

# LM2724A

*LM2724A High Speed 3A Synchronous MOSFET Driver*



Literature Number: SNVS242A

## High Speed 3A Synchronous MOSFET Driver

### General Description

The LM2724A is a dual N-channel MOSFET driver which can drive both the top and bottom MOSFETs in a push-pull structure simultaneously. The LM2724A takes a logic input and splits it into two complimentary signals with a typical 20ns dead time in between. The built-in cross-conduction protection circuitry prevents the top and bottom MOSFETs from turning on simultaneously. With a bias voltage of 5V, the peak sourcing and sinking current for each driver of the LM2724A is about 3A. Input UVLO (Under-Voltage-Lock-Out) ensures that all the driver outputs stay low until the supply rail exceeds the power-on threshold during system power on, or after the supply rail drops below power-on threshold by a specified hysteresis during system power down. The cross-conduction protection circuitry detects both driver outputs and will not turn on a driver until the other driver output is low. The top gate voltage needed by the top MOSFET is obtained through an external boot-strap structure. When not switching, the LM2724A only draws up to 195µA from the 5V rail. The syn-

chronization operation of the bottom MOSFET can be disabled by pulling the SYNC pin to ground.

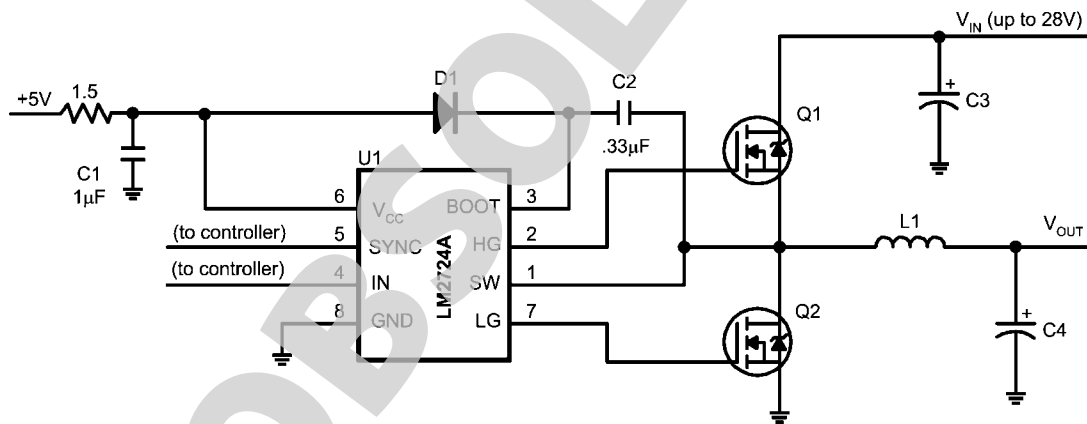
### Features

- Shoot-through protection
- Input Under-Voltage-Lock-Out
- 3A peak driving current
- 195µA quiescent current
- 28V input voltage in buck configuration
- SO-8 and LLP packages

### Applications

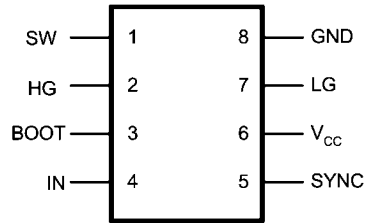
- High Current DC/DC Power Supplies
- High Input Voltage Switching Regulators
- Fast Transient Microprocessors
- Notebook Computers

### Typical Application

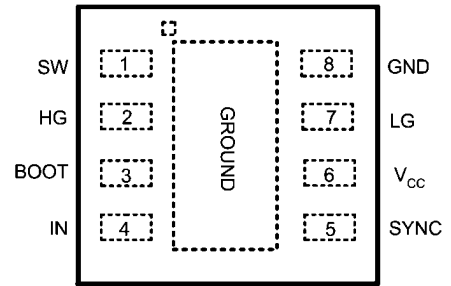


20073501

## Connection Diagram



**8-Lead SO (NS Package # M08A)**  
 $\theta_{JA} = 172^{\circ}\text{C/W}$



**8-Lead LLP (NS Package # LDC08A)**  
 $\theta_{JA} = 39^{\circ}\text{C/W}$

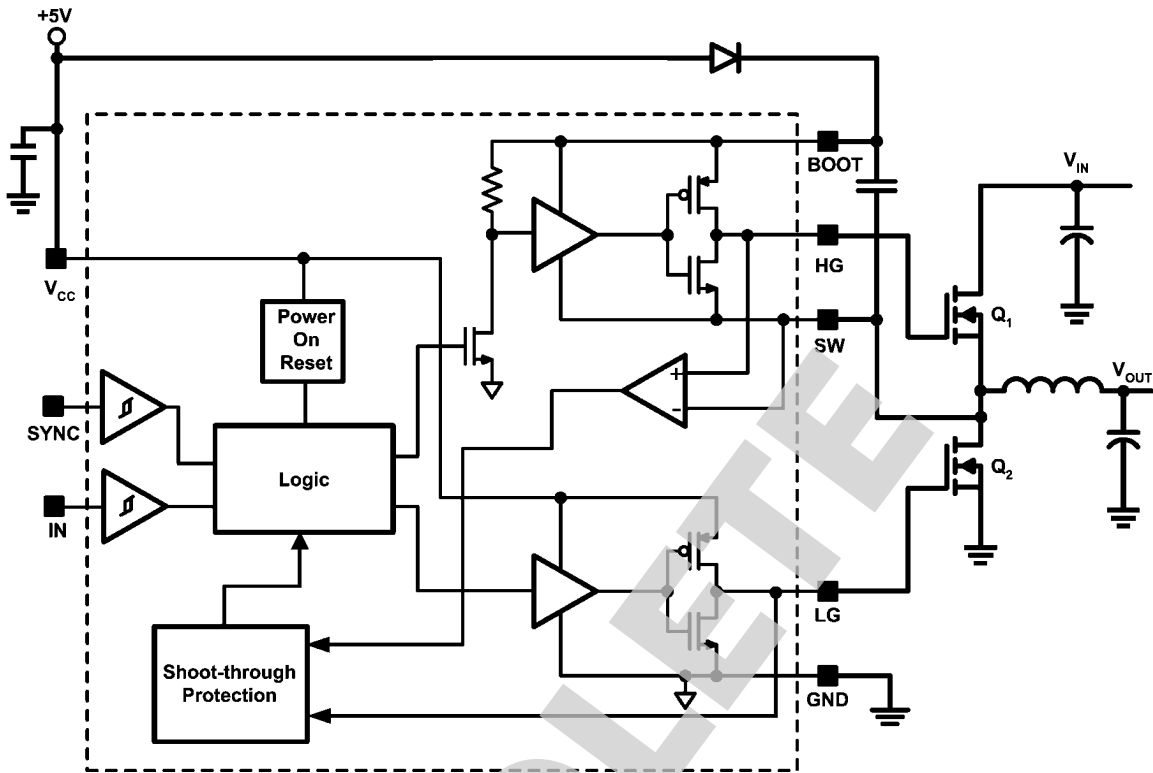
## Ordering Information

Order Number	Size	NSC Package Drawing	Supplied As
LM2724AM	SO-8	M08A	95 Units/Rail
LM2724AMX			2500 Units/Reel
LM2724ALD	LDC08A	LDC08A	1000 Units/Rail
LM2724ALDX			4500 Units/Reel

## Pin Descriptions

Pin	Name	Function
1	SW	Top driver return. Should be connected to the common node of top and bottom FETs
2	HG	Top gate drive output. Should be connected to the top FET gate.
3	BOOT	Bootstrap. Accepts a bootstrap voltage for powering the high-side driver
4	IN	Accepts a logic control signal
5	SYNC	Bottom gate enable
6	$V_{CC}$	Connect to +5V supply
7	LG	Bottom gate drive output. Should be connected to the bottom FET gate.
8	GND	Ground

# Block Diagram



20073503

OBSOLETE

## Absolute Maximum Ratings *(Note 1)*

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

$V_{CC}$	7V
BOOT to SW	7V
BOOT to GND <i>(Note 2)</i>	35V
SW to GND <i>(Note 3)</i>	-2V to 30V
Junction Temperature	+150°C
Power Dissipation <i>(Note 4)</i>	720mW (SO-8) 3.2W (LLP-8)

Storage Temperature	-65°C to 150°C
ESD Susceptibility Human Body Model <i>(Note 5)</i>	2.0 kV
Soldering Time, Temperature	10sec., 300°C

## Operating Ratings *(Note 1)*

$V_{CC}$	4.3V to 6.8V
Junction Temperature Range	-40°C to 125°C

## Electrical Characteristics LM2724A

$V_{CC} = \text{BOOT} = \text{SYNC} = 5\text{V}$ ,  $\text{SW} = \text{GND} = 0\text{V}$ , unless otherwise specified. Typical and limits appearing in plain type apply for  $T_A = T_J = +25^\circ\text{C}$ . Limits appearing in **boldface** type apply over the entire operating temperature range.

Symbol	Parameter	Condition	Min	Typ	Max	Units
<b>POWER SUPPLY</b>						
$I_{q\_op}$	Operating Quiescent Current	IN = 0V		145	<b>195</b>	$\mu\text{A}$
<b>TOP DRIVER</b>						
	Peak Pull-Up Current			3.0		A
	Pull-Up Rds_on	$I_{\text{BOOT}} = I_{\text{HG}} = 0.3\text{A}$		1.2		$\Omega$
	Peak Pull-down Current			-3.2		A
	Pull-down Rds_on	$I_{\text{SW}} = I_{\text{HG}} = 0.3\text{A}$		0.5		$\Omega$
$t_4$	Rise Time	Timing Diagram, $C_{\text{LOAD}} = 3.3\text{nF}$		17		ns
$t_6$	Fall Time			12		ns
$t_3$	Pull-Up Dead Time	Timing Diagram		19		ns
$t_5$	Pull-Down Delay	Timing Diagram, from IN Falling Edge		27		ns
<b>BOTTOM DRIVER</b>						
	Peak Pull-Up Current			3.2		A
	Pull-up Rds_on	$I_{\text{VCC}} = I_{\text{LG}} = 0.3\text{A}$		1.1		$\Omega$
	Peak Pull-down Current			3.2		A
	Pull-down Rds_on	$I_{\text{GND}} = I_{\text{LG}} = 0.3\text{A}$		0.6		$\Omega$
$t_8$	Rise Time	Timing Diagram, $C_{\text{LOAD}} = 3.3\text{nF}$		17		ns
$t_2$	Fall Time			14		ns
$t_7$	Pull-up Dead Time	Timing Diagram		22		ns
$t_1$	Pull-down Delay	Timing Diagram		13		ns
<b>LOGIC</b>						
$V_{\text{uvlo\_up}}$	$V_{CC}$ Under-Voltage-Lock-Out Upper Threshold	$V_{CC}$ rises from 0V toward 5V			<b>4</b>	V
$V_{\text{uvlo\_dn}}$	$V_{CC}$ Under-Voltage-Lock-Out Lower Threshold	$V_{CC}$ falls from 5V toward 0V	<b>2.5</b>			V
$V_{\text{uvlo\_hys}}$	$V_{CC}$ Under-Voltage-Lock-Out Hysteresis	$V_{CC}$ falls from 5V toward 0V		0.8		V
$V_{\text{IH\_SYNC}}$	SYNC Pin High Input		<b>55%</b>			$V_{CC}$
$V_{\text{IL\_SYNC}}$	SYNC Pin Low Input				<b>25%</b>	
$I_{\text{leak\_SYNC}}$	SYNC Pin Leakage Current	SYNC = 5V, Sink Current			<b>2</b>	$\mu\text{A}$
		SYNC = 0V, Source Current			<b>10</b>	
$I_{\text{leak\_IN}}$	IN Pin Leakage Current	IN = 0V, Source Current			<b>2</b>	$\mu\text{A}$
		IN = 5V, Sink Current			<b>10</b>	

Symbol	Parameter	Condition	Min	Typ	Max	Units
$t_{on\_min1}$	Minimum Positive Pulse Width at IN Pin (Note 6)			160		ns
$t_{on\_min2}$	Minimum Positive Pulse Width at IN Pin for HG to Respond (Note 7)			45		
$t_{on\_min3}$	Minimum Positive Pulse Width at IN Pin for LG to Respond (Note 8)			10		
$t_{off\_min1}$	Minimum Negative Pulse Width at IN Pin for LG to Respond (Note 9)			40		
$t_{off\_min2}$	Minimum Negative Pulse Width at IN Pin for HG to Respond (Note 10)			5		
$V_{IH\_IN}$	IN High Level Input Voltage	When IN pin goes high from 0V	55%			
$V_{IL\_IN}$	IN Low Level Input Voltage	When IN pin goes low from 5V			25%	

**Note 1: Absolute Maximum Ratings** are limits beyond which damage to the device may occur. **Operating ratings** are conditions under which the device operates correctly. The guaranteed specifications apply only for the listed test conditions. Some performance characteristics may degrade when the part is not operated under listed conditions.

**Note 2:** If BOOT voltage exceeds this value, the ESD structure will degrade.

**Note 3:** The SW pin can have -2V to -0.5V applied for a maximum duty cycle of 10% with a maximum period of 1 second. There is no duty cycle or maximum period limitation for a SW pin voltage range of -0.5V to 30V.

**Note 4:** Maximum allowable power dissipation is a function of the maximum junction temperature,  $T_{JMAX}$ , the junction-to-ambient thermal resistance,  $\theta_{JA}$ , and the ambient temperature,  $T_A$ . The maximum allowable power dissipation at any ambient temperature is calculated using:  $P_{MAX} = (T_{JMAX} - T_A) / \theta_{JA}$ . The junction-to-ambient thermal resistance,  $\theta_{JA}$ , for LM2724A is 172°C/W. For a  $T_{JMAX}$  of 150°C and  $T_A$  of 25°C, the maximum allowable power dissipation is 0.7W. The  $\theta_{JA}$ , for LM2724A LLP package is 39°C/W. For a  $T_{JMAX}$  of 150°C and  $T_A$  of 25°C, the maximum allowable power dissipation is 3.2W.

**Note 5:** ESD machine model susceptibility is 200V.

**Note 6:** If the positive pulse width at IN pin is below this value but above  $t_{on\_min2}$ , the pulse is internally stretched to  $t_{on\_min1}$ , so the HG width will be a constant value.

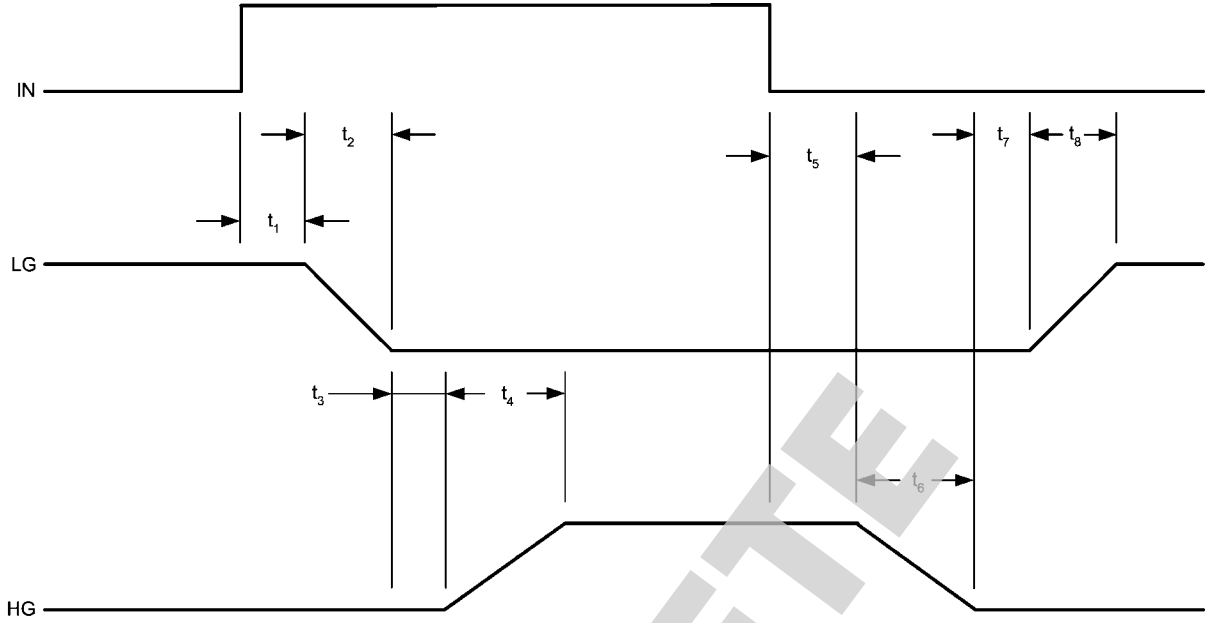
**Note 7:** If the positive pulse width at IN pin is below this value but above  $t_{on\_min3}$ , then HG stops responding while LG still responds to the pulse.

**Note 8:** If the positive pulse width at IN pin is below this value, the pulse will be completely ignored. Neither HG or LG will respond to it.

**Note 9:** If the negative pulse width at IN pin is below this value but above  $t_{off\_min2}$ , then LG stops responding while HG still responds.

**Note 10:** If the negative pulse width at IN pin is below this value, the pulse will be completely ignored. Neither HG or LG will respond to it.

### Timing Diagram



20073504

OBSOLETE



## Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:  
[www.national.com](http://www.national.com)

Products		Design Support	
Amplifiers	<a href="http://www.national.com/amplifiers">www.national.com/amplifiers</a>	WEBENCH® Tools	<a href="http://www.national.com/webench">www.national.com/webench</a>
Audio	<a href="http://www.national.com/audio">www.national.com/audio</a>	App Notes	<a href="http://www.national.com/appnotes">www.national.com/appnotes</a>
Clock and Timing	<a href="http://www.national.com/timing">www.national.com/timing</a>	Reference Designs	<a href="http://www.national.com/refdesigns">www.national.com/refdesigns</a>
Data Converters	<a href="http://www.national.com/adc">www.national.com/adc</a>	Samples	<a href="http://www.national.com/samples">www.national.com/samples</a>
Interface	<a href="http://www.national.com/interface">www.national.com/interface</a>	Eval Boards	<a href="http://www.national.com/evalboards">www.national.com/evalboards</a>
LVDS	<a href="http://www.national.com/lvds">www.national.com/lvds</a>	Packaging	<a href="http://www.national.com/packaging">www.national.com/packaging</a>
Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>	Feedback/Support	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
Voltage References	<a href="http://www.national.com/vref">www.national.com/vref</a>	Design Made Easy	<a href="http://www.national.com/easy">www.national.com/easy</a>
PowerWise® Solutions	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>	Applications & Markets	<a href="http://www.national.com/solutions">www.national.com/solutions</a>
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>	Mil/Aero	<a href="http://www.national.com/milaero">www.national.com/milaero</a>
Temperature Sensors	<a href="http://www.national.com/tempensors">www.national.com/tempensors</a>	SolarMagic™	<a href="http://www.national.com/solarmagic">www.national.com/solarmagic</a>
PLL/VCO	<a href="http://www.national.com/wireless">www.national.com/wireless</a>	PowerWise® Design University	<a href="http://www.national.com/training">www.national.com/training</a>

THE CONTENTS OF THIS DOCUMENT ARE PROVIDED IN CONNECTION WITH NATIONAL SEMICONDUCTOR CORPORATION ("NATIONAL") PRODUCTS. NATIONAL MAKES NO REPRESENTATIONS OR WARRANTIES WITH RESPECT TO THE ACCURACY OR COMPLETENESS OF THE CONTENTS OF THIS PUBLICATION AND RESERVES THE RIGHT TO MAKE CHANGES TO SPECIFICATIONS AND PRODUCT DESCRIPTIONS AT ANY TIME WITHOUT NOTICE. NO LICENSE, WHETHER EXPRESS, IMPLIED, ARISING BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT.

TESTING AND OTHER QUALITY CONTROLS ARE USED TO THE EXTENT NATIONAL DEEMS NECESSARY TO SUPPORT NATIONAL'S PRODUCT WARRANTY. EXCEPT WHERE MANDATED BY GOVERNMENT REQUIREMENTS, TESTING OF ALL PARAMETERS OF EACH PRODUCT IS NOT NECESSARILY PERFORMED. NATIONAL ASSUMES NO LIABILITY FOR APPLICATIONS ASSISTANCE OR BUYER PRODUCT DESIGN. BUYERS ARE RESPONSIBLE FOR THEIR PRODUCTS AND APPLICATIONS USING NATIONAL COMPONENTS. PRIOR TO USING OR DISTRIBUTING ANY PRODUCTS THAT INCLUDE NATIONAL COMPONENTS, BUYERS SHOULD PROVIDE ADEQUATE DESIGN, TESTING AND OPERATING SAFEGUARDS.

EXCEPT AS PROVIDED IN NATIONAL'S TERMS AND CONDITIONS OF SALE FOR SUCH PRODUCTS, NATIONAL ASSUMES NO LIABILITY WHATSOEVER, AND NATIONAL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY RELATING TO THE SALE AND/OR USE OF NATIONAL PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

#### LIFE SUPPORT POLICY

**NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS PRIOR WRITTEN APPROVAL OF THE CHIEF EXECUTIVE OFFICER AND GENERAL COUNSEL OF NATIONAL SEMICONDUCTOR CORPORATION.** As used herein:

Life support devices or systems are devices which (a) are intended for surgical implant into the body, or (b) support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in a significant injury to the user. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system or to affect its safety or effectiveness.

National Semiconductor and the National Semiconductor logo are registered trademarks of National Semiconductor Corporation. All other brand or product names may be trademarks or registered trademarks of their respective holders.

Copyright© 2011 National Semiconductor Corporation

For the most current product information visit us at [www.national.com](http://www.national.com)



[www.national.com](http://www.national.com)

**National Semiconductor  
Americas Technical  
Support Center**  
Email: [support@nsc.com](mailto:support@nsc.com)  
Tel: 1-800-272-9959

**National Semiconductor Europe  
Technical Support Center**  
Email: [europe.support@nsc.com](mailto:europe.support@nsc.com)

**National Semiconductor Asia  
Pacific Technical Support Center**  
Email: [ap.support@nsc.com](mailto:ap.support@nsc.com)

**National Semiconductor Japan  
Technical Support Center**  
Email: [jpn.feedback@nsc.com](mailto:jpn.feedback@nsc.com)

## 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

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 Mobile 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

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>
Transportation and Automotive	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

TI E2E Community Home Page

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

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2011, Texas Instruments Incorporated