

LM5165 3V–65V, 150mA, Synchronous Buck Converter with Ultra-Low I_Q

1 Features

- Wide Input Voltage Range of 3 V to 65 V
- Fixed (3.3 V, 5 V) and Adjustable Output Voltages
- Load Current as High as 150 mA
- -40°C to 150°C Junction Temperature Range
- Selectable PFM or COT Mode Operation
- 10.5- μA Quiescent Current
- Integrated 2- Ω PMOS Buck Switch
 - Supports 100% Duty Cycle for Low Dropout
- Integrated 1- Ω NMOS Synchronous Rectifier
 - Eliminates External Schottky Diode
- Programmable Current Limit Setpoint (4 levels)
- $\pm 1\%$ Internal Voltage Reference
- 0.9-ms Internal or Programmable Soft-Start
- Monotonic Startup into Pre-Biased Outputs
- Diode Emulation and Pulse Skipping for Ultra-High Light-Load Efficiency Performance
- No Loop Compensation or Bootstrap Components
- Precision Enable/Input UVLO with Hysteresis
- Open-Drain Power Good Indicator
- Active Slew Rate Control for Low EMI
- Thermal Shutdown Protection with Hysteresis
- 10-Lead, 3 x 3-mm² VSON Package

2 Applications

- 4–20 mA Loop-Powered Sensors
- Automotive and Battery-powered Equipment
- High-voltage LDO Replacement
- Industrial Control Systems
- General Purpose Bias Supplies

3 Description

The LM5165 is a compact, easy-to-use, 3-V to 65-V, ultra-low I_Q synchronous buck converter with high efficiency over wide input voltage and load current ranges. With integrated high-side and low-side power MOSFETs, up to 150-mA of output current is delivered at fixed output voltages of 3.3 V or 5 V, or an adjustable output. The converter is designed to simplify its implementation while giving the option to optimize its usage according to the target application. Pulse Frequency Modulation (PFM) mode is selected for optimal light-load efficiency or Constant On-Time (COT) control for nearly constant operating frequency. Both control schemes do not require loop compensation, providing excellent line and load transient response and short PWM on-time for large step-down conversion ratios.

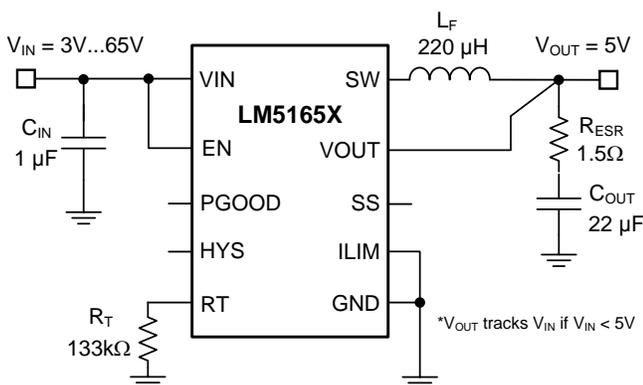
The high-side p-channel MOSFET can operate at 100% duty cycle for low dropout voltage and does not require a bootstrap capacitor for gate drive. Also, the current limit setpoint is adjustable to optimize inductor size for a particular output current requirement. Selectable/adjustable soft-start timing options include minimum delay (no soft-start), internally-fixed (0.9 ms), and externally-adjustable soft-start. An open-drain PGOOD indicator is used for sequencing and output voltage monitoring. The LM5165 is qualified to automotive AEC-Q100 grade 1 and is available in a thermally enhanced VSON-10 package with 0.5-mm pitch.

Device Information(1)

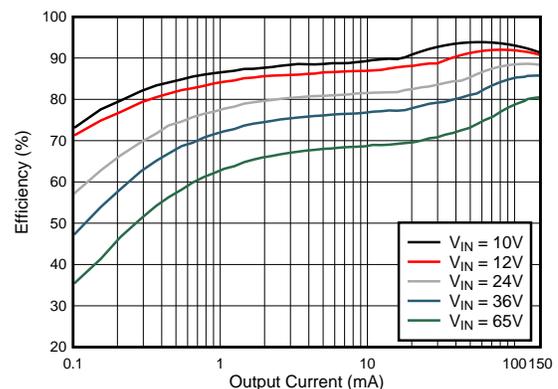
ORDER NUMBER	PACKAGE	BODY SIZE
LM5165DRCR	VSON (10)	3 mm x 3 mm

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

Typical Schematic, Fixed Output



Typical Efficiency, $V_{OUT} = 5\text{V}$



4 Revision History

DATE	REVISION	NOTES
February 2016	*	Product Preview release.

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5 Device and Documentation Support

5.1 Device Support

5.1.1 Development Support

- LM5165 [Quickstart](#) Design Tool
- [PowerLab™](#)
- [WEBENCH® Design Center](#)

5.2 Documentation Support

5.2.1 Related Documentation

- [LM5165-HD-P50A EVM User's Guide, SNVU474](#)
- [LM5165-HD-C50X EVM User's Guide, SNVU511](#)
- [AN-2162: Simple Success with Conducted EMI from DC-DC Converters, SNVA489](#)
- [Automotive Cranking Simulator User's Guide, SLVU984](#)
- [Using New Thermal Metrics Application Report, SBVA025](#)
- [Semiconductor and IC Package Thermal Metrics, SPRA953](#)

5.3 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](#), 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.

5.4 Trademarks

E2E is a trademark of Texas Instruments.

5.5 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.

5.6 Glossary

[SLYZ022](#) — *TI Glossary*.

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

6 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 datasheet, refer to the left-hand navigation.

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
LM5165DRCR	PREVIEW	VSON	DRC	10	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 150	5165	
LM5165DRCT	PREVIEW	VSON	DRC	10	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-2-260C-1 YEAR	-40 to 150	5165	
LM5165XDRCR	PREVIEW	VSON	DRC	10	3000	TBD	Call TI	Call TI	-40 to 150		
LM5165XDRCT	PREVIEW	VSON	DRC	10	250	TBD	Call TI	Call TI	-40 to 150		
LM5165YDRCR	PREVIEW	VSON	DRC	10	3000	TBD	Call TI	Call TI	-40 to 150		
LM5165YDRCT	PREVIEW	VSON	DRC	10	250	TBD	Call TI	Call TI	-40 to 150		

(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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OTHER QUALIFIED VERSIONS OF LM5165 :

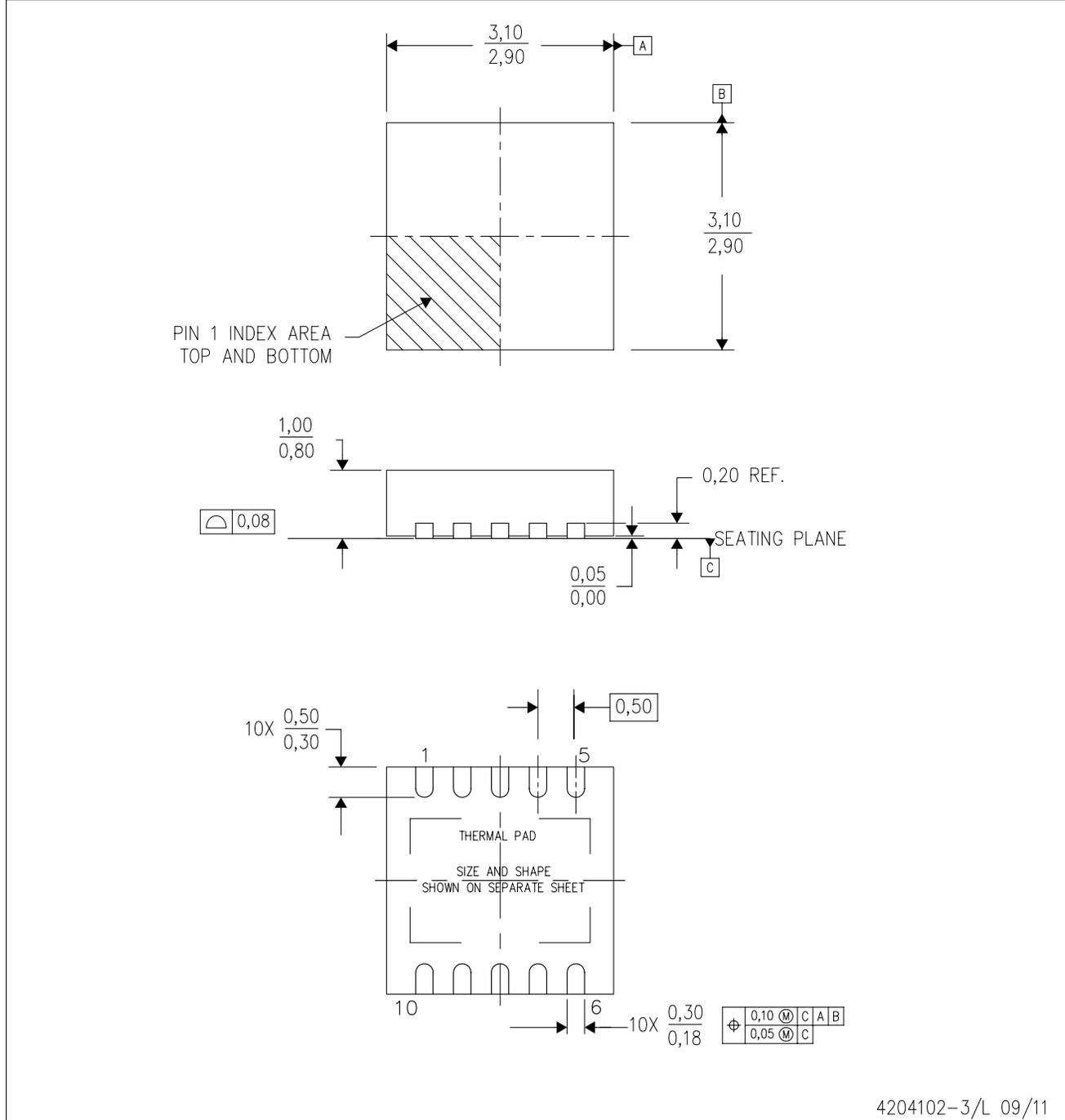
- Automotive: [LM5165-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

DRC (S-PVSON-N10)

PLASTIC SMALL OUTLINE NO-LEAD



- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - This drawing is subject to change without notice.
 - Small Outline No-Lead (SON) package configuration.
 - The package thermal pad must be soldered to the board for thermal and mechanical performance, if present.
 - See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions, if present

THERMAL PAD MECHANICAL DATA

DRC (S-PVSON-N10)

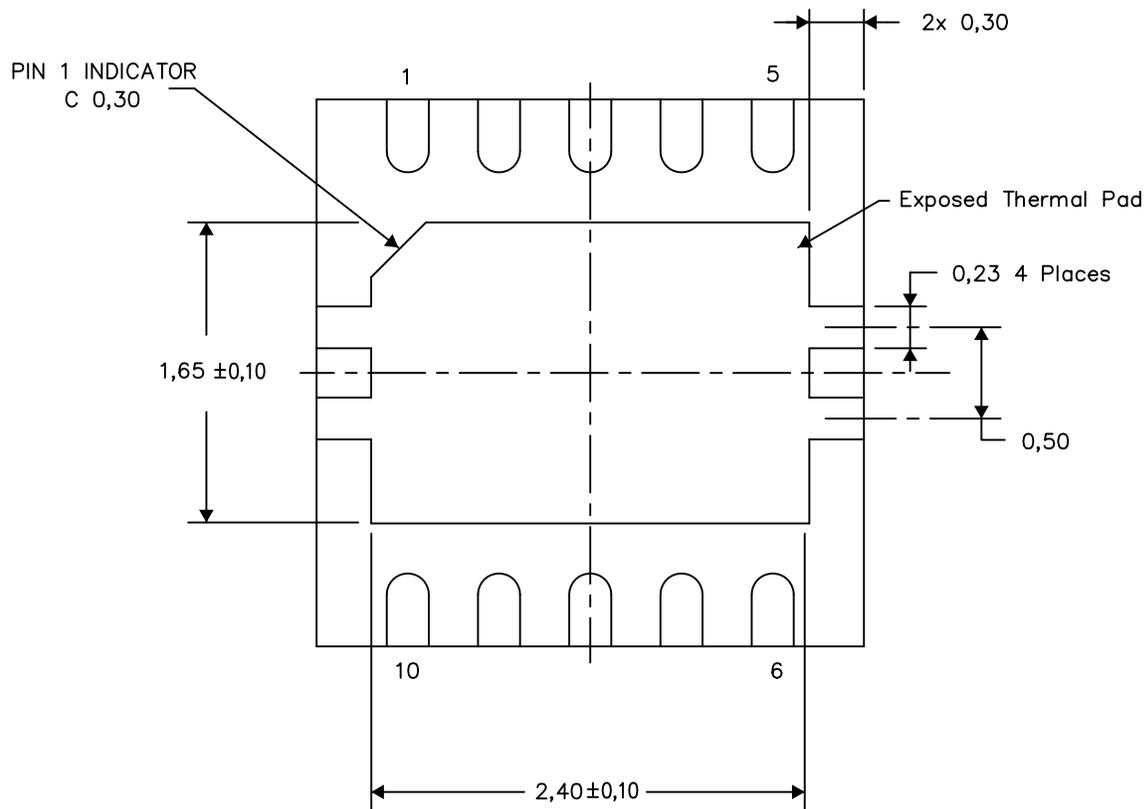
PLASTIC SMALL OUTLINE NO-LEAD

THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at www.ti.com.

The exposed thermal pad dimensions for this package are shown in the following illustration.



Bottom View

Exposed Thermal Pad Dimensions

4206565-3/Y 08/15

NOTE: A. All linear dimensions are in millimeters

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