User's Guide

LM2744 Buck Controller Evaluation Module User's Guide

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Trademarks

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1 Introduction

This user's guide describes the LM2743 printed circuit board (PCB) design and provides an example typical application circuit. The demo board allows component design flexibility in order to demonstrate the versatility of the LM2744 IC.

The demo board contains a voltage-mode, high-speed synchronous buck regulator controller with an external adjustable reference voltage between 0.5 V and 1.5 V. The demo board design incorporates the LM4140 high precision low noise reference IC providing 1.0 V to the reference pin (V_{REF}). Though the control sections of the IC are rated for 3 to 6 V (V_{CC}), the driver sections are designed to accept input supply rails (V_{IN}) as high as 14 V. It operates at a fixed frequency, adjustable from 50 kHz to 1 MHz with one external resistor.

The demo board design regulates to an output voltage of 1.2 V at 3.5 A with a switching frequency of 1 MHz. Note, the demo board is optimized for a 1-MHz, 14-V input voltage compensation design. If another switching frequency and input voltage is desired, please consult the *LM2744 Low Voltage N-Chan MOSFET Synch Buck Regr Cntrl w/ Ext Ref* data sheet for control loop compensation procedures. For additional design modifications, refer to the *Design Consideration* section of the *LM2744 Low Voltage N-Chan MOSFET Synch Buck Regr Cntrl w/ Ext Ref* data sheet.

2 Additional Footprints

A Schottky diode footprint (D1) is available in parallel to the low-side MOSFET. This component can improve efficiency, due to the lower forward drop than the low-side MOSFET body diode conducting during the anti-shoot–through period. Select a Schottky diode that maintains a forward drop around 0.4 V to 0.6 V at the maximum load current (consult the I-V curve). In addition, select the reverse breakdown voltage to have sufficient margin above the maximum input voltage.

Footprint C13 is available for a multilayer ceramic capacitor (MLCC) connected as close as possible to the source of the low-side MOSFET and drain of the high-side MOSFET. This will provide low supply impedance to the high speed switch currents, thus minimizing the input supply noise. For example; a MLCC is used (C13) in combination with aluminum electrolytic input filter capacitors, placed in designators C12 and C14, because MLCC has lower impedance than electrolytics. If MLCCs are used in designators C12 and C14, component C13 is not necessary.

The PCB is designed on two layers with 1-oz. copper on a 62-mil FR4 laminate.

3 Guidelines for Additional Options

When using a DC power supply to set a reference voltage (V_{REF}), connect a capacitor (C20) from V_{DCS} to GND to filter the DC power supply. A good starting point is 10 µF, but it may need to be varied depending on the magnitude of the DC power supply noise (any make of capacitor will do as long as the capacitance is maintained within the operating temperature range). Remove R10 and place a 0-Ω jumper in designator R12.

Designators R12 and R13 are provided for DDR SDRAM (double data rate synchronous dynamic random access memory) active termination design. Set V_{REF} to half the DDR supply voltage by using designators R12 and R13 as a voltage divider. Remove resistors R7 and R10 and capacitor C21, and connect the DDR supply voltage rail to terminal V_{DCS}. Refer to Figure 4-2. The modified circuit in Figure 4-1 can sink or source current in excess of 3 A. A load transient response applied to the output of Figure 4-2 is provided in Figure 5-1.

Do not exceed 5.6 V on the VCC pin of the demo board. The board layout connects both the input voltage of the LM4140-1.0 (pin 2) and the control section of the LM2744 (VCC). The maximum DC supply voltage for the control section of the LM2744 is 6 V, while 5.6 V is the maximum rating for any input pin of the LM4140. If the design requires the control section of the LM2744 to be 6 V, a shunt zener reference can be placed at designator location (D3) to maintain the input voltage of the LM4140 between 1.8 V and 5.5 V. The cathode of the zener is connected to the input of the LM4140 and the anode to GND. The resistance of R10 must be selected to supply the appropriate amount of biasing current into the zener and the LM4140 (refer to the *Electrical Characteristics* table of the *LM2744 Low Voltage N-Chan MOSFET Synch Buck Regr Cntrl w/ Ext Ref* data sheet.

4 Typical Application Circuit

The typical application circuit in Figure 4-1 provides the component designators used on the demo board.

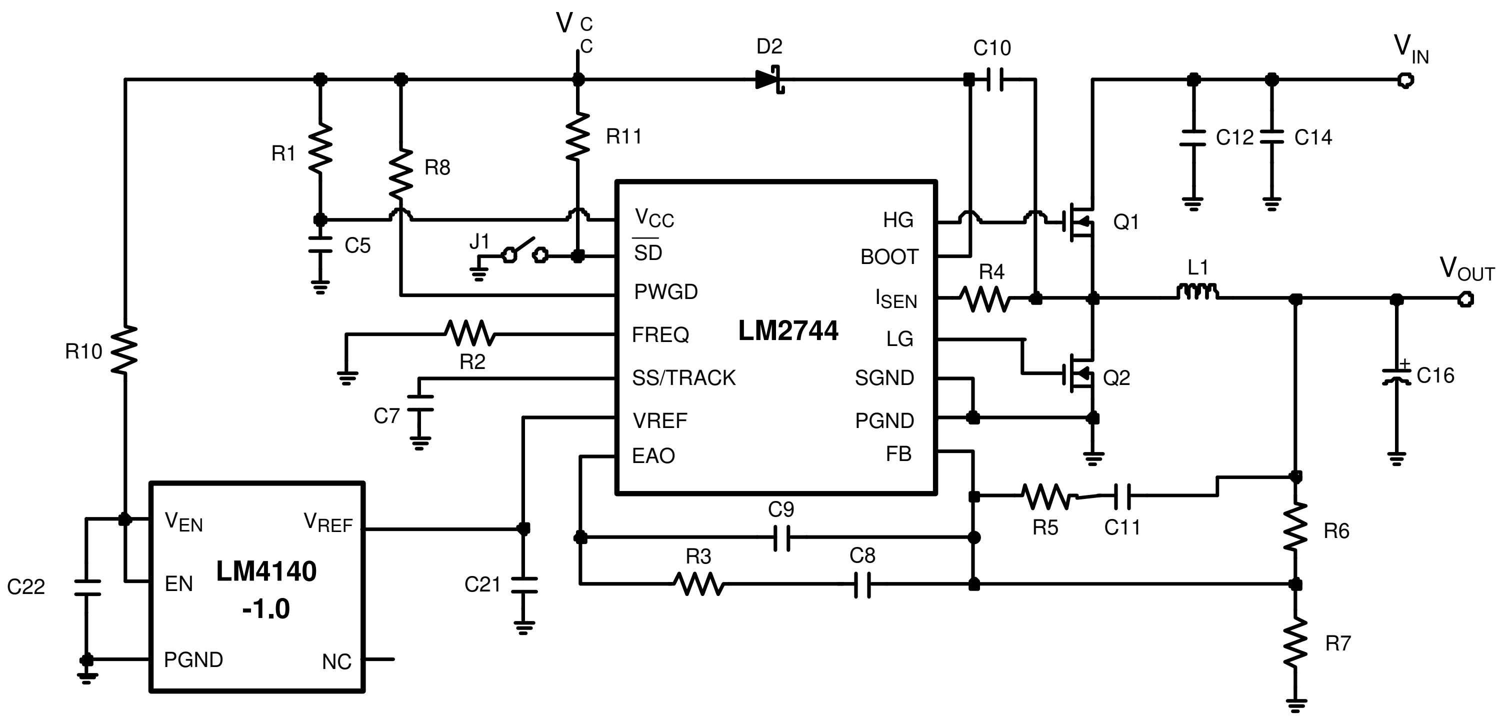

Figure 4-1. Typical Application

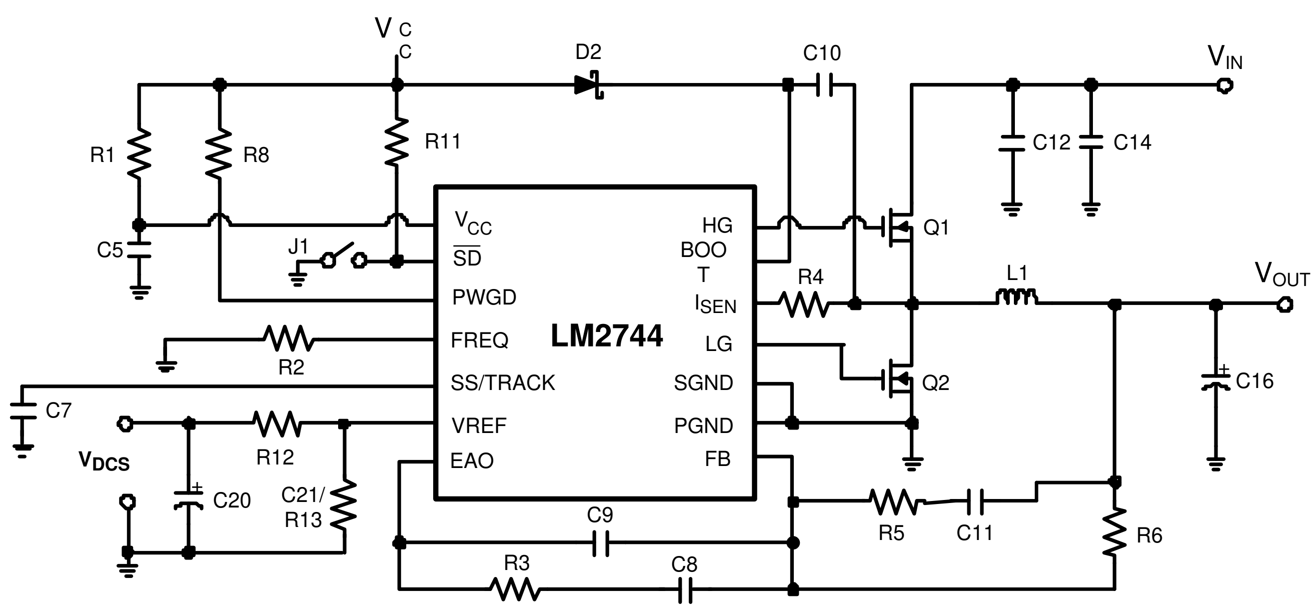

Figure 4-2. DDR SDRAM Termination Supply

5 Performance Characteristics

5.1 Load Transient Response

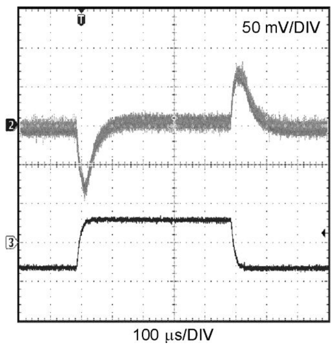

Figure 5-1. ±3-A Load Transient Response Applied to the Circuit in Figure 4-2 (V_{IN} = V_{CC} = 3.3 V and V_{OUT} = 1.2 V). CH 2 - V_{OUT} AC Coupled and CH 3 - 5 A/DIV

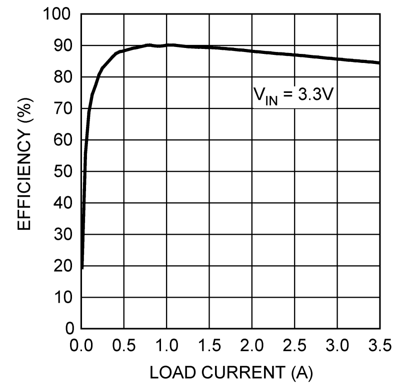

Figure 5-2. Efficiency vs. Load Current V_{OUT} = 1.2 V, f_{SW} = 1 MHz

5.2 Switch Node Voltage and Output Ripple Voltage

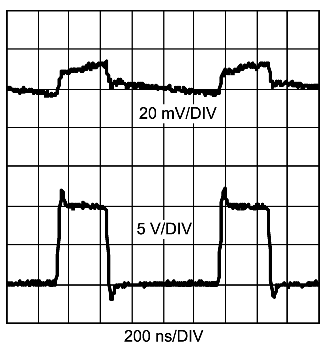

Figure 5-3. V_{IN} = V_{CC} = 3.3 V, V_{OUT} = 1.2 V, I_{LOAD} = 0 A, f_{SW} = 1 MHz, 20-MHz Bandwidth Limit

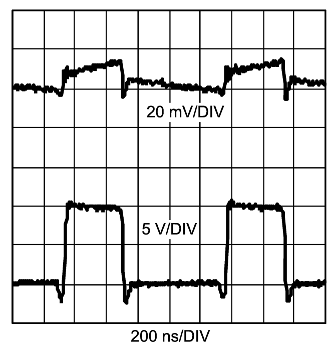

Figure 5-4. V_{IN} = V_{CC} = 3.3 V, V_{OUT} = 1.2 V, I_{LOAD} = 3.5 A, f_{SW} = 1 MHz, 20-MHz Bandwidth Limit

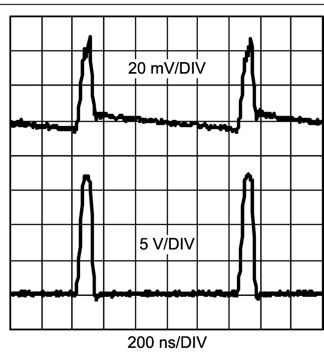

Figure 5-5. V_{IN} = 14 V, V_{CC} = 5 V, V_{OUT} = 1.2 V, I_{LOAD} = 0 A, f_{SW} = 1 MHz, 20-MHz Bandwidth Limit

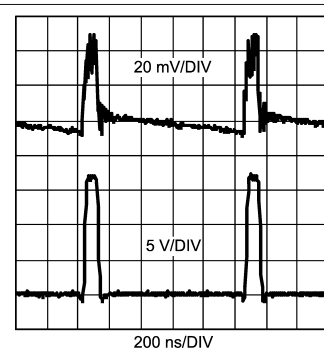

Figure 5-6. V_{IN} = 14 V, V_{CC} = 5 V, V_{OUT} = 1.2 V, I_{LOAD} = 3.5 A, f_{SW} = 1 MHz, 20-MHz Bandwidth Limit

Table 5-1. Bill of Materials

Designator	Function	Part Description	Part Number
U1	Controller	IC LM2744 TSSOP14	Texas Instruments
U2	Low Dropout Reg	IC LM4140BCM-1.0 SOIC-8	Texas Instruments
C5	VCC Decoupling	Ceramic Capacitor, 1 µF, 25 V, 10%, 0805	Murata GRM216R61E105KA12B
C7	Soft Start Cap	Ceramic Capacitor, 12 nF, 25 V, 10%, 0805	Vishay VJ0805Y123KXX

Table 5-1. Bill of Materials (continued)

Designator	Function	Part Description	Part Number
C8	Comp Cap	Ceramic Capacitor, 1.2 nF, 25 V, 10%, 0805	Vishay VJ0805Y122KXX
C9	Comp Cap	Ceramic Capacitor, 15 pF, 50 V, 10%, 0805	Vishay VJ0805A150KAA
C10	Cboot	Ceramic Capacitor, 0.1 µF, 25 V, 10%, 0805	Vishay VJ0805Y104KXX
C11	Comp Cap	Ceramic Capacitor, 1.8 nF, 25 V, 10%, 0805	Vishay VJ0805Y182KXX
C12	Input Filter Cap	Ceramic Capacitor, 10 µF, 25 V, 10%, 1210	AVX 12103D106MAT
C14	Input Filter Cap	Ceramic Capacitor, 10 µF, 25 V, 10%, 1210	AVX 12103D106MAT
C16	Output Filter Cap	470 µF, 6.3 V, 10-mΩ ESR POScap	Sanyo 6TPD470
C21	Reference Output Cap	Niobium Oxide Capacitor, 4.7 µF, 6 V	AVX NOJA475M0006R
C22	Reference Input Cap	Ceramic Capacitor, 0.47 µF, 25 V, 10%, 1206	Vishay VJ1206Y474KXX
R1	VCC Filter Resistor	Resistor 10 Ω, .25 W, 0805	Vishay CRCW08051000F
R2	Frequency Adjust Resistor	Resistor, 24.9 kΩ, .25 W, 0805	Vishay CRCW08052492F
R3	Comp Resistor	Resistor, 21 kΩ, .25 W, 0805	Vishay CRCW08052102F
R4	Current Limit Resistor	Resistor, 3.16 kΩ, .25 W, 0805	Vishay CRCW08053161F
R5	Comp Resistor	Resistor, 2.94 kΩ, .25 W, 0805	Vishay CRCW08052941F
R6	Resistor Divider, upper	Resistor, 10.0 kΩ, .25 W, 0805	Vishay CRCW08051002F
R7	Resistor Divider, lower	Resistor, 59 kΩ, .25 W, 0805	Vishay CRCW08055902F
R8	PWGD Pull-Up	Resistor, 100 kΩ, .25 W, 0805	Vishay CRCW08051003F
R10	Zero Ohm	Resistor, 0 Ω, 0805	Vishay CRCW08050000
R11	Shut Down Pull-Up	Resistor, 100 kΩ, .25 W, 0805	Vishay CRCW12061003F
D2	Bootstrap Diode	Schottky Diode, SOD-123	MBR0530LTI
L1	Output Filter Inductor	Inductor 1 µH, 5.3 Arms, 10.2 mΩ	Cooper DR73-1R0
Q1-Q2	Top and Bottom FETs	Dual N-MOSFET, V_{DS} = 20 V, 24 mΩ at 2.5 V	Vishay 9926BDY

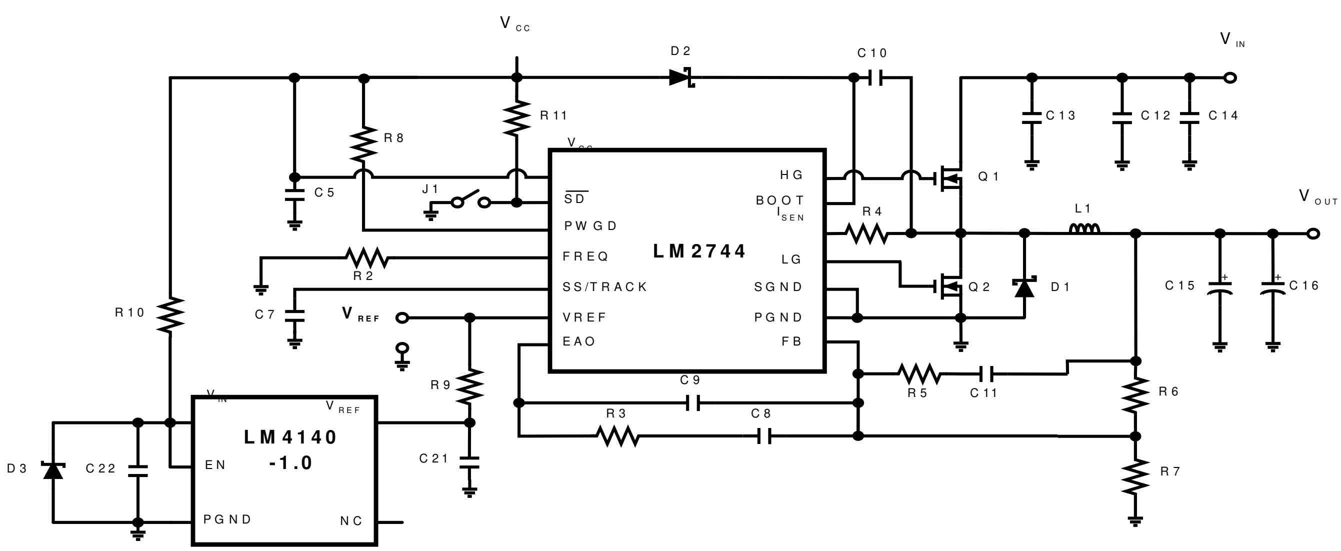

Figure 5-7. Complete Demo Board Schematic

6 PCB Layout Diagrams

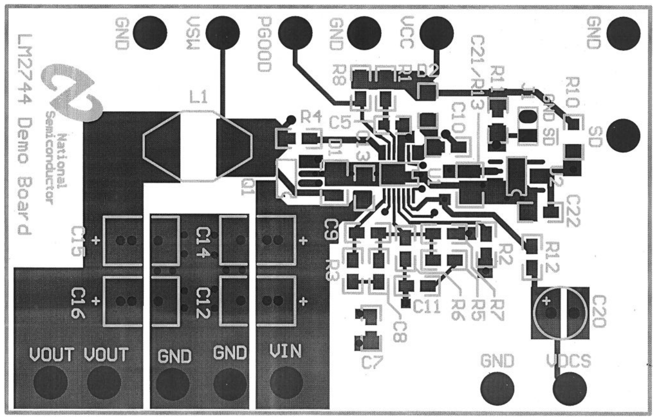

Figure 6-1. Top Layer and Top Overlay

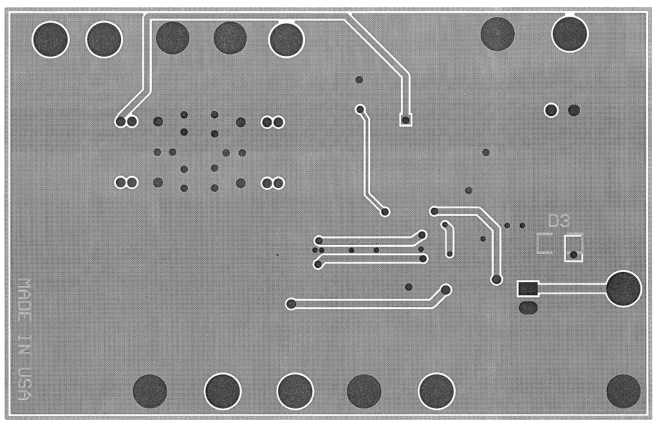

Figure 6-2. Bottom Layer

7 Revision History

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

Changes from Revision A (April 2013) to Revision B (February 2022)	Page