AN-2193 LMR24220 Multi-Rail Reference Board

1 Introduction

The LMR24220 multi-rail reference board implements an extremely compact solution. It is designed to convert from 12 V or 24 V rails down to typical point-of-load voltages of 3.3V, 1.8V and 1.2V. This design utilizes an LMR24220 Nano Regulator and two LMZ10501 Nano Modules to demonstrate a complete solution for space constrained multi-rail applications.

The complete solution size is 20.32 x 13.34 x 2mm with all components placed on a single side. The board can be plugged into a standard 8-pin header with 100 mil spacing and total thickness less than 100 mils for ease of prototyping.

2 Features

- 5 V to 32 V Input Voltage Range
- 3.3 V / 1.8 V / 1.2 V Output Voltage Rails
- Up to 1000 mA Output Current Per Rail
- Small Solution Size (20.32 x 13.34 x 2mm)
- No External Compensation Required

3 Shutdown Operation

The reference board includes a resistor divider that implements an under voltage lockout (UVLO) that disables the part when V_{IN} is below 4 V. The threshold for the UVLO can be adjusted to suit the needs of the application.

$$Ret = (V_{UVLO} * 10K - 12.4K) \quad (1)$$

The midpoint of the resistor divider is clamped to 4.3 V by diode D2 so that the EN pin voltage of the LMR24220 does not exceed 7V. The midpoint is also tied to pin 8 of the header (EN). Use the EN pin to disable the device by pulling this node to GND. A logic signal may be applied to the post to test startup and shutdown of the device.

4 Adjusting the Output Voltage

The output voltage on the LMR24220 can be changed from 3.3 V to another voltage by adjusting the feedback resistors using Equation 2.

$$R1 = [(V_{OUT} / V_{FB}) - 1] * R2 \quad (2)$$

Where V_{FB} is 0.8V.

The output voltage of either LMZ10501 can be changed from 1.8 V/1.2 V to another voltage by adjusting the feedback resistors using Equation 3.

$$RB = [V_{OUT} / (5.875 - V_{OUT})] * RT \quad (3)$$

For more information on component selection and features, see the LMR24220 and LMZ10501 data sheets.

All trademarks are the property of their respective owners.

Copyright © 2011–2013, Texas Instruments Incorporated

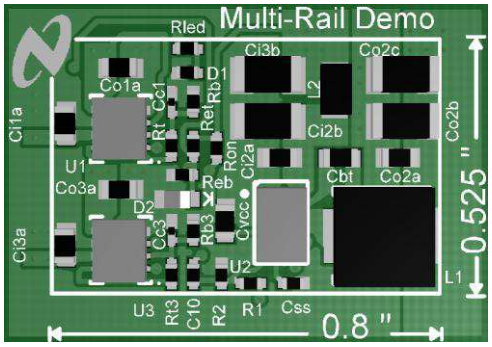
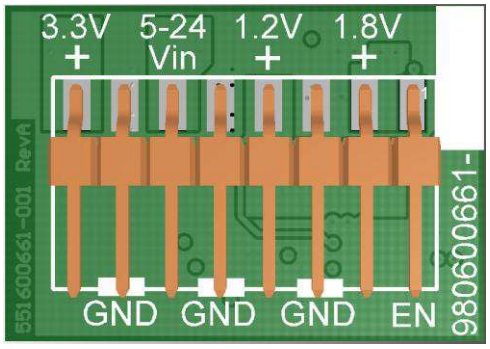


Figure 1. LMR24220 Multi-Rail Reference Board - Top View



Bottom View

Figure 2. LMR24220 Multi-Rail Reference Board - Bottom View

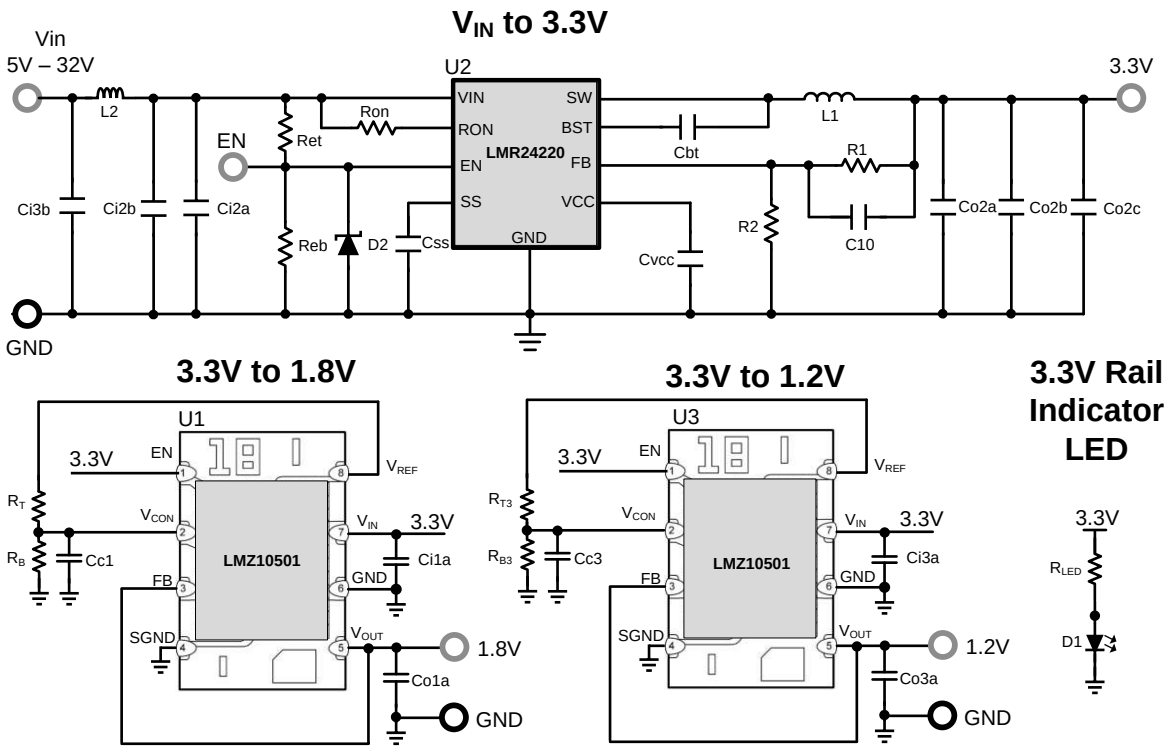


Figure 3. LMR24220 Reference Board Schematic

Table 1. Bill of Materials (BOM) LMR24220

Designation	Description	Size	Manufacturer Part #	Vendor
U1	LMZ10501	SE08A	LMZ10501	TI
U2	LMR24220	28-ball DSBGA	LMR24220	TI
U3	LMZ10501	SE08A	LMZ10501	TI
C10	Cap 10nF 25V X7R	0402	C1005X7R1E103K	TDK
Cbt, Ci2a, Co2a	Cap 0.047µF 50V X7R	0603	GRM188R71H473KA61D	Murata
Cc1, Cc3	Cap 1000pF 25V X7R	0201	GRM033R71E102KA01D	Murata
Ci1a, Ci3a, Co1a, Co3a	Cap 4.7µF 6.3V X5R	0603	C1608X5R0J475M	TDK
Ci2b, Ci3b	Cap 10µF 35V X5R	1206	GRM31CR6YA106KA12L	Murata

Copyright © 2011–2013, Texas Instruments Incorporated

Table 1. Bill of Materials (BOM) LMR24220 (continued)

Designation	Description	Size	Manufacturer Part #	Vendor
Ci2b, Ci3b (alt)	Cap 10µF 50V X5R	1210	UMK325BJ106MMT	Taiyo Yuden
Co2b, Co2c	Cap 47µF 6.3V X5R	1206	C3216X5R0J476M	TDK
Css	Cap 22nF 16V X7R	0402	C1005X7R1C223K	TDK
Cvcc	Cap 1µF 25V X7R	0805	GCM21BR71E105KA56L	Murata
D1	LED, Blue, SMD	0402	LNJ947W8CRA	Panasonic
D2	Zener Diode 4.3V 200mW	SOD-523F	MM5Z4V3	Fairchild
L1	Shielded Inductor 6.8µH 2.4A	(5.49mm x 5.18mm x 2.00mm)	IHLP2020BZER6R8M01	Vishay-Dale
L2	LTCC Inductor 2.2µH 0.9A	(2.50mm x 1.50mm x 1.20mm)	CPL2512T2R2M	Vishay-Dale
R1	RES, 6.81k ohm, 1%, 0.063W	0402	CRCW04026K81FKED	Vishay-Dale
R2	RES, 2.21k ohm, 1%, 0.063W	0402	CRCW04022K21FKED	Vishay-Dale
Reb	RES, 12.4k ohm, 1%, 0.063W	0402	CRCW040212K4FKED	Vishay-Dale
Ret	RES, 28.0k ohm, 1%, 0.063W	0402	CRCW040228K0FKED	Vishay-Dale
Ron	RES, 76.8k ohm, 1%, 0.063W	0402	CRCW040276K8FKED	Vishay-Dale
Rb, Rb3	RES, 82.5k ohm, 1%, 0.063W	0402	CRCW040282K5FKED	Vishay-Dale
Rt	RES, 187k ohm, 1%, 0.063W	0402	CRCW0402187KFKED	Vishay-Dale
Rt3	RES, 316k ohm, 1%, 0.063W	0402	CRCW0402316KFKED	Vishay-Dale
Rled	RES, 332 ohm, 1%, 0.063W	0402	CRCW0402332RFKED	Vishay-Dale
J1	0.100" (2.54mm), Surface Mount Header, 1x8, Gold plated,Right Angle		961108-5500-AR-PR	3M
J2	0.100" (2.54 mm) Female Header: 1x8-Pin, Straight		960108-6202-AR	3M

5 Test Setup

Table 2. Pin Descriptions

Pin	Name	Description
1	3.3 V	3.3 V Output Voltage — Output from the LMR24220 (U2). Supplies current to both the LMZ10501s and any external load. Total Current up to 1.5 Amps without airflow. 2 Amps with airflow.
2, 4, 6	GND	Ground — Reference point for all stated voltages.
3	VIN	Input supply — Nominal operating range is 5 V to 32 V. To increase the maximum operating voltage of the design to 42 V, use the alternate Ci2b, and Ci3b capacitors called out in the BOM.
5	1.2V	1.2 V Output Voltage — Output from the LMZ10501 (U1). Load current up to 1A.
7	1.8V	1.8 V Output Voltage — Output from the LMZ10501 (U3). Load current up to 1A.
8	EN	Enable — Input to the LMR24220 precision enable comparator. Rising threshold is 1.274 V typical. Leave floating to allow the resistor divider to enable the reference board when V_{IN} exceeds 4 V.

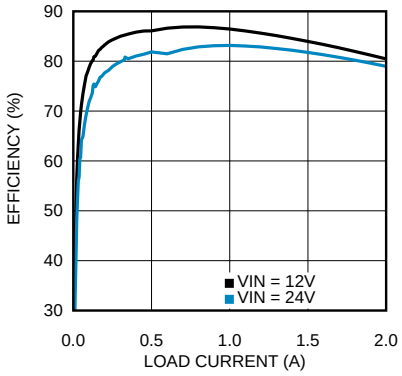
Copyright © 2011–2013, Texas Instruments Incorporated

Table 3. Demonstration Board Quick Setup Procedures

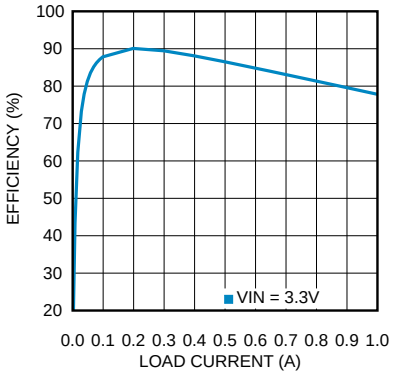
Step	Description	Notes
1	Connect a power supply to V_{IN} terminal	V_{IN} range: 5 V to 32 V
2	Connect a load to 3.3 V / 1.8 V / 1.2 V terminals	I_{OUT} range: 0A to 1.0A
3	EN should be left floating for normal operation. Short this to ground to shutdown the part	
4	Set V_{IN} = 12 V, with 0A load applied, check 3.3 V / 1.8 V / 1.2 V rails with a voltmeter	
5	Apply a 1.0A load to any rail and check 3.3 V / 1.8 V / 1.2 V rails with a voltmeter	

6 Typical Performance Characteristics

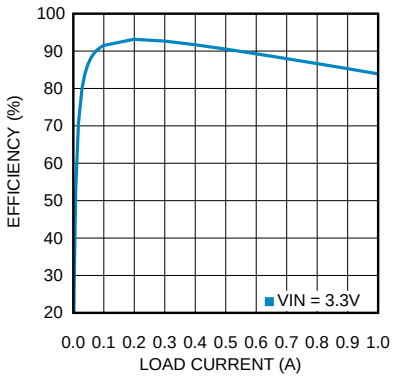
Efficiency vs. Load Current LMR24220, V_{OUT} = 3.3V



Efficiency vs. Load Current LMZ10501, V_{OUT} = 1.2V



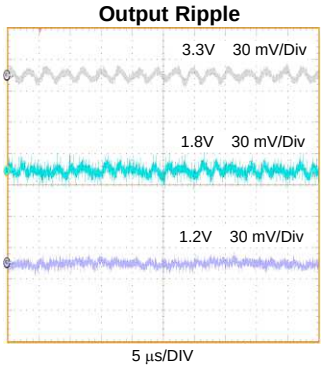
Efficiency vs. Load Current LMZ10501, V_{OUT} = 1.8V

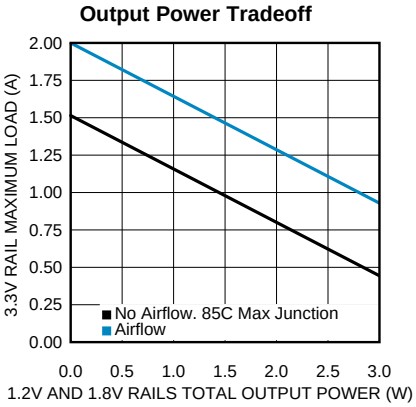


Startup Waveform



Copyright © 2011–2013, Texas Instruments Incorporated





7 Layout

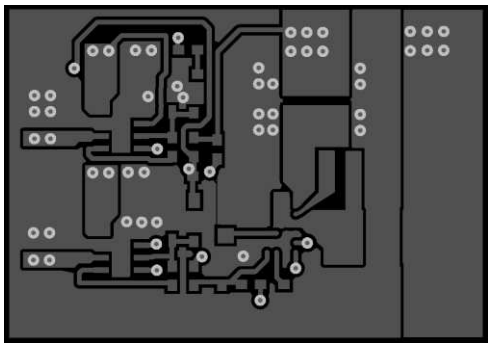


Figure 4. Top Layer

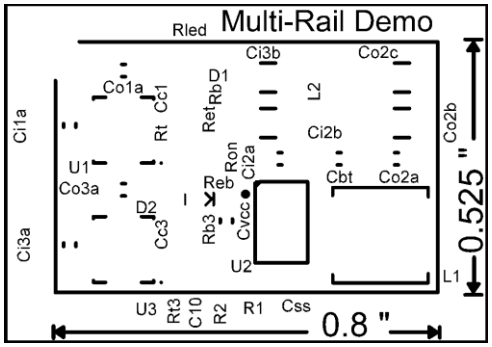


Figure 5. Top Overlay

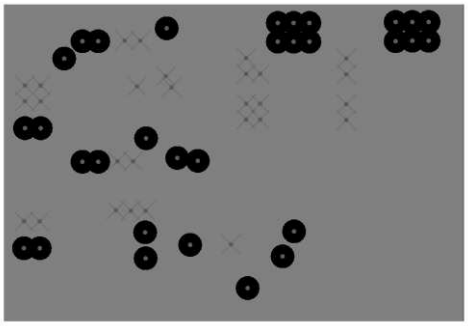


Figure 6. Mid Layer1 (GND)

Copyright © 2011–2013, Texas Instruments Incorporated

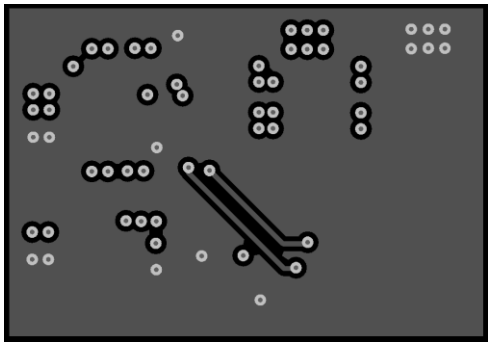


Figure 7. Mid Layer2 (3.3V)

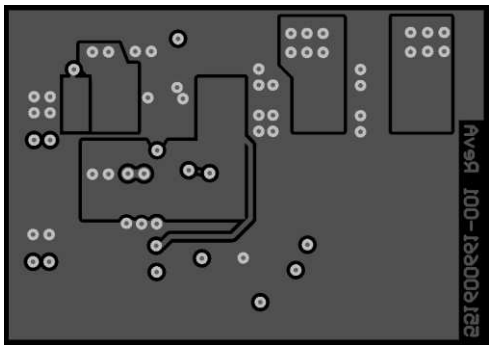


Figure 8. Bottom Layer

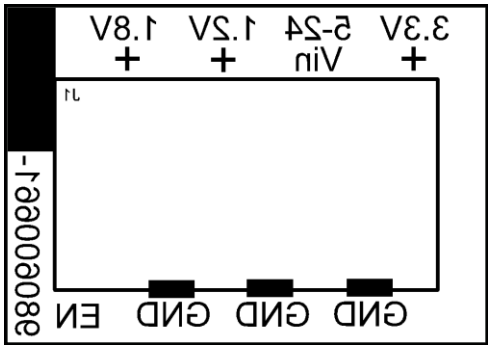


Figure 9. Bottom Overlay

Copyright © 2011–2013, Texas Instruments Incorporated

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

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

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

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

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Applications Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2013, Texas Instruments Incorporated