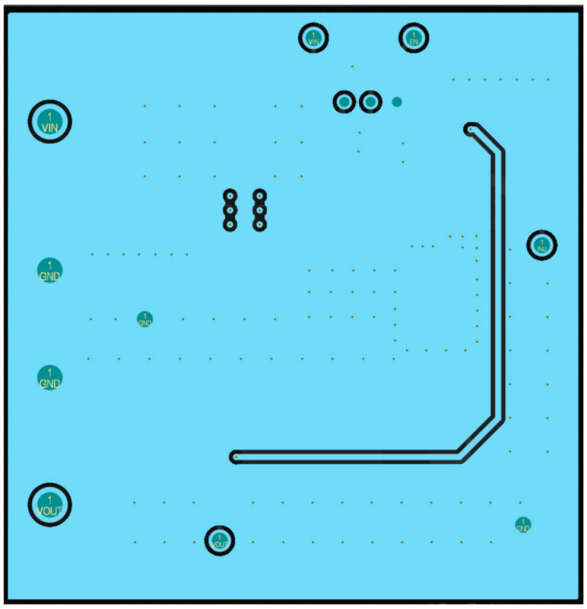


Figure 3-6. Middle Layer 2

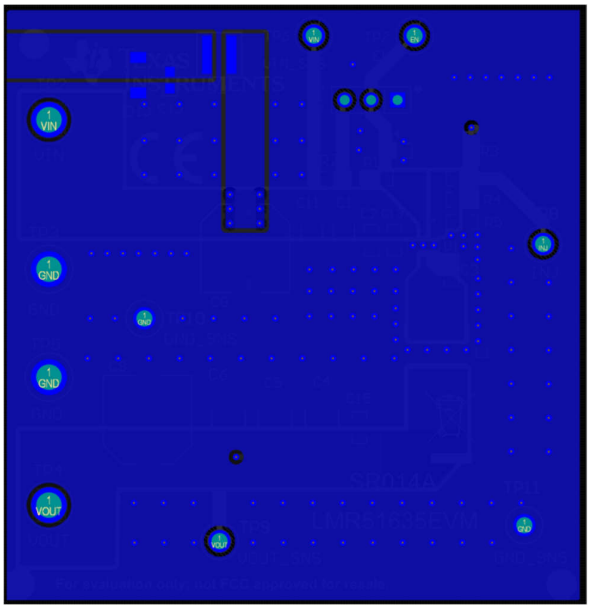


Figure 3-7. Bottom Layer

3.3 Bill of Materials

Table 3-1. Bill of Material

Designator	QTY	Description	Part Number	Manufacturer
PCB	1	Printed circuit board, 2165mil × 2244mil	SR014	–
C1, C11	2	Capacitor, Ceramic, 2.2uF, 100V, X7S, 1206	C3216X7S2A225K160AB	TDK
C2	1	Capacitor, Ceramic, 0.1uF, 100V, X7R, 0603	GRM188R72A104KA35J	MuRata
C3	1	Capacitor, Ceramic, 0.1µF, 16V, X7R, AEC-Q200 Grade 1, 0603	0603YC104K4T4A	AVX
C4, C5	2	Capacitor, Ceramic, 22uF, 25V, X7R, AEC-Q200 Grade 1,	CGA8P1X7R1E226M250KC	TDK
C8	1	Capacitor, Aluminum, 22uF, 100V, 1.3Ω, AEC-Q200 Grade 2, SMD	EEE-FK2A220P	Panasonic
C13	1	Capacitor, Ceramic, 0.01uF, 100V, X7R, 0603	GRM188R72A103KA01D	MuRata
C15	1	Capacitor, Ceramic, 0.1uF, 50V, X7R, 0603	C1608X7R1H104K080AA	TDK
JP1	1	Header, 100mil, 3x1, Tin, TH	PEC03SAAN	Sullins Connector Solutions
L1	1	Inductor, Shielded, Hyperflux, 10µH, 5A, 0.02915Ω, SMD	74439346100	Wurth Elektronik
R1	1	Resistor, 1.00MΩ, 1%, 0.1W, 0603	RC0603FR-071ML	Yageo
R2	1	Resistor, 178kΩ, 1%, 0.1W, 0603	CRCW0603178KFKEA	Vishay-Dale
R3	1	Resistor, 49.9Ω, 1%, 0.1W, 0603	RC0603FR-0749R9L	Yageo
R4	1	Resistor, 100kΩ, 1%, 0.1W, 0603	RC0603FR-07100KL	Yageo
R5	1	Resistor, 19.1kΩ, 1%, 0.1W, 0603	RC0603FR-0719K1L	Yageo
SH-JP1	1	Shunt, 100mil, Gold plated, Black	SNT-100-BK-G	Samtec
TP2, TP3, TP4, TP5	4	Terminal, Turret, TH, DO1502-2	1502-2	Keystone
TP6, TP9	2	Test Point, Multipurpose, Red, TH	5010	Keystone
TP7, TP8	2	Test Point, Multipurpose, Yellow, TH	5014	Keystone
TP10, TP11	2	Test Point, Multipurpose, Black, TH	5011	Keystone
U1	1	IC, LMR51635X, 60V, 3.5A, Synchronous Buck Converter in a SOT-23 Package	LMR51635XDDCR	Texas Instruments

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

5 Related Documentation

Texas Instruments, *LMR51635 4.3V to 60V, 3.5A Synchronous Buck Converter* data sheet

6 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision * (August 2024) to Revision A (November 2024)	Page
• Updated the hardware figure	1
• Added the *Kit Contents* section	2
• Updated Figure 3-1	6
• Updated Figure 3-2 through Figure 3-7	7
• Updated the BOM list	9

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