

# LMR23610 SIMPLE SWITCHER® 36 V, 1 A Synchronous Step-Down Converter

## 1 Features

- 4 V to 36 V Input Range
- 1 A Continuous Output Current
- Integrated Synchronous Rectification
- Current Mode Control
- Minimum Switch-On Time: 60 ns
- 400 kHz Switching Frequency With PFM Mode
- 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 LMR23610 SIMPLE SWITCHER® is an easy to use 36 V, 1 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. An extended family is available in 2.5 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.

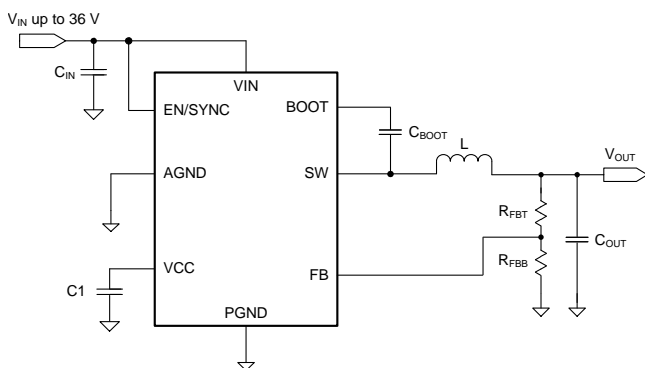
The LMR23610 is available in an 8-pin HSOIC package with exposed pad for low thermal resistance.

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

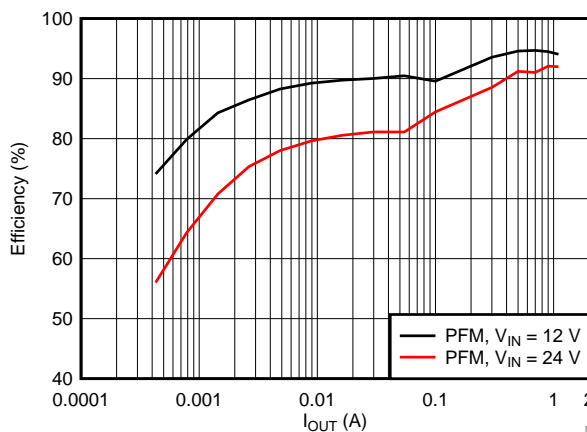
PART NUMBER	PACKAGE	BODY SIZE (NOM)
LMR23610A	HSOIC (8)	4.89 mm x 3.90 mm

(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



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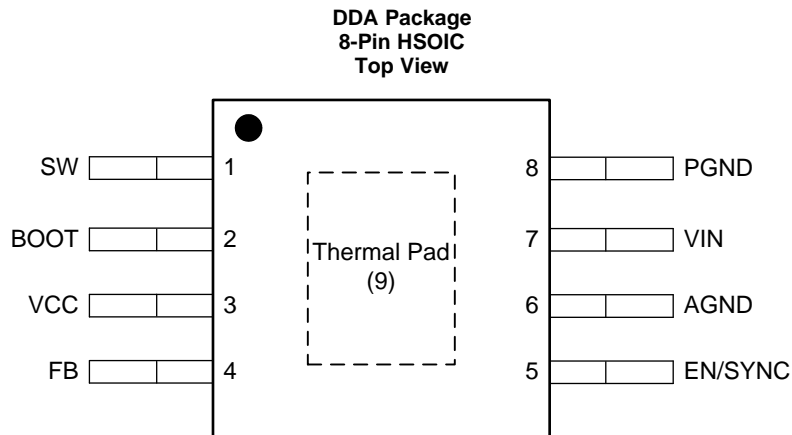
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## 4 Revision History

DATE	REVISION	NOTES
December 2015	*	Initial release.

## 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
LMR23610ADDA	PREVIEW	SO PowerPAD	DDA	8	75	TBD	Call TI	Call TI	-40 to 125		
LMR23610ADDAR	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.

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DDA (R-PDSO-G8)

PowerPAD™ PLASTIC SMALL-OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5-1994.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
  - D. 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>>.
  - E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
  - F. This package complies to JEDEC MS-012 variation BA

PowerPAD is a trademark of Texas Instruments.



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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

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### Applications

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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>
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