LM20242 Demonstration Board

National Semiconductor
LM20242
CADC Design Group
November 2007

1.0 Design Specifications

Inputs	Output #1
VinMin=8V	Vout1=3.3V
VinMax=18V	Iout1=2A

2.0 Design Description

The LM20242 demonstration board is designed to provide the design engineer with a small, fully functional buck converter based on Current Mode Control to evaluate the LM20242 switching regulator IC. The demonstration board provides a 3.3V output with 2A current capability. The input voltage ranges from 8V to 18V, and is optimized for 12V. The design operates at 300KHz, a good compromise between conversion efficiency and solution size, and employs a soft-start sequence. The printed circuit board consists of 2 layers of 2 ounce copper on FR4 material with a thickness of 0.062 inches. Refer to the LM20242 datasheet for complete circuit design information.

3.0 Features

- Optimized for 12V to 3.3V conversion
- 2A output current, 89% efficiency
- 1.5% output voltage accuracy
- 300 kHz switching frequency
- Current Mode Control
- Starts up into pre-biased loads
- Soft-start set by external capacitor
- Precision enable pin with hysteresis
- OVP, UVLO inputs and PGOOD output
- Internally protected with peak current limit, shutdown and restart
- Accurate current limit with frequency foldback
- Input voltage range 8V to 18V

4.0 Schematic

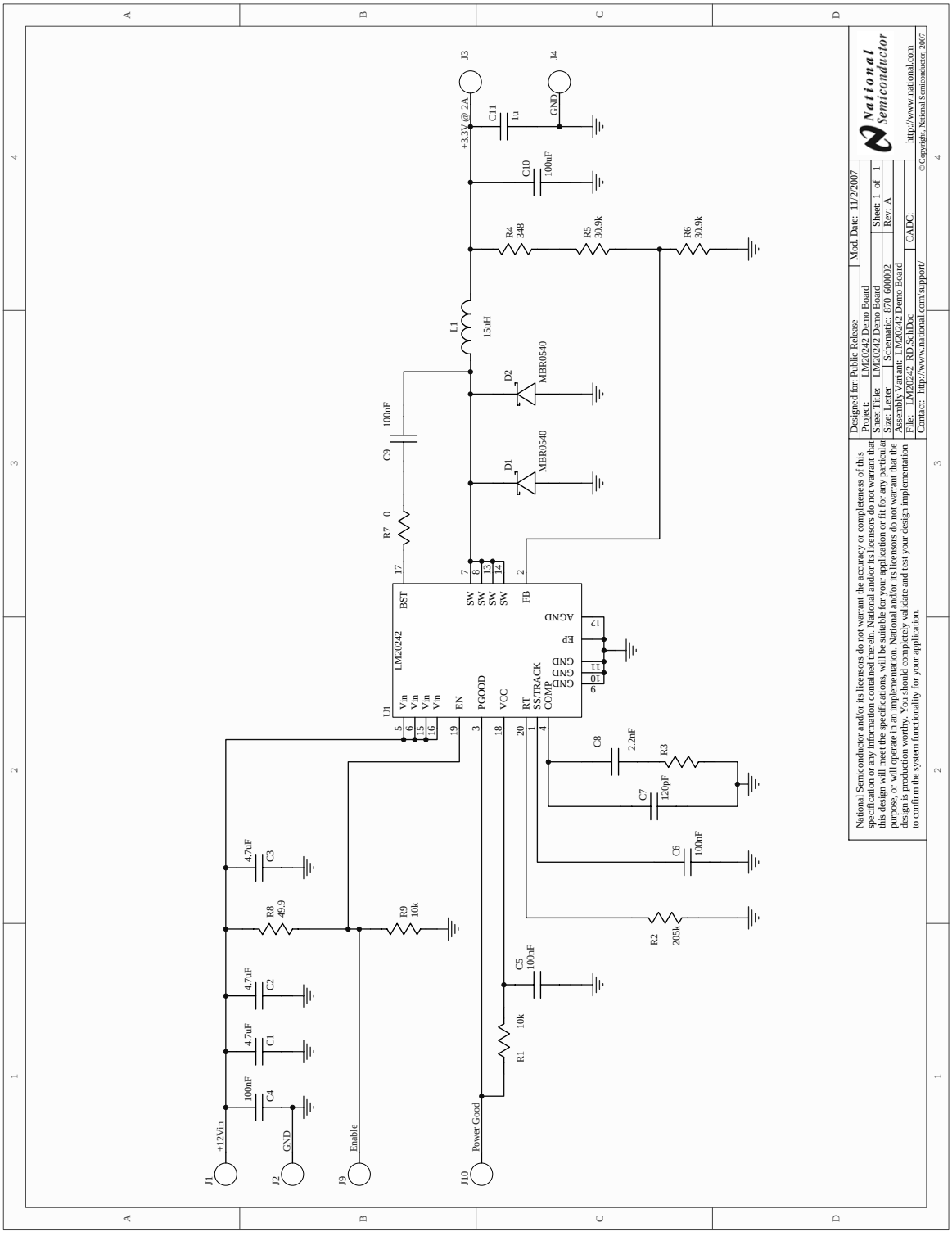


FIGURE 1. Schematic

5.0 Bill of Materials

Designator	CompType	Value	Footprint	Parameters	Vendor	PartNumber
C1, C2, C3	Capacitor	4.7uF	1210	Ceramic, X7R, 50V, 10%	MuRata	GRM32ER71H475K
C4	Capacitor	100nF	0805	Ceramic, X7R, 100V, 10%	TDK	C2012X7R2A104K
C5, C6, C9	Capacitor	100nF	0603	Ceramic, X7R, 16V, 10%	MuRata	GRM188R71C104KA01D
C7	Capacitor	120pF	0603	Ceramic, C0G, 50V, 5%	AVX	06035A121JAT2A
C8	Capacitor	2.2nF	0603	Ceramic, X7R, 50V, 10%	MuRata	GRM188R71H222KA01D
C10	Capacitor	100uF	1210	Ceramic, X7R, 6.3V, 20%	TDK	C3225X5R0J107M
C11	Capacitor	1uF	0805	Ceramic, X7R, 50V, 10%	MuRata	GRM21BR71H105KA12L
D1, D2	Diode		SOD-123	Vr = 40V, Io = 0.5A, Vf = 0.51V	Fairchild	MBR0540
J1, J2, J3, J4	Terminal		TURRET		Keystone	1503-2
J9, J10	Test Point		TESTPOINT		Keystone	5002
L1	Inductor	15uH	MSS1278	Shielded Drum Core, 6.5A, 0.038Ohm	Coilcraft Inc.	MSS1278-153
R1, R9	Resistor	10kΩ	0603	1%, 0.1W	Vishay	CRCW06031002F
R2	Resistor	205kΩ	0603	1%, 0.1W	Vishay	CRCW06032053F
R3	Resistor	12.1kΩ	0603	1%, 0.1W	Vishay	CRCW06031212F
R4	Resistor	348Ω	0603	1%, 0.1W	Vishay	CRCW0603348RF
R5, R6	Resistor	30.9kΩ	0603	1%, 0.1W	Vishay	CRCW06033092F
R7	Resistor	0Ω	0603	0%, 0.1W	Vishay	CRCW06030000Z0EA
R8	Resistor	49.9Ω	0603	1%, 0.1W	Vishay	CRCW06034992F
U1	Switcher		MXA20A		National Semiconductor	LM20242

6.0 Other Operating Values

Operating Values

Description	Parameter	Value	Unit
Steady State Efficiency	Efficiency	89	%
Input Voltage	Vin	12	V
Load Current	Iout	2	A
Load Regulation		0.1	%
Line Regulation		0.1	%

7.0 Board Photos

boardphoto1

FIGURE 3. LM20242 Demo Board Photo

8.0 Quick Start

Powering and Loading Considerations

Read this entire section prior to attempting to power the demonstration board.

QUICK SETUP PROCEDURE

Step 1:

Set the input voltage source current limit to 2A. Turn off the input source. Connect the positive output of the input voltage source to J1 and the negative output to J2.

Step 2:

Connect the load, with 2A capability, to J3 for the positive output voltage connection and J4.

Step 3:

The ENABLE pin, J9, should be left open for normal operation.

Step 4:

Set the input voltage source to 12V and the load to 0.1A. The load voltage should be in regulation with a nominal 3.3V output.

Step 5:

Slowly increase the load while monitoring the load voltage at J3 and J4. It should remain in regulation with a nominal 3.3V output as the load is increased up to 2A.

Step 6:

Slowly sweep the input source voltage from 12V to 18V. The load voltage should remain in regulation with a nominal 3.3V output.

Step 7:

Temporally short the ENABLE pin (J9) to GND (J2 or J4) to check the shutdown function.

Step 8:

Increase the load beyond the normal range to check current limiting while the input source is set to 12V. The output current should limit at approximately 3.9A. The input source current limit should be increased for this step. Fan cooling is critical during this step.

AIR FLOW

Prolonged operation at full power and high ambient temperature will cause the thermal shutdown circuit within the regulator IC to activate. A fan with a minimum of 200 LFM should always be provided.

POWERING UP

Using the ENABLE pin (J9) provided will allow powering up the input source with the current level set low. It is suggested that the load power be kept low during the first power up. Set the current limit of the input source to provide about 1.5 times the anticipated wattage of the load. As you remove the connection from the ENABLE pin to GND (J2), immediately check for 3.3V at the output. A quick efficiency check is the best way to confirm that everything is operating properly. If something

is amiss you can be reasonably sure that it will affect the efficiency adversely. Few parameters can be incorrect in a switching power supply without creating losses and potentially damaging heat.

OVER CURRENT PROTECTION

The demonstration board is configured with peak over-current protection. This function is completely contained in the LM20242.

POWER GOOD

A POWER GOOD pin (J10) has been provided on the demonstration board. This pin can be used to monitor the output voltage status. Refer to the LM20242 datasheet for complete information.

BUCK TOPOLOGY

An excellent introduction to the buck converter is available on the National Semiconductor website. The Application Notes AN-1197 and AN-1253 discuss both output inductor selection and considerations for wide input voltage range designs when using buck converters.

9.0 Layouts

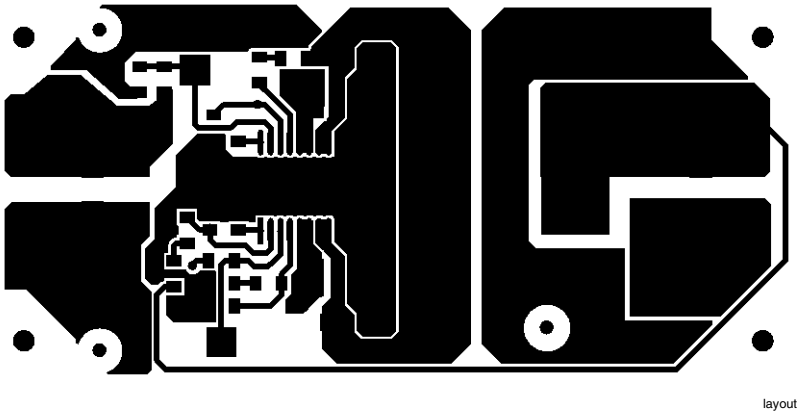


FIGURE 4. Top Layer

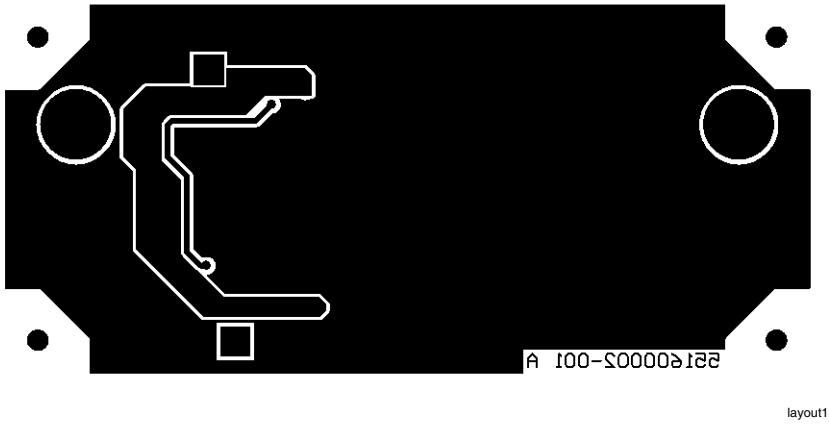


FIGURE 5. Bottom Layer

10.0 Waveforms

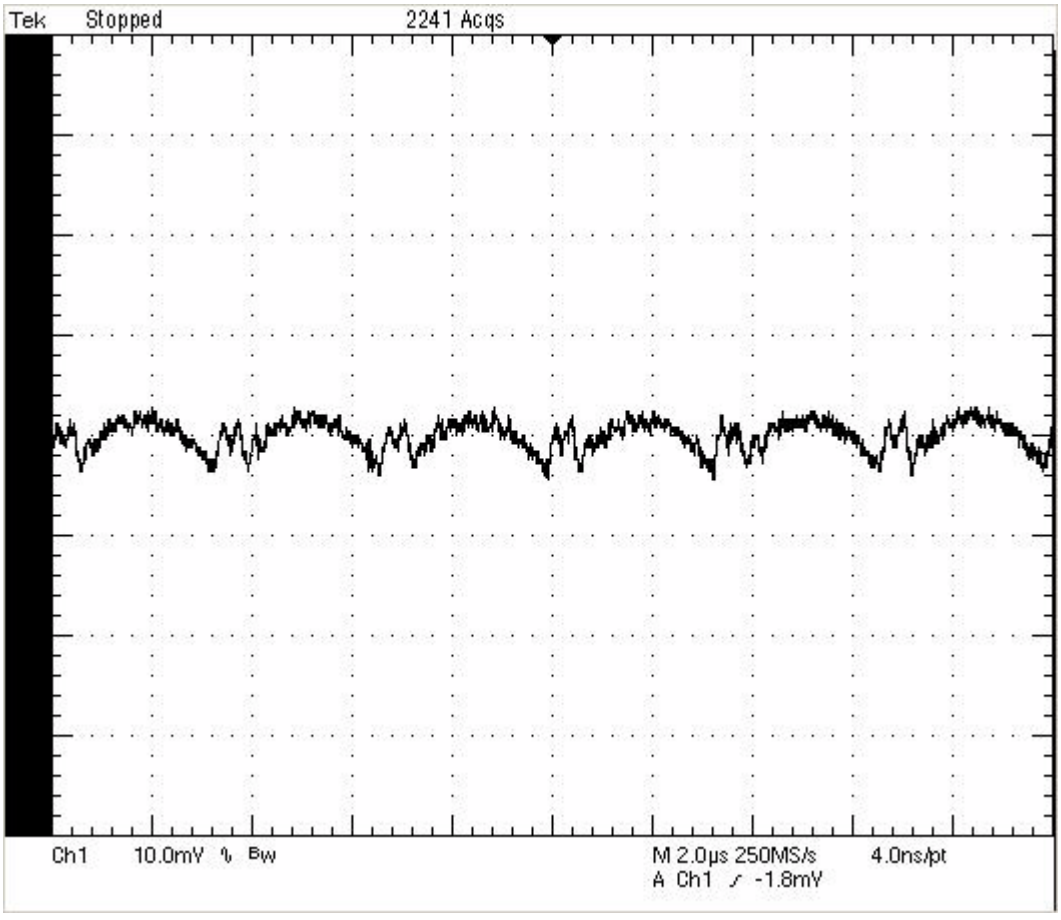


FIGURE 6. shows the output voltage ripple. Input Voltage = 12VDC, Output Current = 2A. This measurement was taken with the scope probe tip placed on the J3 load terminal and the scope probe ground barrel pushed against the J4 load terminal. The scope bandwidth is set to 20MHz

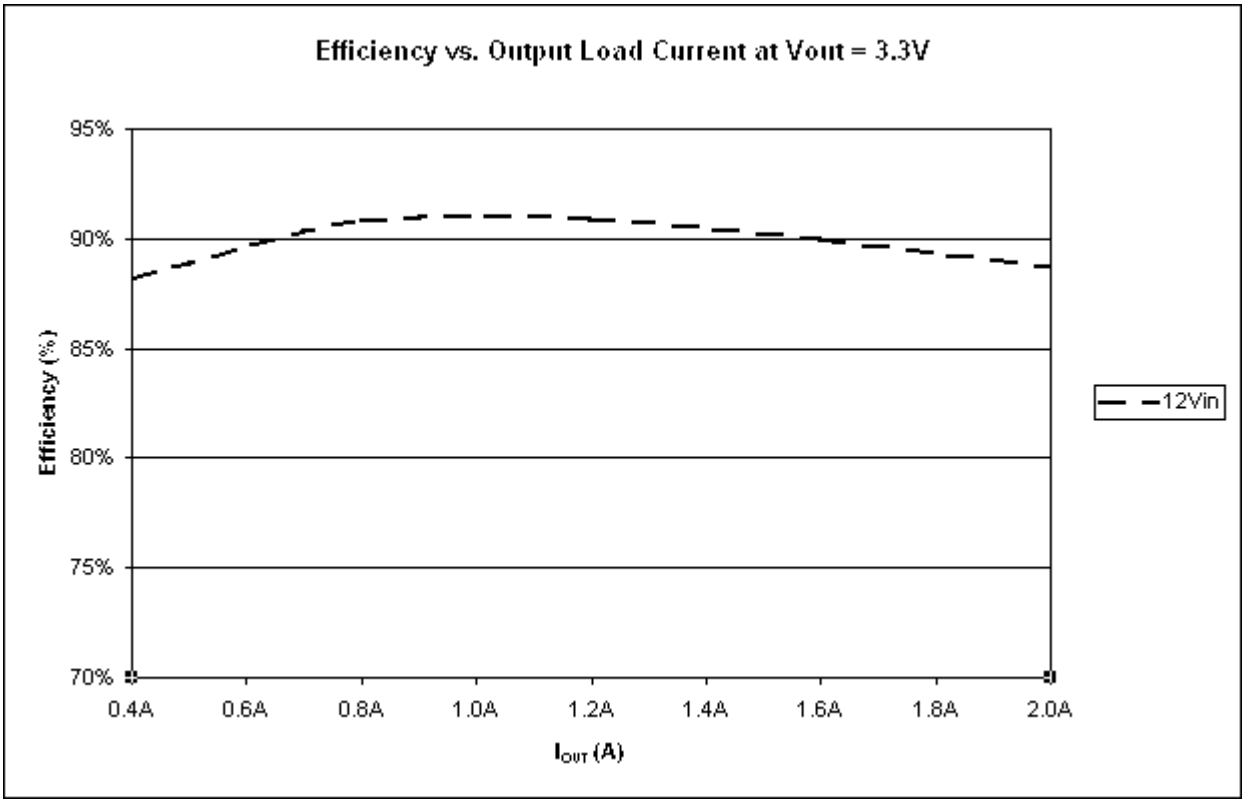


FIGURE 7. shows the conversion efficiency versus output at Vin = 12V

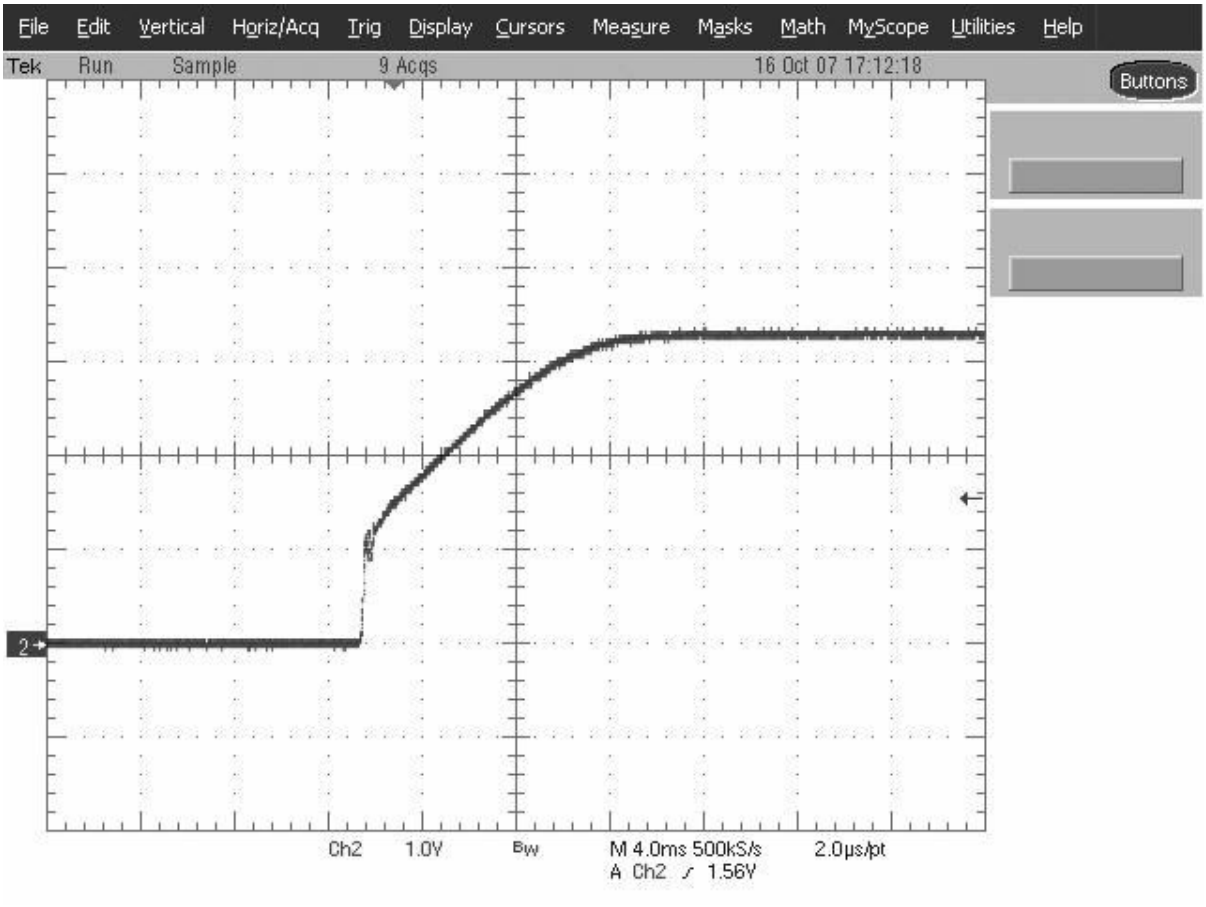


FIGURE 8. Output voltage during a typical start-up sequence.

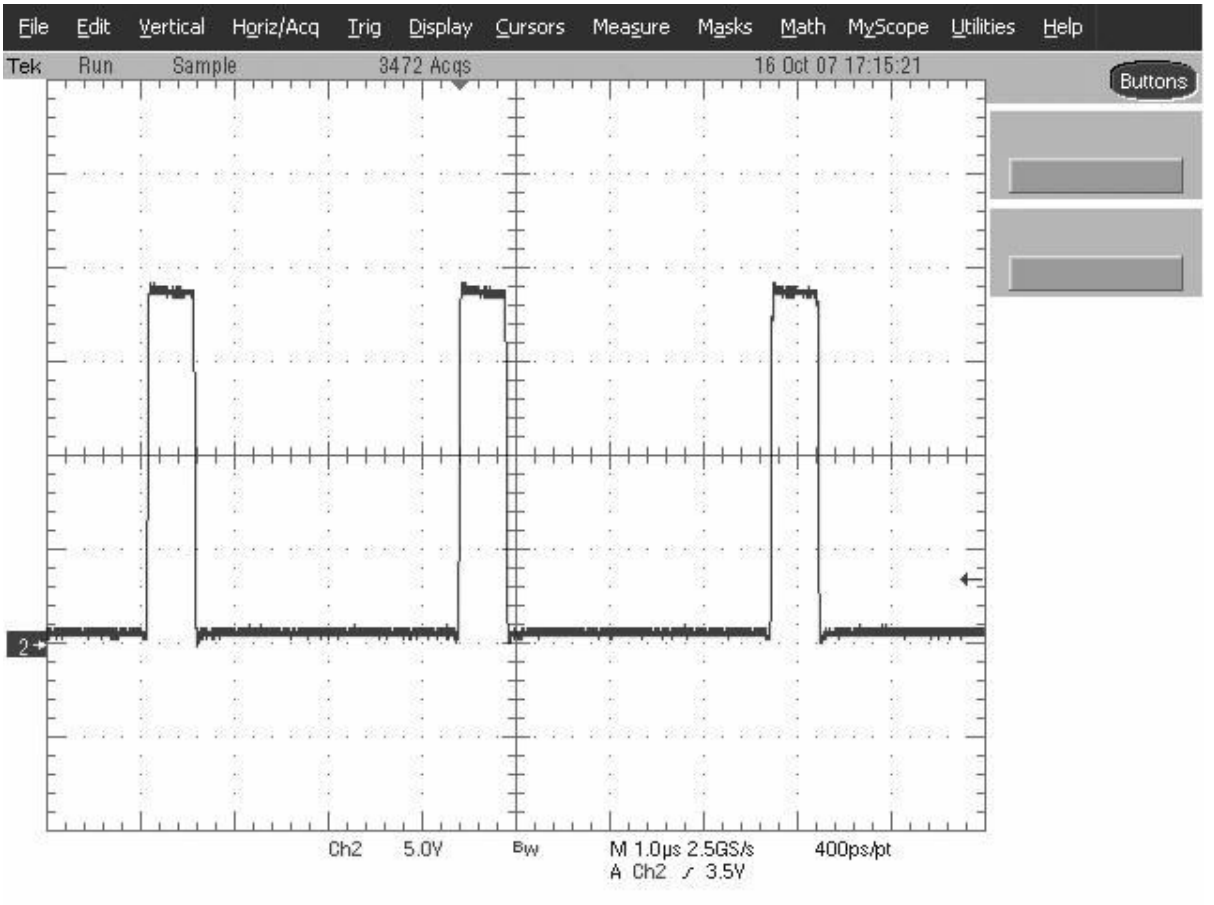
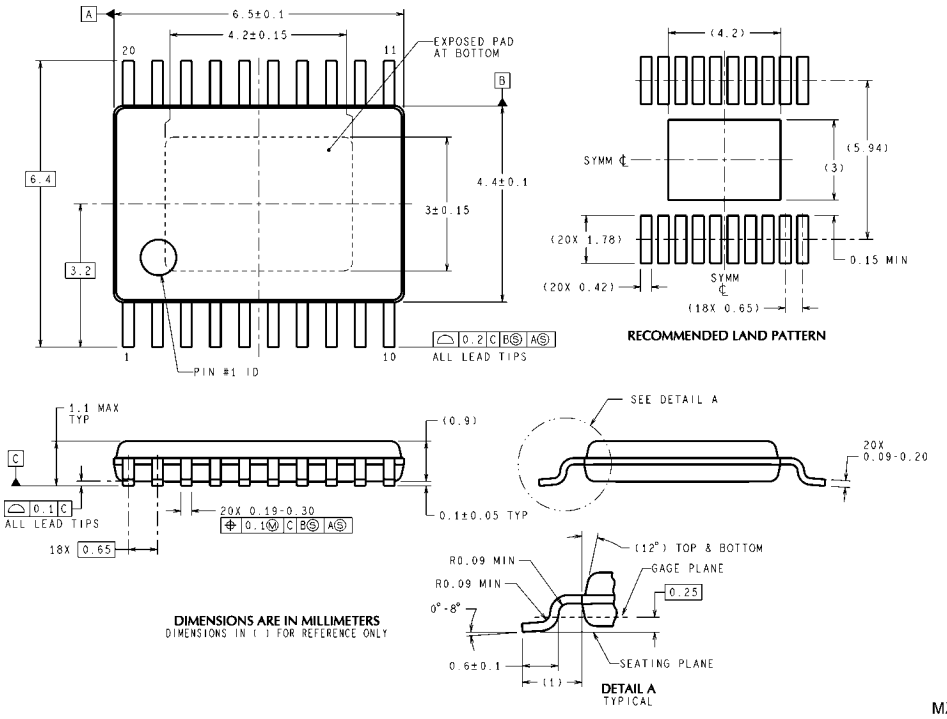


FIGURE 9. shows the typical primary voltage during continuous conduction mode (CCM).

11.0 Physical Dimensions inches (millimeters) unless otherwise noted



MXA20A (Rev C)

Notes

Notes

National Semiconductor Americas Customer Support Center
Email: new.feedback@nsc.com
Tel: 1-800-272-9959

National Semiconductor Europe Customer Support Center
Fax: +49 (0) 180-530-85-86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 69 9508 6208
English Tel: +49 (0) 870 24 0 2171
Français Tel: +33 (0) 1 41 91 8790

National Semiconductor Asia Pacific Customer Support Center
Email: ap.support@nsc.com

National Semiconductor Japan Customer Support Center
Fax: 81-3-5639-7507
Email: jpn.feedback@nsc.com
Tel: 81-3-5639-7560

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	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 Mobile Processors	www.ti.com/omap		
Wireless Connectivity	www.ti.com/wirelessconnectivity		
	TI E2E Community Home Page		e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265