

# LMR23625 SIMPLE SWITCHER® 36 V, 2.5 A Synchronous Step-Down Converter

## 1 Features

- 4 V to 36 V Input Range
- 2.5 A Continuous Output Current
- Integrated Synchronous Rectification
- Current Mode Control
- Minimum Switch-On Time: 60 ns
- 2.1 MHz Switching Frequency With PFM and Forced PWM Mode Options
- Frequency Synchronization to External Clock
- Internal Compensation for Ease of Use
- 75  $\mu$ A Quiescent Current at No Load
- Soft-Start into a Pre-Biased Load
- High Duty Cycle Operation Supported
- Precision Enable Input
- Output Short-Circuit Protection with Hiccup Mode
- Thermal and Overvoltage Protection
- 8-Pin HSOIC with PowerPAD™ Package

## 2 Applications

- Automotive Battery Regulation
- Industrial Power Supplies
- Telecom and Datacom Systems
- General Purpose Wide Vin Regulation

## 3 Description

The LMR23625 SIMPLE SWITCHER® is an easy to use 36 V, 2.5 A synchronous step down regulator. With a wide input range from 4 V to 36 V, it's suitable for various applications from industrial to automotive for power conditioning from unregulated sources. Peak current mode control is employed to achieve simple control loop compensation and cycle-by-cycle current limiting. The regulator's quiescent current is 75  $\mu$ A makes it suitable for battery powered systems. An ultra-low 2  $\mu$ A current in shutdown mode can further prolong battery life. Internal loop compensation means that the user is free from the tedious task of loop compensation design. This also minimizes the external components of the device. The device has option for fixed frequency FPWM mode to eliminate frequency variation to minimize EMI. An extended family is available in 1 A and 3 A load current options in pin to pin compatible package which allows simple, optimum PCB layout. A precision enable input allows simplification of regulator control and system power sequencing. Protection features include cycle-by-cycle current limit, hiccup mode short circuit protection and thermal shutdown due to excessive power dissipation.

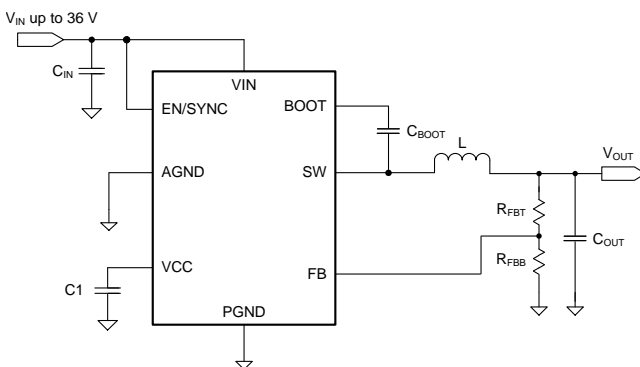
The LMR23625 is available in an 8-pin HSOIC package with exposed pad for low thermal resistance.

### Device Information<sup>(1)</sup>

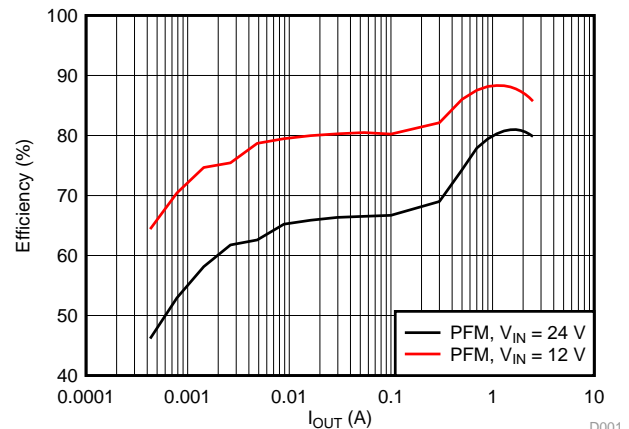
PART NUMBER	PACKAGE	BODY SIZE (NOM)
LMR23625C	HSOIC (8)	4.89 mm x 3.90 mm
LMR23625CF (FPWM Option)	HSOIC (8)	4.89 mm x 3.90 mm

(1) For all available packages, see the orderable addendum at the end of the data sheet.

### Simplified Schematic



### Efficiency vs Load Vout = 5 V



D001



## Table of Contents

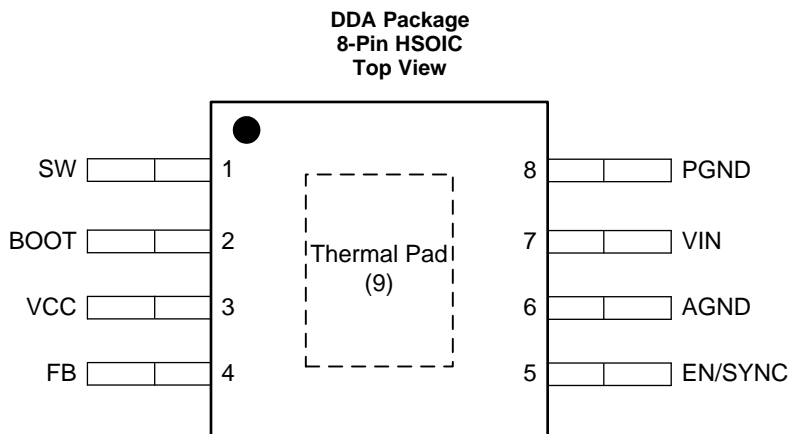
1	<b>Features</b> .....	1	6.1	Community Resources.....	4
2	<b>Applications</b> .....	1	6.2	Trademarks .....	4
3	<b>Description</b> .....	1	6.3	Electrostatic Discharge Caution .....	4
4	<b>Revision History</b> .....	2	6.4	Glossary .....	4
5	<b>Pin Configuration and Functions</b> .....	3	7	<b>Mechanical, Packaging, and Orderable Information</b> .....	5
6	<b>Device and Documentation Support</b> .....	4			

## 4 Revision History

DATE	REVISION	NOTES
December 2015	*	Initial release.

PRODUCT PREVIEW

## 5 Pin Configuration and Functions



**Pin Functions**

PIN		I/O <sup>(1)</sup>	DESCRIPTION
NAME	NO.		
SW	1	O	Switching output of the regulator. Internally connected to both power MOSFETs. Connect to power inductor.
BOOT	2	O	Boot-strap capacitor connection for high-side driver. Connect a high quality 470 nF capacitor from BOOT to SW.
VCC	3	O	Internal bias supply output for bypassing. Connect bypass capacitor from this pin to AGND. Do not connect external loading to this pin. Never short this pin to ground during operation.
FB	4	I	Feedback input to regulator, connect the feedback resistor divider tap to this pin.
EN/SYNC	5	I	Enable input to regulator. High = On, Low = Off. Can be connected to VIN. Do not float. Adjust the input under voltage lockout with two resistors. See the Enable and Adjusting Under voltage Lockout section. The internal oscillator can be synchronized to an external clock by coupling a positive pulse into this pin through a small coupling capacitor. See the frequency synchronization section for detail.
AGND	6	G	Analog ground pin. Ground reference for internal references and logic. Connect to system ground.
VIN	7	I	Input supply voltage with 4 V to 36 V operating range.
PGND	8	G	Power ground pin, connected internally to the low side power FET. Connect to system ground, PAD, AGND, ground pins of C <sub>IN</sub> and C <sub>OUT</sub> . Path to C <sub>IN</sub> must be as short as possible.
PAD	9	G	Low impedance connection to AGND. Connect to PGND on PCB. Major heat dissipation path of the die. Must be used for heat sinking to ground plane on PCB.

(1) I = Input, O = Output, G = Ground.

**PRODUCT PREVIEW**

## 6 Device and Documentation Support

### 6.1 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**TI E2E™ Online Community** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At [e2e.ti.com](http://e2e.ti.com), you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**Design Support** *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

### 6.2 Trademarks

PowerPAD, E2E are trademarks of Texas Instruments.  
SIMPLE SWITCHER is a registered trademark of Texas Instruments.

### 6.3 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### 6.4 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 7 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

**PRODUCT PREVIEW**

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LMR23625CDDA	PREVIEW	SO PowerPAD	DDA	8	75	TBD	Call TI	Call TI	-40 to 125		
LMR23625CDDAR	PREVIEW	SO PowerPAD	DDA	8	2500	TBD	Call TI	Call TI	-40 to 125		
LMR23625CFDDA	PREVIEW	SO PowerPAD	DDA	8	75	TBD	Call TI	Call TI	-40 to 125		
LMR23625CFDDAR	PREVIEW	SO PowerPAD	DDA	8	2500	TBD	Call TI	Call TI	-40 to 125		

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

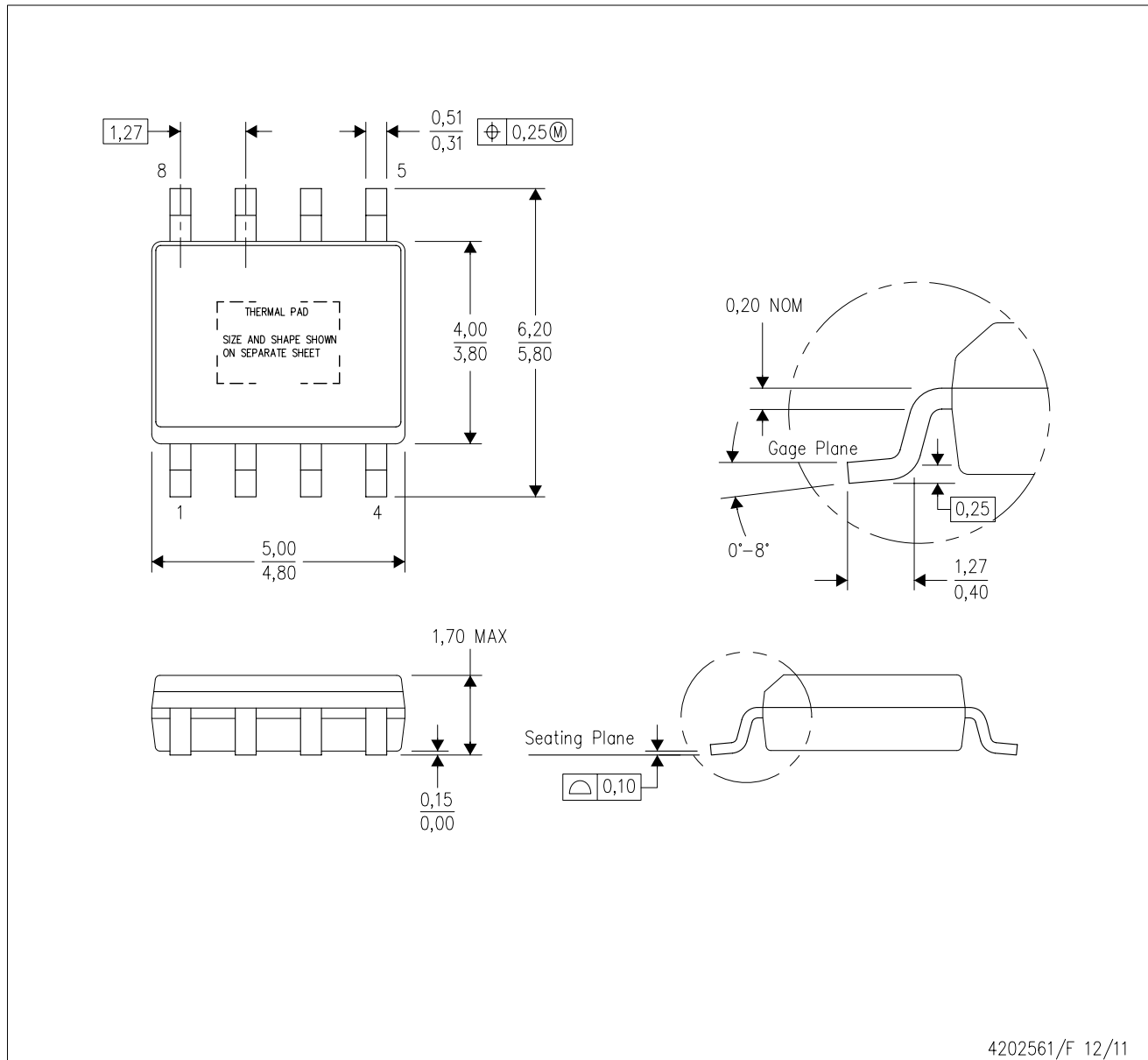
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

DDA (R-PDSO-G8)

PowerPAD™ PLASTIC SMALL-OUTLINE



4202561/F 12/11

- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5-1994.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion not to exceed 0,15.
  - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
  - This package complies to JEDEC MS-012 variation BA

PowerPAD is a trademark of Texas Instruments.

## 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

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
Consumer Electronics	<a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>
Energy and Lighting	<a href="http://www.ti.com/energy">www.ti.com/energy</a>
Industrial	<a href="http://www.ti.com/industrial">www.ti.com/industrial</a>
Medical	<a href="http://www.ti.com/medical">www.ti.com/medical</a>
Security	<a href="http://www.ti.com/security">www.ti.com/security</a>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)