Texas Instruments LM3477 Buck Controller Evaluation Module User Guide

Contents

LM3477 Buck Controller Evaluation Module

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Product Information

The LM3477 Buck Controller Evaluation Module is a current mode, high-side N channel FET controller. It is commonly used in buck configurations. The LM3477 allows for a large variety of inputs, outputs, and loads. The evaluation board comes ready to operate with specific conditions.

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Product Usage Instructions

1. Ensure that the power components (catch diode, inductor, and filter capacitors) are placed close together on the PCB layout. Make the traces between them short.
2. Use wide traces between the power components and for power connections to the DC-DC converter circuit.
3. Connect the ground pins of the input and output filter capacitors and catch diode as close as possible using appropriate layout techniques.

Bill of Materials (BOM)

Component	Value	Part Number
CIN1	594D127X0020R2	No connect
CIN2	No connect	No connect
COUT1	LMK432BJ226MM (Taiyo Yuden)	LMK432BJ226MM (Taiyo Yuden)
COUT2	DO3316P-103 (Coilcraft)	1.8 k
L	CRCW08051821FRT1 (Vitramon)	12 nF/50 V
RC	VJ0805Y123KXAAT (Vitramon)	No connect
CC1	5 A, 30 V	IRLMS2002 (IRF)
CC2	100 V, 3 A	MBRS340T3 (Motorola)
Q1	20	CRCW080520R0FRT1 (Vitramon)
D	1 k	CRCW08051001FRT1 (Vitramon)
RDR	16.2 k	CRCW08051622FRT1 (Vitramon)
RSL	10.0 k	CRCW08051002FRT1 (Vitramon)
RFB1	470 pF	VJ0805Y471KXAAT (Vitramony)
RFB2	0.03	No connect

Performance

The efficiency vs load and efficiency vs VIN graphs are shown in the user manual for reference.

Layout Fundamentals

For proper layout of the LM3477 Buck Controller Evaluation Module, follow these guidelines:

1. Place the power components (catch diode, inductor, and filter capacitors) close together on the PCB layout. Make the traces between them short.
2. Use wide traces between the power components and for power connections to the DC-DC converter circuit.
3. Connect the ground pins of the input and output filter capacitors and catch diode as close as possible using appropriate layout techniques.

Refer to the user manual for the LM3477 Evaluation Board PCB Layout diagram.

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1 Introduction

The LM3477 is a current mode, high-side N channel FET controller. It is most commonly used in buck configurations, as shown in Figure 1-1. All the power conducting components of the circuit are external to the LM3477, so a large variety of inputs, outputs, and loads can be accommodated by the LM3477.

The LM3477 evaluation board comes ready to operate at the following conditions:

· 4.5 V VIN 15 V · VOUT = 3.3 V · 0 A IOUT 1.6 A

The circuit and BOM for this application are given in Figure 1-1 and Table 1-1.

Figure 1-1. LM3477 Buck Converter

Component CIN1 CIN2 COUT1 COUT2 L RC CC1 CC2 Q1 D RDR RSL RFB1 RFB2 CFF RSN

Table 1-1. Bill of Materials (BOM)

Value

Part Number

120 µF/20 V

594D127X0020R2

No connect

22 µF/10 V

LMK432BJ226MM (Taiyo Yuden)

22 µF/10 V

LMK432BJ226MM (Taiyo Yuden)

10 µH, 3.8 A

DO3316P-103 (Coilcraft)

1.8 k

CRCW08051821FRT1 (Vitramon)

12 nF/50 V

VJ0805Y123KXAAT (Vitramon)

No connect

5 A, 30 V

IRLMS2002 (IRF)

100 V, 3 A

MBRS340T3 (Motorola)

20

CRCW080520R0FRT1 (Vitramon)

1 k

CRCW08051001FRT1 (Vitramon)

16.2 k

CRCW08051622FRT1 (Vitramon)

10.0 k

CRCW08051002FRT1 (Vitramon)

470 pF

VJ0805Y471KXAAT (Vitramony)

0.03

WSL 2512 0.03 ±1% (Dale)

2 Performance

Figure 2-1 to Figure 2-2 show some benchmark data taken from the circuit above on the LM3477 evaluation board. This evaluation board can also be used to evaluate a buck regulator circuit optimized for a different operating point or to evaluate a trade-off between cost and some performance parameter. For example, the conversion efficiency can be increased by using a lower RDS(ON) MOSFET, ripple voltage can be lowered with lower ESR output capacitors, and the hysteretic threshold can be changed as a function of the RSN and RSL resistors.

The conversion efficiency can be increased by using a lower RDS(ON) MOSFET, however, it drops as input voltage increases. The efficiency reduces because of increased diode conduction time and increased switching losses. Switching losses are due to the Vds × Id transition losses and to the gate charge losses, both of which can be lowered by using a FET with low gate capacitance. At low duty cycles, where most of the power loss in the FET is from the switching losses, trading off higher RDS(ON) for lower gate capacitance will increase efficiency.

Figure 2-1. Efficiency vs Load VOUT = 3.3 V

Figure 2-2. Efficiency vs VIN VOUT = 3.3 V, IOUT = 2 A

Figure 3-1 shows a bode plot of LM3477 open loop frequency response using the external components listed in Table 1-1.

Magnitude = 20 dB/Decade, Bandwidth = 39.8 kHz, Phase = 45°/Decade, Phase Margin = 41°

Figure 2-3. Open Loop Frequency Response VIN = 5 V, VOUT = 3.3 V, IOUT = 1.5 A

3 Hysteretic Mode

As the load current is decreased, the LM3477 will eventually enter a 'hysteretic' mode of operation. When the load current drops below the hysteretic mode threshold, the output voltage rises slightly. The overvoltage protection (OVP) comparator senses this rise and causes the power MOSFET to shut off. As the load pulls current out of the output capacitor, the output voltage drops until it hits the low threshold of the OVP comparator and the part begins switching again. This behavior results in a lower frequency, higher peak-to-peak output voltage ripple than with the normal pulse width modulation scheme. The magnitude of the output voltage ripple is determined by the OVP threshold levels, which are referred to the feedback voltage and are typically 1.25 V to 1.31 V. For more information, see the Electrical Characteristics table in the LM3477 High Efficiency High-Side N-Channel Controller for Switching Regulator Data Sheet. In the case of a 3.3-V output, this translates to a regulated output voltage between 3.27 V and 3.43 V. The hysteretic mode threshold point is a function of RSN and RSL. Figure 3-1 shows the hysteretic threshold versus VIN for the LM3477 evaluation board with and without RSL.

Figure 3-1. ITH vs VIN

4 Increasing Current Limit

TthheemRiSnLimreusmisitnodr uocfftearnscfelefxoirbsilittaybiinlitcyh(osoeseinthgethSelorpaemCpoomf tpheensslaotpioencsoemctpioennsinattihoen.LSMlo3p4e77coHmigphenEsffaictiioenncayffeHcigtshSide N-Channel Controller for Switching Regulator Data Sheet), but also helps determine the current limit and hysteretic threshold. As an example, RSL can be disconnected and replaced by a 0- resistor so that no extra slope compensation is added to the current sense waveform to increase the current limit. A more conventional way to adjust the current limit is to change RSN. RSL is used here to change current limit for the sake of simplicity and to demonstrate the dependence of current limit to RSL. By changing RSL to 0 , the following conditions can be met:

4.5 V VIN 15 V

VOUT = 3.3 V

0 A IOUT 3 A

The current limit is a weak function of slope compensation and a strong function of the sense resistor. By decreasing RSL, slope compensation is decreased, and as a result the current limit increases. The hysteretic mode threshold will also increase to about 1 A (see Figure 3-1).

Figure 4-1 shows a bode plot of LM3477 open loop frequency response using the modified (RSL = 0) components to achieve higher output current capability.

Magnitude = 20 dB/Decade, Bandwidth = 55.3 kHz, Phase = 45°/Decade, Phase Margin = 42°

Figure 4-1. Open Loop Frequency Response VIN = 5 V, VOUT = 3.3 V, IOUT = 3 A

5 Layout Fundamentals

Good layout for DC-DC converters can be implemented by following a few simple design guidelines:

1. Place the power components (catch diode, inductor, and filter capacitors) close together. Make the traces between them short.

2. Use wide traces between the power components and for power connections to the DC-DC converter circuit. 3. Connect the ground pins of the input and output filter capacitors and catch diode as close as possible using generous component-side copper fill as a pseudo-ground plane. Then, connect this to the ground-plane with several vias. 4. Arrange the power components so that the switching current loops curl in the same direction. 5.

Route high-frequency power and ground return as direct continuous parallel paths. 6. Separate noise sensitive traces, such as the voltage feedback path, from noisy traces associated with the power components. 7. Ensure a good low-impedance ground for the converter IC. 8. Place the supporting components for the converter IC, such as compensation, frequency selection and charge-pump components, as close to the converter IC as possible but away from noisy traces and the power components. Make their connections to the converter IC and its pseudo-ground plane as short as possible. 9. Place noise sensitive circuitry, such as radio-modem IF blocks, away from the DC-DC converter, CMOS digital blocks, and other noisy circuitry.

Figure 5-1. LM3477 Evaluation Board PCB Layout (Top Side)

Figure 5-2. LM3477 Evaluation Board PCB Layout (Bottom Side)

6 Revision History

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

Changes from Revision E (April 2013) to Revision F (February 2022)

Page

- Updated the numbering format for tables, figures, and cross-references throughout the document. …………….2
- Updated the updated user's guide title………………………………………………………………………………………… 2

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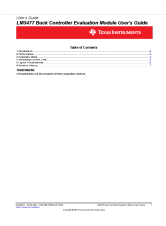	Texas Instruments LM3477 Buck Controller Evaluation Module [pdf] User Guide LM3477 Buck Controller Evaluation Module, LM3477, Buck Controller Evaluation Module, Controller Evaluation Module, Evaluation Module, Module

References

- Analog | Embedded processing | Semiconductor company | TI.com
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