LMR24220 Multi-Rail Reference Board

National Semiconductor
Application Note 2193
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Introduction

The LMR24220 Multi-Rail reference board implements an extremely compact solution. It is designed to convert from 12V or 24V 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 LMR24220 Nano Regulator is ideal for intermediate rail conversions and can withstand input voltages up to 42V. It uses a constant on-time (COT) with emulated ripple mode architecture that requires no loop compensation and allows the use of low ESR ceramic capacitors. To further reduce conducted noise on the input supply a pi filter has been implemented on the LMR24220. The LMZ10501 Nano Module is ideal at the point-of-load and uses a current mode architecture combined with an integrated inductor for high efficiency, low noise, and low EMI.

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 100mils for ease of prototyping.

Features

- 5V to 32V Input Voltage Range
- 3.3V / 1.8V / 1.2V 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

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 4V. The threshold for the UVLO can be adjusted to suit the needs of the application.

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

The midpoint of the resistor divider is clamped to 4.3V 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 start-up and shutdown of the device.

Adjusting the Output Voltage

The output voltage on the LMR24220 can be changed from 3.3V to another voltage by adjusting the feedback resistors using the following equation:

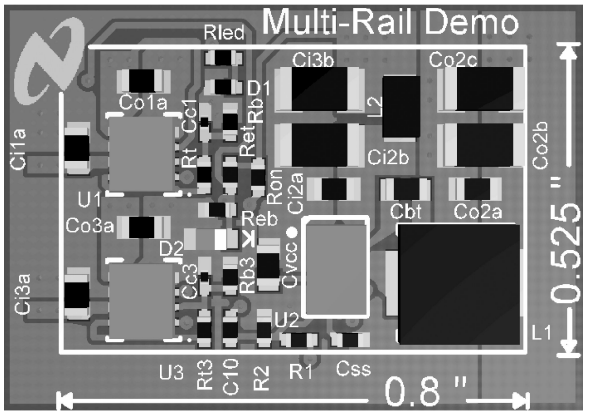
$$R1 = [(V_{OUT} / V_{FB}) - 1] * R2$$

Where V_{FB} is 0.8V.

The output voltage of either LMZ10501 can be changed from 1.8V/1.2V to another voltage by adjusting the feedback resistors using the following equation:

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

For more information on component selection and features see the LMR24220 and LMZ10501 datasheets.



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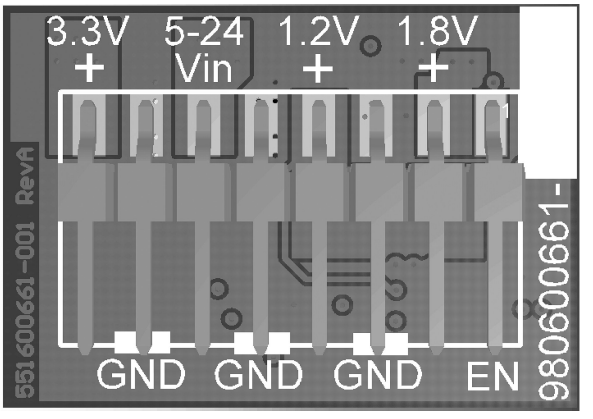
Top View



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Bottom View

FIGURE 1. LMR24220 Multi-Rail Reference Board

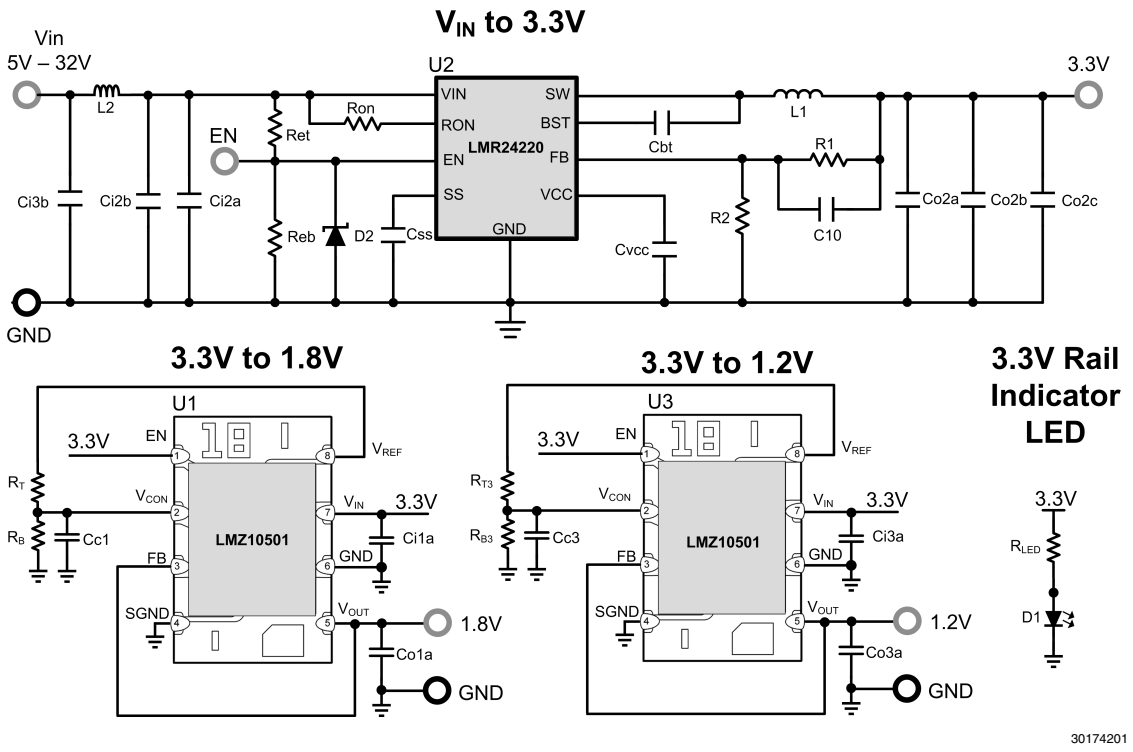


FIGURE 2. LMR24220 Reference Board Schematic

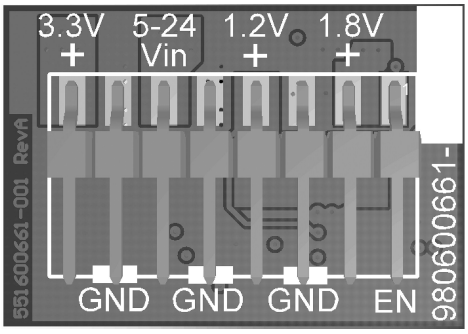
Bill of Materials (BOM) LMR24220

Designation	Description	Size	Manufacturer Part #	Vendor
U1	LMZ10501	SE08A	LMZ10501SEX	National
U2	LMR24220	28-ball µSMD	LMR24220TLX	National
U3	LMZ10501	SE08A	LMZ10501SEX	National
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
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

Designation	Description	Size	Manufacturer Part #	Vendor
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

Test Setup

Bottom View



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Pin Descriptions

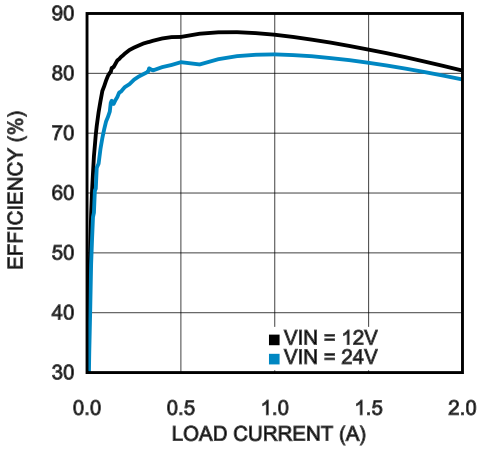
Pin	Name	Description
1	3.3V	3.3V Output Voltage — Output from the LMR24220 (U2). Supplies current to both the LMZ10501s and any external load. Total Current up to 1.5Amps without airflow. 2Amps with airflow.
2, 4, 6	GND	Ground — Reference point for all stated voltages.
3	VIN	Input supply — Nominal operating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

Demonstration Board Quick Setup Procedures

Step	Description	Notes
1	Connect a power supply to V_{IN} terminal	V_{IN} range: 5V to 32V
2	Connect a load to 3.3V / 1.8V / 1.2V 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} = 12V, with 0A load applied, check 3.3V / 1.8V / 1.2V rails with a voltmeter	
5	Apply a 1.0A load to any rail and check 3.3V / 1.8V / 1.2V rails with a voltmeter	

Typical Performance Characteristics

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



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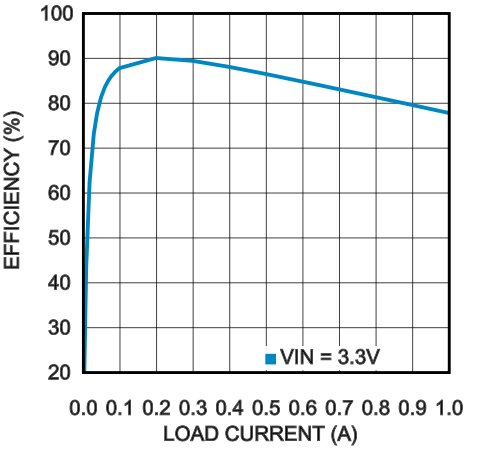
Efficiency vs. Load Current LMZ10501, V_{OUT} = 1.2V



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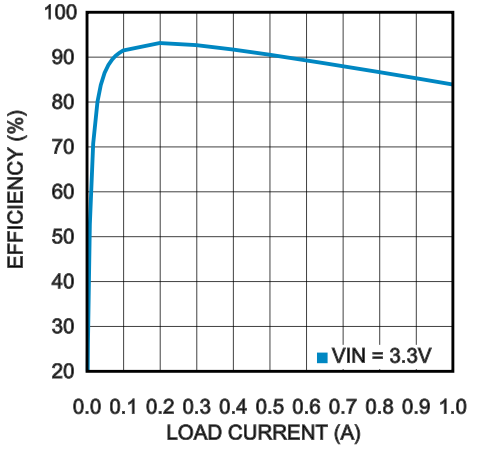
Efficiency vs. Load Current LMZ10501, V_{OUT} = 1.8V



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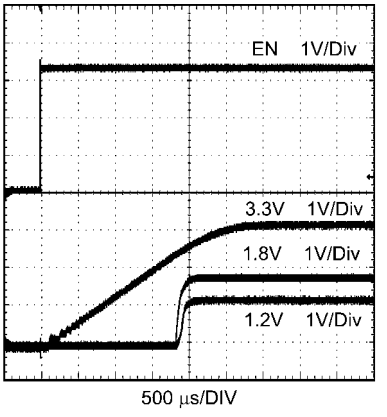
Startup Waveform



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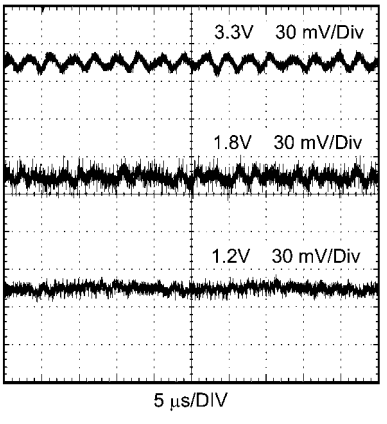
Output Ripple



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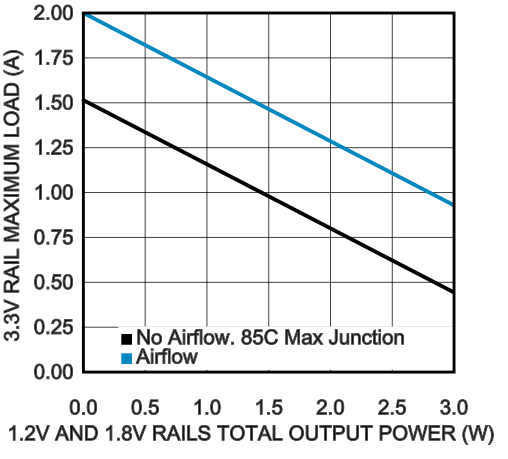
Output Power Tradeoff



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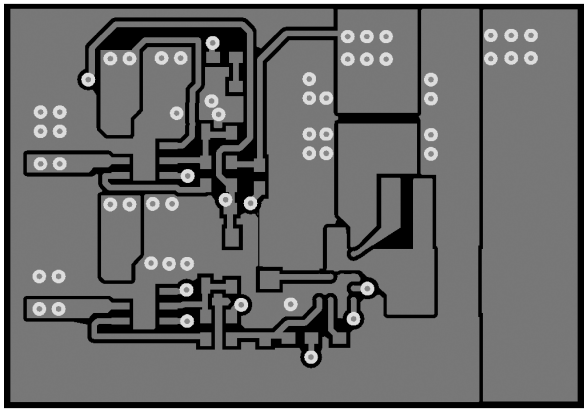
Layout



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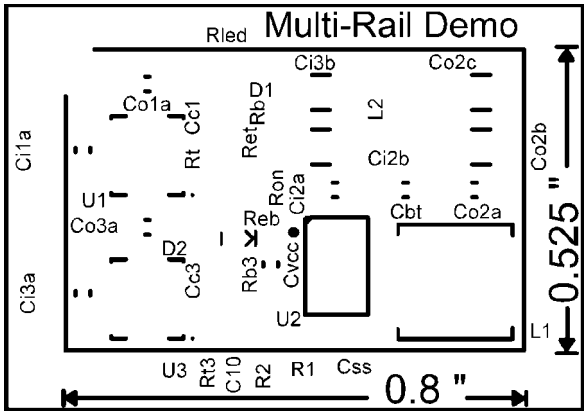
Top Layer



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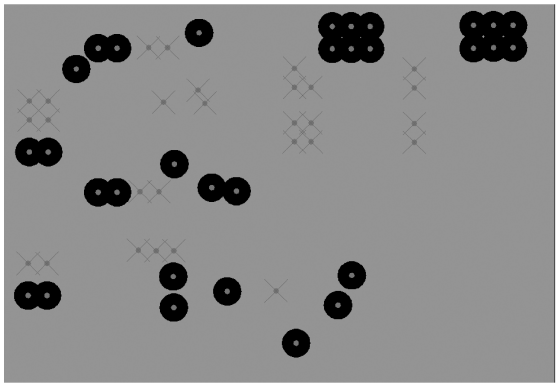
Top Overlay



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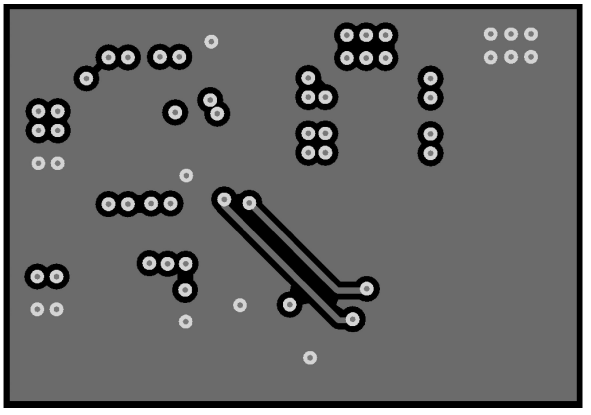
Mid Layer1 (GND)



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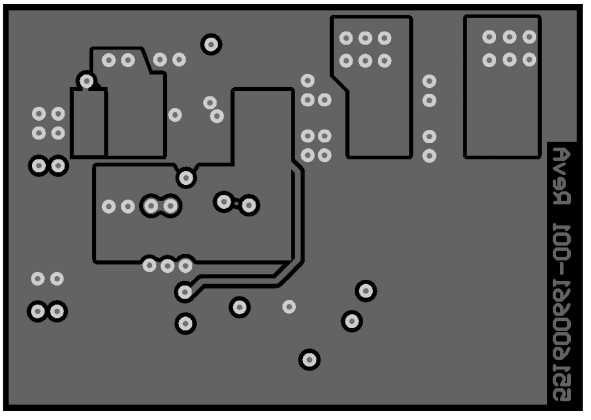
Mid Layer2 (3.3V)



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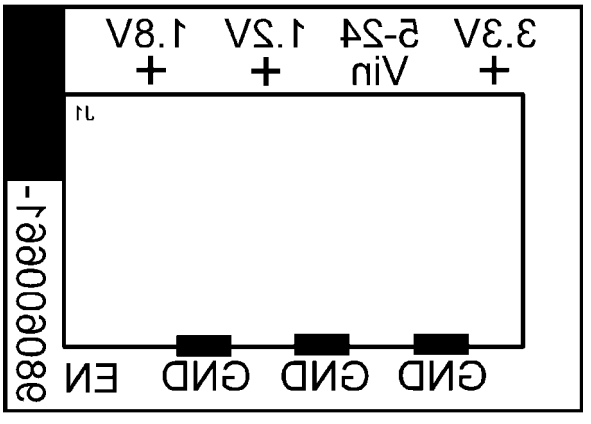
Bottom Layer



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Bottom Overlay

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