LMZ12001,LMZ12002,LMZ12003,LMZ14201, LMZ14202,LMZ14203

Application Note 2024 LMZ1420x / LMZ1200x Evaluation Board



Literature Number: SNVA422D

LMZ1420x / LMZ1200x Evaluation Board

National Semiconductor Application Note 2024 Alan Martin March 26, 2010



Introduction

The LMZ1420x and LMZ1200x SIMPLE SWITCHER® power modules are easy-to-use DC-DC solution capable of driving up to a 3A load with exceptional power conversion efficiency, output voltage accuracy, line and load regulation. They are available in an innovative package that enhances thermal performance and allows for hand or machine soldering.

The LMZ14203/2/1 can accept an input voltage rail between 6V and 42V and the LMZ12003/2/1 can accept an input voltage rail between 4.5V and 20V. The devices can deliver an adjustable and highly accurate output voltage as low as 0.8V and as high as 6V. The control structure is constant on-time with input voltage feed forward. This creates a nearly constant switching frequency across the input voltage range. The control loop operates well with low ESR output capacitors such as ceramics. An output feed-forward capacitor across the upper feedback resistor trims for optimum transient response. The precision enable input allows for programmable UVLO of the input supply. The external soft-start capacitor facilitates controlled startup output rise time. The LMZ1420x and LMZ1200x family is a reliable and robust solution with the following features: lossless cycle-by-cycle valley current limit to protect for over current or short-circuit fault, thermal shutdown, input under-voltage lock-out, and will start up into a prebiased output.

Board Specifications

- LMZ1420x V_{IN} = 6V to 42V
- LMZ1420x enable UVLO = 8V
- LMZ1420x V_{OUT} = 3.3V
- LMZ1200x V_{IN} = 4.5V to 20V
- LMZ1200x enable UVLO = 4.5V
- LMZ1200x V_{OUT} = 1.8V
- Operates at full load up to 80°C ambient at 12V input
- $\theta_{AA} = 20^{\circ}\text{C} / \text{W}, \ \theta_{AC} = 1.9^{\circ}\text{C} / \text{W}$
- Designed on four layers, all four layers are 1 oz. copper weight
- · The two internal ground planes are identical
- Measures 1.705 in. x 3.03 in. (4.33 cm x 7.7cm) and is 62mil (.062") thick of FR4 laminate material

For additional circuit modifications refer to the Design Consideration section of the LMZ1420x or LMZ1200x data sheet. For negative output voltage connections see AN-2027.

Additional Footprints

Additional component mounting pads are available to experiment with alternative Cin and Cout combinations or a zener clamp on the enable input. See Figure 6 for corresponding schematic locations.

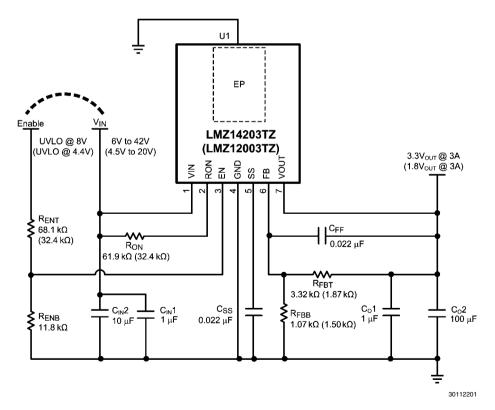


FIGURE 1. Evaluation Board Schematic (LMZ12003 1.8V application values shown in parentheses)

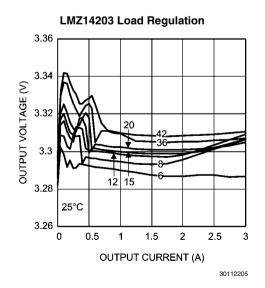
TABLE 1. LMZ1420x Bill of Materials, V_{IN} = 8V to 42V, V_{OUT} = 3.3V, $I_{OUT\,(MAX)}$ = 3A / 2A / 1A

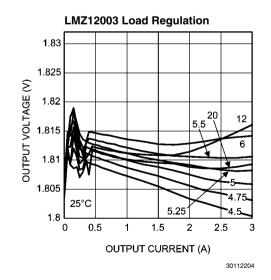
Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	SIMPLE SWITCHER®	TO-PMOD-7	National	LMZ14203TZ-ADJ or	1
			Semiconductor	LMZ14202TZ-ADJ or	
				LMZ14201TZ-ADJ	
C _{IN4} , C _{O1}	1 μF, X7R, 50V	1206	Taiyo Yuden	UMK316B7105KL-T	2
C _{IN2}	10 μF, X5R, 50V	1210	Taiyo Yuden	UMK325BJ106MM-T	1
C _{O2}	100 μF, X5R, 6.3V	1210	Taiyo Yuden	JMK325BJ107MM-T	1
C _{SS} , C _{FF}	0.022 μF, X7R, 100V	0805	AVX	08051C223JAT2A	2
R _{ENB}	11.8k	0805	Panasonic	ERJ-6ENF1182V	1
R _{ENT}	68.1 kΩ	0805	Panasonic	ERJ-6ENF6812V	1
R _{FBT}	3.32 kΩ	0805	Vishay-Dale	CRCW08053K32FKEA	1
R _{FBB}	1.07 kΩ	0805	Panasonic	CRCW080534K8FKEA	1
R _{ON}	61.9 kΩ	0805	Panasonic	ERJ-6ENF6192V	1

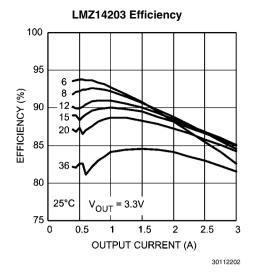
TABLE 2. LMZ1200x Bill of Materials, V_{IN} = 4.5 to 20V, V_{OUT} = 1.8V, $I_{OUT\,(MAX)}$ = 3A / 2A / 1A

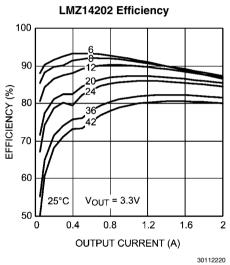
Designator	Description	Case Size	Manufacturer	Manufacturer P/N	Quantity
U1	SIMPLE SWITCHER®	TO-PMOD-7	National	LMZ12003TZ-ADJ or	1
			Semiconductor	LMZ12002TZ-ADJ or	
				LMZ12001TZ-ADJ	
C _{IN4} , C _{O1}	1 μF, X7R, 50V	1206	Taiyo Yuden	UMK316B7105KL-T	2
C _{IN2}	10 μF, X5R, 50V	1210	Taiyo Yuden	UMK325BJ106MM-T	1
C _{O2}	100 μF, X5R, 6.3V	1210	Taiyo Yuden	JMK325BJ107MM-T	1
C _{SS} , C _{FF}	0.022 μF, X7R, 100V	0805	AVX	08051C223JAT2A	2
R _{ENB}	11.8k	0805	Panasonic	ERJ-6ENF1182V	1
R _{ENT}	32.4ΚΩ	0805	Panasonic	ERJ-6ENF3242V	1
R _{FBT}	1.87 kΩ	0805	Vishay-Dale	CRCW08051K87FKEA`	1
R _{FBB}	1.50 kΩ	0805	Panasonic	CRCW08051K50FKEA	1
R _{ON}	32.4ΚΩ	0805	Panasonic	ERJ-6ENF3242V	1

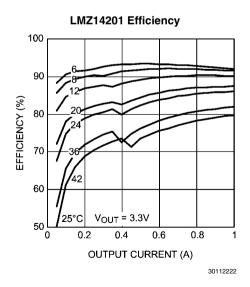
Performance Characteristics

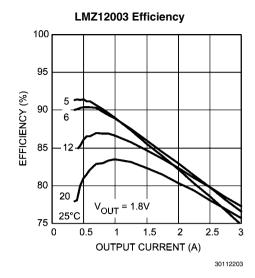


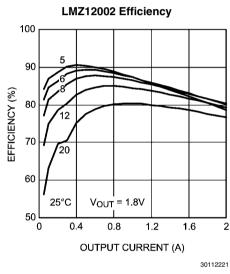


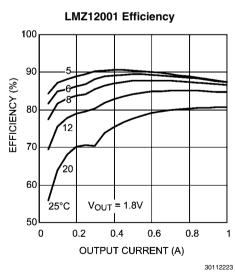


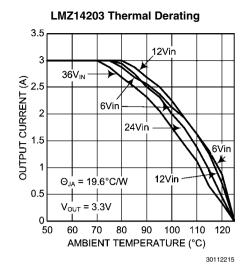


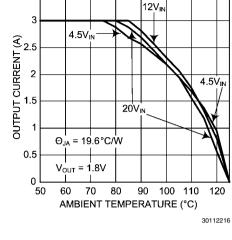






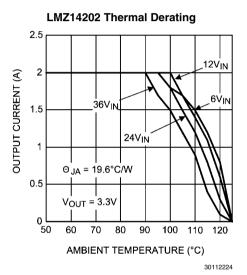


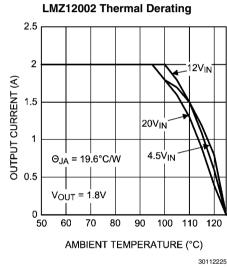


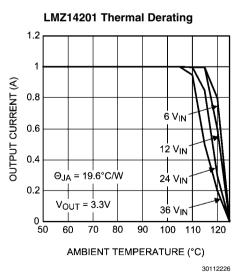


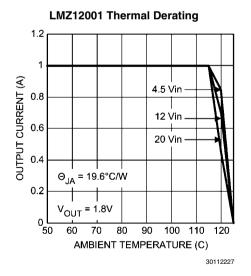
LMZ12003 Thermal Derating

3.5

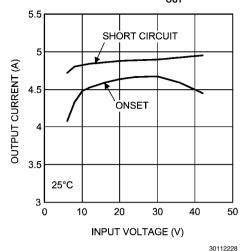


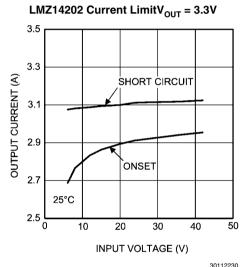




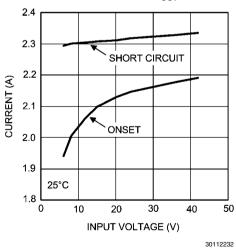


LMZ14203 Current Limit V_{OUT} = 3.3V

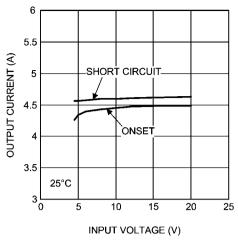




LMZ14201 Current Limit V_{OUT} = 3.3V

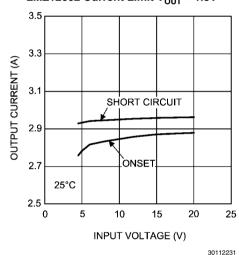


LMZ12003 Current Limit V_{OUT} = 1.8V

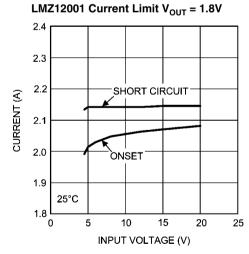


30112229

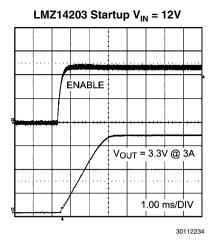
LMZ12002 Current Limit V_{OUT} = 1.8V

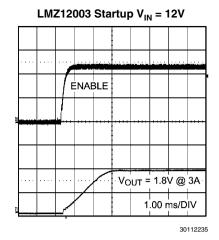


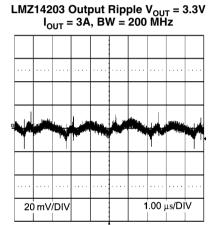
001122

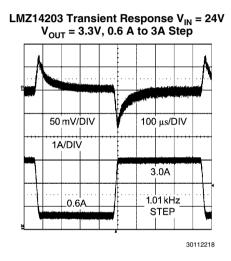


30112233





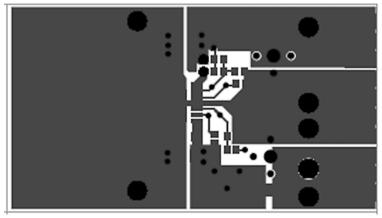




PCB Layout Diagrams

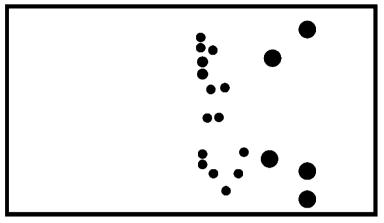
Gerber and CAD files can be download from the LMZ14203 product folder.

30112217



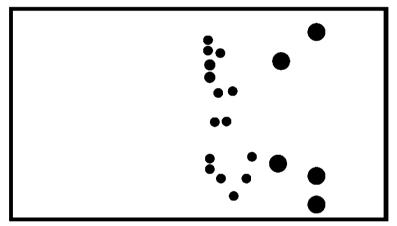
30112209

FIGURE 2. Top Layer



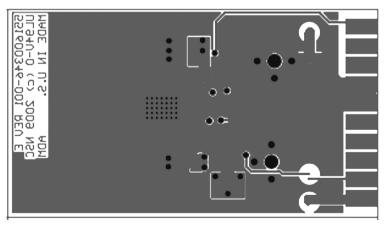
30112210

FIGURE 3. Internal Layer I (Ground) Heat Sinking Layer



30112211

FIGURE 4. Internal Layer II (Ground) Heat Sinking Layer



30112212

FIGURE 5. Bottom Layer (Ground and Routing) Heat Sinking Layer

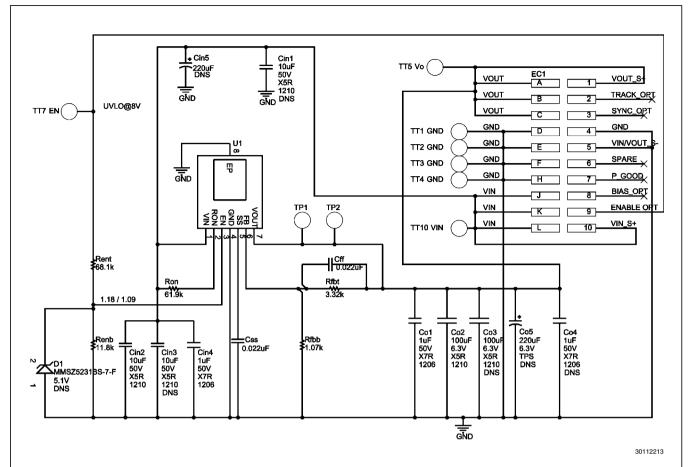


FIGURE 6. LMZ14203 PCB CAD package schematic DNS = Component not installed

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at: www.national.com

Pr	oducts	Design Support		
Amplifiers	www.national.com/amplifiers	WEBENCH® Tools	www.national.com/webench	
Audio	www.national.com/audio	App Notes	www.national.com/appnotes	
Clock and Timing	www.national.com/timing	Reference Designs	www.national.com/refdesigns	
Data Converters	www.national.com/adc	Samples	www.national.com/samples	
Interface	www.national.com/interface	Eval Boards	www.national.com/evalboards	
LVDS	www.national.com/lvds	Packaging	www.national.com/packaging	
Power Management	www.national.com/power	Green Compliance	www.national.com/quality/green	
Switching Regulators	www.national.com/switchers	Distributors	www.national.com/contacts	
LDOs	www.national.com/ldo	Quality and Reliability	www.national.com/quality	
LED Lighting	www.national.com/led	Feedback/Support	www.national.com/feedback	
Voltage References	www.national.com/vref	Design Made Easy	www.national.com/easy	
PowerWise® Solutions	www.national.com/powerwise	Applications & Markets	www.national.com/solutions	
Serial Digital Interface (SDI)	www.national.com/sdi	Mil/Aero	www.national.com/milaero	
Temperature Sensors	www.national.com/tempsensors	SolarMagic™	www.national.com/solarmagic	
PLL/VCO	www.national.com/wireless	PowerWise® Design University	www.national.com/training	

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

LIFE SUPPORT POLICY

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2010 National Semiconductor Corporation

For the most current product information visit us at www.national.com



National Semiconductor Americas Technical Support Center Email: support@nsc.com Tel: 1-800-272-9959 National Semiconductor Europe Technical Support Center Email: europe.support@nsc.com National Semiconductor Asia Pacific Technical Support Center Email: ap.support@nsc.com

National Semiconductor Japan Technical Support Center Email: jpn.feedback@nsc.com

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products	Applications
----------	--------------

Audio www.ti.com/audio Communications and Telecom www.ti.com/communications **Amplifiers** amplifier.ti.com Computers and Peripherals www.ti.com/computers dataconverter.ti.com Consumer Electronics www.ti.com/consumer-apps **Data Converters DLP® Products** www.dlp.com **Energy and Lighting** www.ti.com/energy DSP dsp.ti.com Industrial www.ti.com/industrial Clocks and Timers www.ti.com/clocks Medical www.ti.com/medical Interface interface.ti.com Security www.ti.com/security

Logic logic.ti.com Space, Avionics and Defense www.ti.com/space-avionics-defense

Power Mgmt power.ti.com Transportation and Automotive www.ti.com/automotive
Microcontrollers microcontroller.ti.com Video and Imaging www.ti.com/video

RFID <u>www.ti-rfid.com</u>
OMAP Mobile Processors www.ti.com/omap

Wireless Connectivity <u>www.ti.com/wirelessconnectivity</u>

TI E2E Community Home Page <u>e2e.ti.com</u>