

# LM53625/35-Q1, 2.5/3.5A, 36 V Wide-V<sub>IN</sub> Synchronous, 2.1MHz, Automotive Step Down DC-DC Converter

## 1 Features

- Qualified for Automotive Applications
- AEC-Q100 Qualified With the Following Results:
  - Device Temperature Grade 1: –40°C to 125°C Ambient Operating Temperature Range
  - Device HBM Classification Level 2
  - Device CDM Classification Level C5
- 4 mm x 5 mm, 0.5 mm Pitch SON Package with Wettable Flanks and 0.6 mm VIN Spacing
- –40°C to 150°C Junction Temperature Range
- Current Mode Control with Internal Compensation
- 2.1MHz (±10%) Fixed Switching Frequency
- Low EMI
- Spread Spectrum as a Factory Option
- Min OFF Time-80ns (maximum)
- Min ON Time-60ns (maximum)
- External Frequency Synchronization
- $\overline{\text{RESET}}$  Output with Filter and 3ms Release Timer
- Automatic Light Load Mode for Improved Efficiency
- Pin Selectable Forced PWM Mode
- Built in Compensation, Soft-start, Current Limit, Thermal Shutdown and UVLO
- 3.5 V to 36 V Input Voltage with Transients up to 42 V
- LM53625-Q1 = 2.5 A Maximum Load Current
- LM53635-Q1 = 3.5 A Maximum Load Current
- 91% Efficiency while Converting 13.5 V to 5 V, 3.5 A
- 0.6 V Dropout at 3.5 A Load, 1.4 V @ 1.85MHz @ 105°C TA
- Output Voltage Options: 5 V, 3.3 V and Adjustable
- ±1.5% Output Voltage Tolerance (over temperature)
- 2- $\mu$ A Shutdown Current (typical)
- 15- $\mu$ A I<sub>q</sub> - Quiescent Current at no Load (Typical) with 3.3 V Typical

## 2 Applications

- Automotive Telematics
- Navigation Systems
- In-Dash Instrumentation
- Battery-Powered Applications

## 3 Description

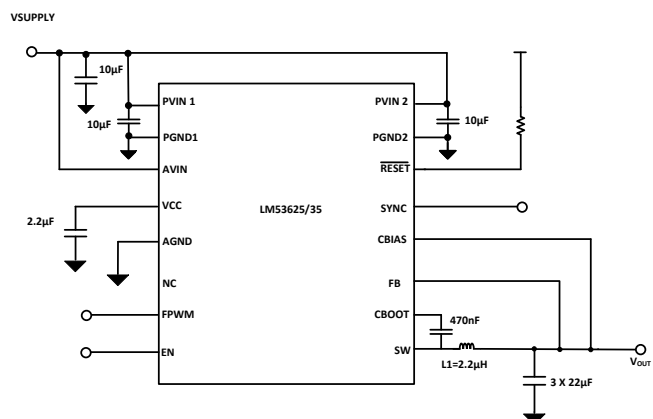
The LM53625-Q1/LM53635-Q1 synchronous buck regulator is optimized for automotive applications, providing an output voltage of 5 V, 3.3 V, or an adjustable output. Advanced high speed circuitry allows the LM53625-Q1/LM53635-Q1 to regulate from an input of 13.5 V to an output 3.3 V at a fixed frequency of 2.1MHz. Innovative architecture allows the device to regulate a 3.3 V output from an input voltage of only 3.5 V. All aspects of the LM53625-Q1/LM53635-Q1 are optimized for automotive and performance driven industrial customers. An input voltage range up to 36 V, with transient tolerance up to 42 V, eases input surge protection design. An open drain reset output, with filtering and delay, provides a true indication of system status. This feature negates the requirement for an additional supervisory component, saving cost and board space. Seamless transition between PWM and PFM modes, along with a quiescent current of only 15- $\mu$ A for 3.3 V option, ensures high efficiency and superior transient response at all loads.

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

DEVICE NAME	PACKAGE	BODY SIZE
LM53625-Q1	SON (22)	4 mm x 5 mm
LM53635-Q1		

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

### Typical Application Circuit



Automotive Wide-VIN Buck Converter, 3.5-36 V input, available in 3.3 V, 5.0 V and Adjustable output.



## Table of Contents

<b>1 Features</b> .....	<b>1</b>	5.2 Related Links .....	<b>3</b>
<b>2 Applications</b> .....	<b>1</b>	5.3 Community Resources.....	<b>3</b>
<b>3 Description</b> .....	<b>1</b>	5.4 Trademarks .....	<b>3</b>
<b>4 Revision History</b> .....	<b>2</b>	5.5 Electrostatic Discharge Caution.....	<b>3</b>
<b>5 Device and Documentation Support</b> .....	<b>3</b>	5.6 Glossary .....	<b>3</b>
5.1 Documentation Support .....	<b>3</b>	<b>6 Mechanical, Packaging, and Orderable Information</b> .....	<b>4</b>

## 4 Revision History

DATE	REVISION	NOTES
December 2015	*	Initial release.

## 5 Device and Documentation Support

### 5.1 Documentation Support

#### 5.1.1 Related Documentation

**Table 1. Resources for Thermal PCB Design**

TITLE	LINK
AN-2020 <i>Thermal Design By Insight, Not Hindsight</i>	<a href="#">SNVA419</a>
AN-1520 <i>A Guide to Board Layout for Best Thermal Resistance for Exposed Pad Packages</i>	<a href="#">SNVA183</a>
SPRA953B <i>Semiconductor and IC Package Thermal Metrics</i>	<a href="#">SPRA953</a>
SNVA719 <i>Thermal Design made Simple with LM43603 and LM43602</i>	<a href="#">SNVA719</a>
SLMA002 <i>PowerPAD™ Thermally Enhanced Package</i>	<a href="#">SLMA002</a>
SLMA004 <i>PowerPAD Made Easy</i>	<a href="#">SLMA004</a>

### 5.2 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

**Table 2. Related Links**

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
LM53625-Q1	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>
LM53635-Q1	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>

### 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](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.

### 5.4 Trademarks

PowerPAD, E2E are trademarks 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 data sheet, 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
LM536253QRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L536253	
LM536253QRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L536253	
LM536255QRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L536255	
LM536255QRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L536255	
LM53625AQRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L53625A	
LM53625AQRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L53625A	
LM53625LQRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L53625L	
LM53625LQRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L53625L	
LM53625MQRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L53625M	
LM53625MQRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L53625M	
LM53625NQRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L53625N	
LM53625NQRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L53625N	
LM536353QRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L536353	
LM536353QRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L536353	
LM536355QRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L536355	
LM536355QRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L536355	
LM53635AQRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L53635A	
LM53635AQRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L53635A	
LM53635LQRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L53635L	
LM53635LQRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L53635L	
LM53635MQRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L53635M	
LM53635MQRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L53635M	
LM53635NQRNLRQ1	PREVIEW	VQFN-HR	RNL	22	3000	TBD	Call TI	Call TI	-40 to 125	L53635N	
LM53635NQRNLQ1	PREVIEW	VQFN-HR	RNL	22	250	TBD	Call TI	Call TI	-40 to 125	L53635N	

(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.

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

---

<sup>(2)</sup> 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)

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

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

<sup>(5)</sup> 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.

<sup>(6)</sup> 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.

## 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)