LM5041,LM5100

LM5041 Application: DC - DC Converter Featuring the Cascaded Power Converter Topology

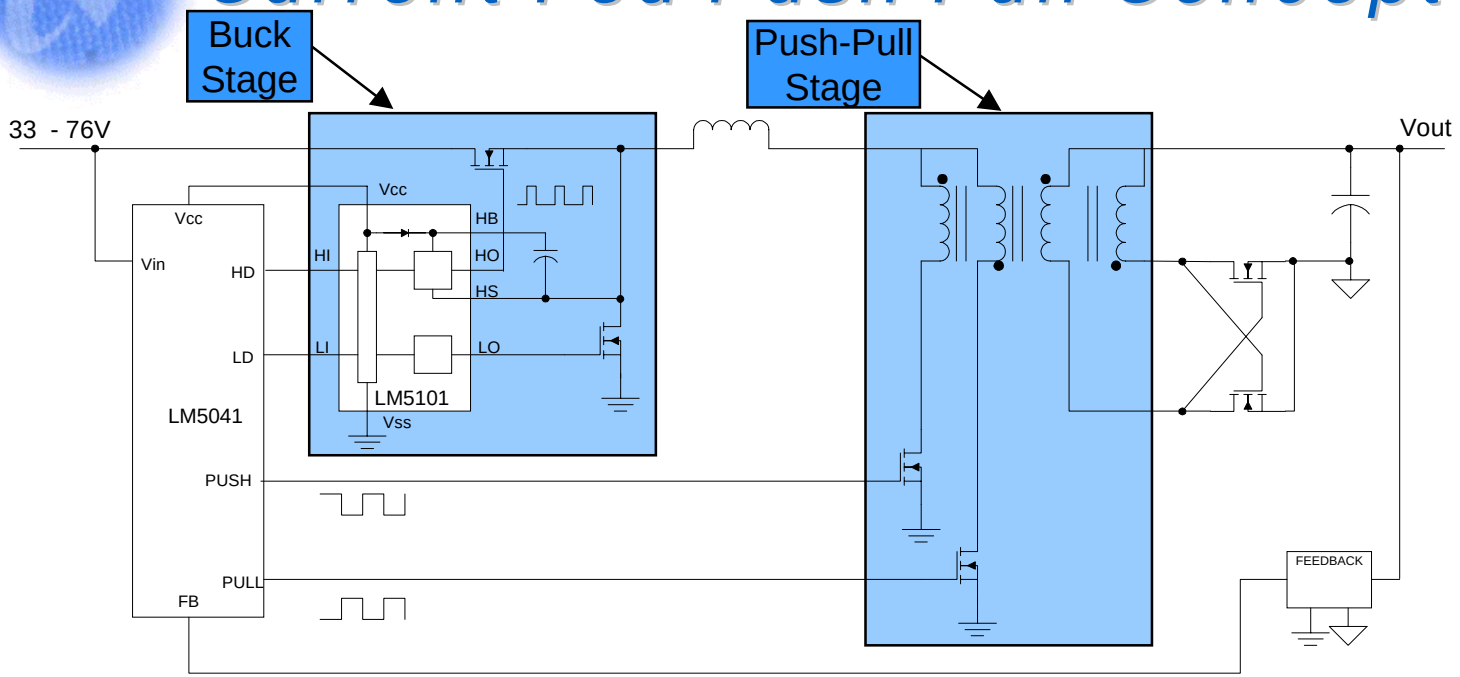
Literature Number: SNVA560

National Semiconductor

The Sight & Sound of Information

LM5041 Application DC – DC Converter Featuring the Cascaded Power Converter Topology

Current Fed Push-Pull Concept



- Push and Pull outputs operate continuously, alternating with a slight overlap.
- Output voltage is controlled by the Buck stage which operates at 2X the Push-Pull frequency.
- Continuous output current from the Push-Pull stage requires minimal filtering.
- High Efficiency achieved with low Push-Pull switching losses and matched Sync rectifier loading.
- Favorable topology for multi-output converters.

National Semiconductor
The Sight & Sound of Information

CASCADED CURRENT FED BENEFITS

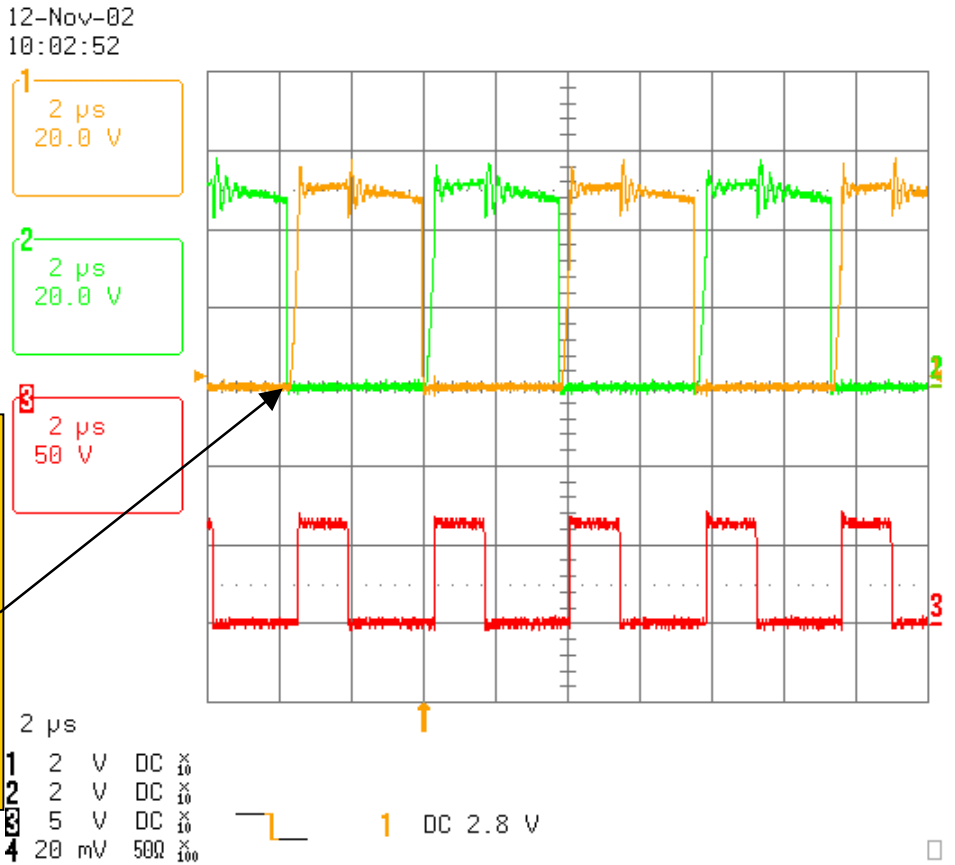
- A Current-Fed Push-Pull Converter is a Buck type converter consisting of a Buck Regulation stage followed by (cascaded by) a Push-Pull Isolation Stage
- The Buck Stage Capacitor and the Output Stage Inductor have been eliminated from the Voltage-Fed
- Reduced switching loss in PP stage
- The Push-Pull Stage voltage stresses are reduced to Vout * N * 2 over all line conditions, similar to Voltage-Fed
- The output rectification can be easily optimized, similar to Cascaded Voltage-Fed

Current-Fed Waveforms

Trace 1: Push_Pull XFR Side A

Trace 2: Push_Pull XFR Side B

Trace 3: Buck Stage Switching Node



Note; There is an overlap time where both the Push and the Pull switches are ON.
This is required to maintain the inductor current path

Vin =60V
Vout =2.5V
Iout = 20A

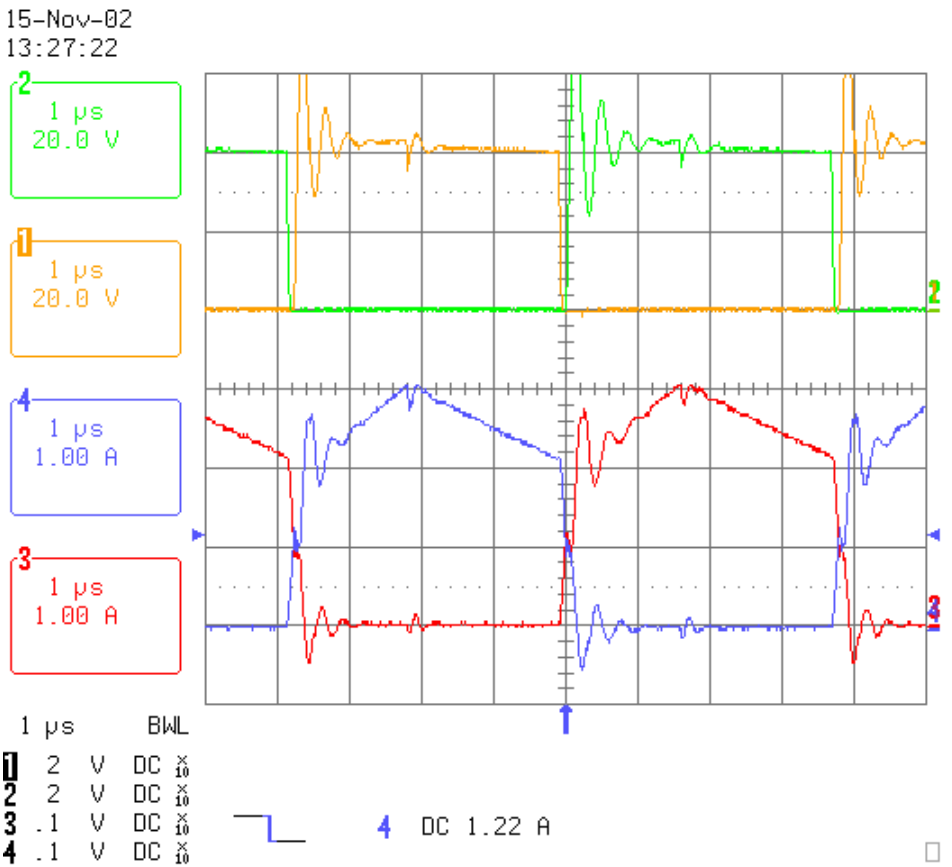
National Semiconductor
The Sight & Sound of Information

Current-Fed Waveforms

Ch 1,2 Push-Pull Vds

Ch 3,4 Push-Pull Ids

Vin =48V
Vout =2.5V
Iout = 20A



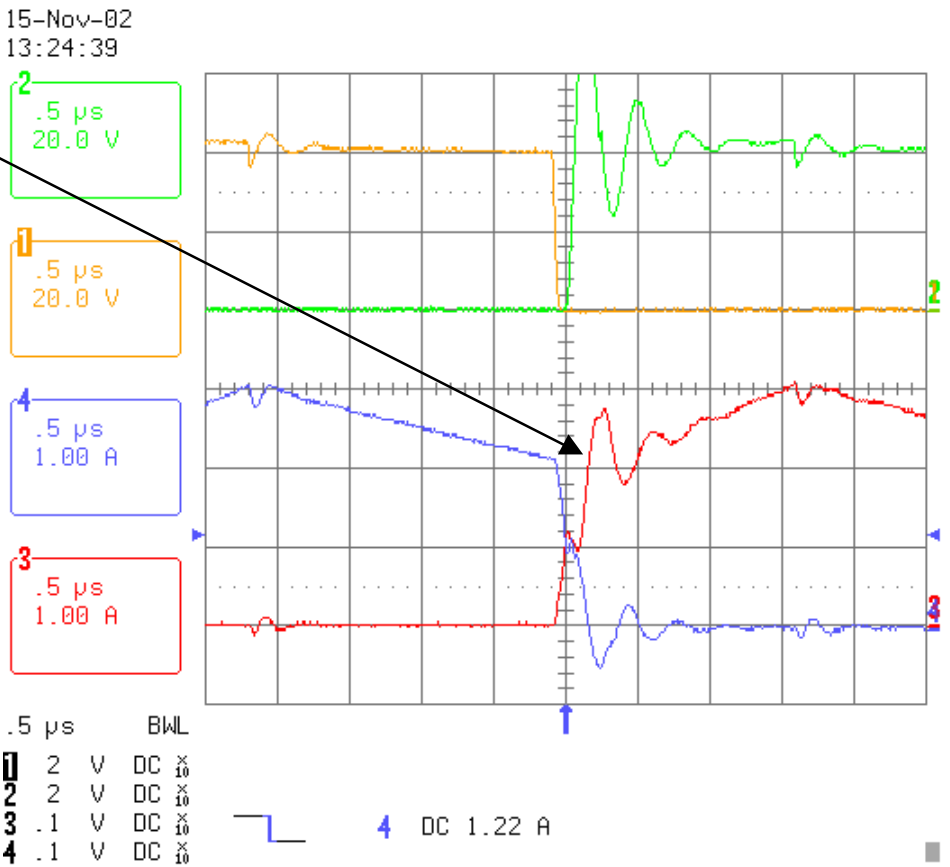
Current-Fed Waveforms Expanded Scale

Note, Switches only switch ½ current

Ch 1,2 Push-Pull V_{DS}

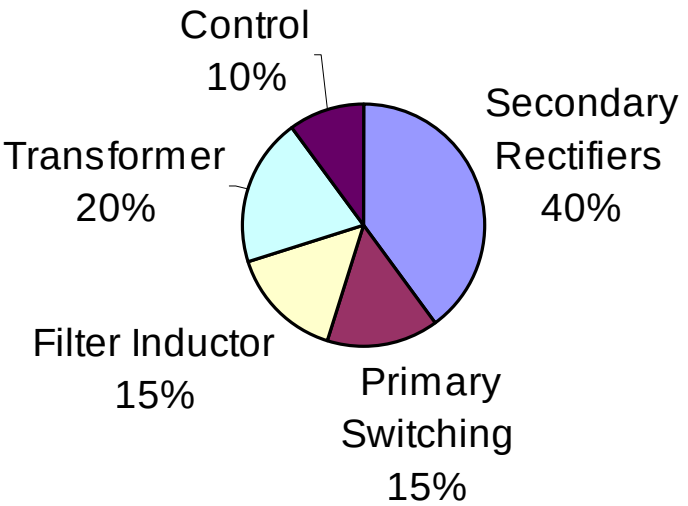
Ch 3,4 Push-Pull I_{DS}

Vin =48V
Vout =2.5V
Iout = 20A



National Semiconductor
The Sight & Sound of Information

Why is Reducing Secondary Rectification Losses Important?



Estimate for typical 3.3V Output, 35 – 80V Input

National Semiconductor
The Sight & Sound of Information

Comparison of Rectifier Stresses

Topology	Rectifier Voltage Stresses	Example: 3.3V Out, 35 - 80V Input	Example: Assumptions
Forward	Vin * (Ns/Np)	20V	High Line with XFR Ratio 4:1
Push-Pull	Vin * (Ns/Np) * 2	26.7V	High Line with XFR Ratio 6:1
Cascaded PP	Vout * 2	6.6V	All Line conditions XFR Ratio 6:1

Topology	Rectifier Current Ratios	Example: 3.3V Out, 35 - 80V Input	Example: Assumptions
Forward	Iout * D and Iout * (1-D)	16 / 84%	Ratio at High Line
Push-Pull	50% * Iout	50%	All line conditions
Cascaded PP	50% * Iout	50%	All line conditions

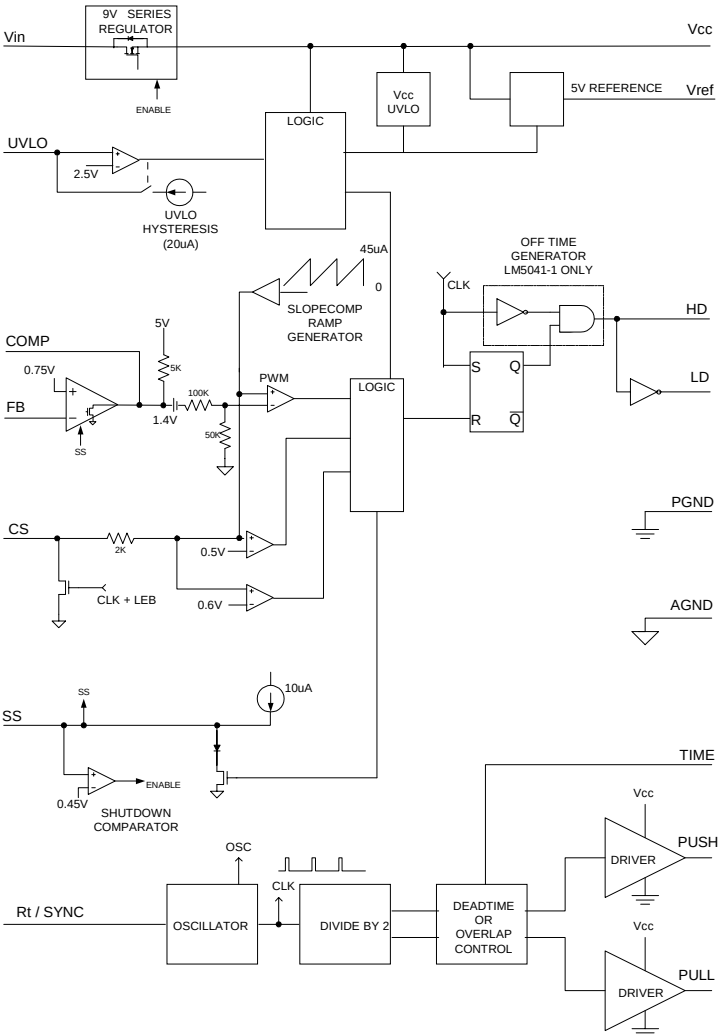
National Semiconductor
The Sight & Sound of Information

LM5041 Cascaded PWM Controller

Features

- Internal Start-up Bias Regulator
- Programmable Line Under Voltage Lockout with Adjustable Hysteresis
- Current Mode Control
- Internal Error Amplifier with Reference
- Dual Mode Over-Current Protection
- Programmable Push-Pull Overlap or Deadtime
- Internal Push-Pull Gate Drivers
- Programmable Soft-Start
- Programmable Oscillator with Sync Capability
- Precision Reference
- Thermal Shutdown (165°C)

Packages: TSSOP16 and LLP16 (5 x 5 mm)



National Semiconductor
The Sight & Sound of Information

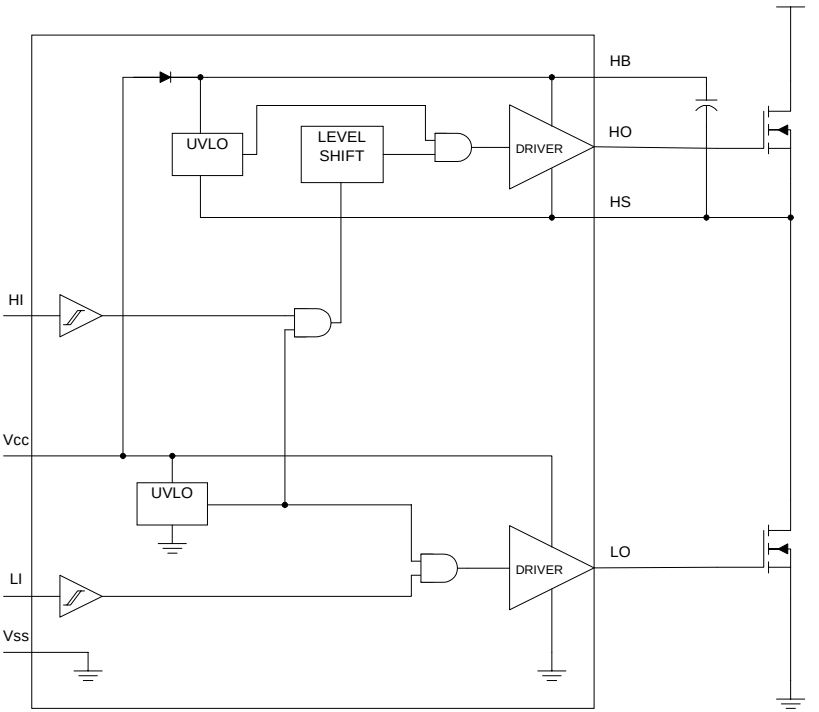
LM5100 / 1 High Voltage Buck Stage Gate Driver

Features

- Drives both a High Side and Low Side N-Channel MOSFET
- Independent Inputs (TTL for LM5101 or CMOS for LM5100)
- Bootstrap Supply Voltage to 116VDC
- Fast Propagation Times
- Drives 1000pF Loads with 10nS Rise and Fall Times
- Outputs Unaffected by Supply Glitching, HS Ringing Below Ground or HS High Slew Rates
- Supply Rail Under-voltage Lockout
- Low Power Consumption
- Pin for pin compatible with HIP2100/2101

Typical Applications

- Current Fed Push-Pull Power Converters
- Half Bridge Power Converters
- Full Bridge Power Converters
- Two Switch Forward Power Converters
- Active Clamp Forward Power Converters



Package

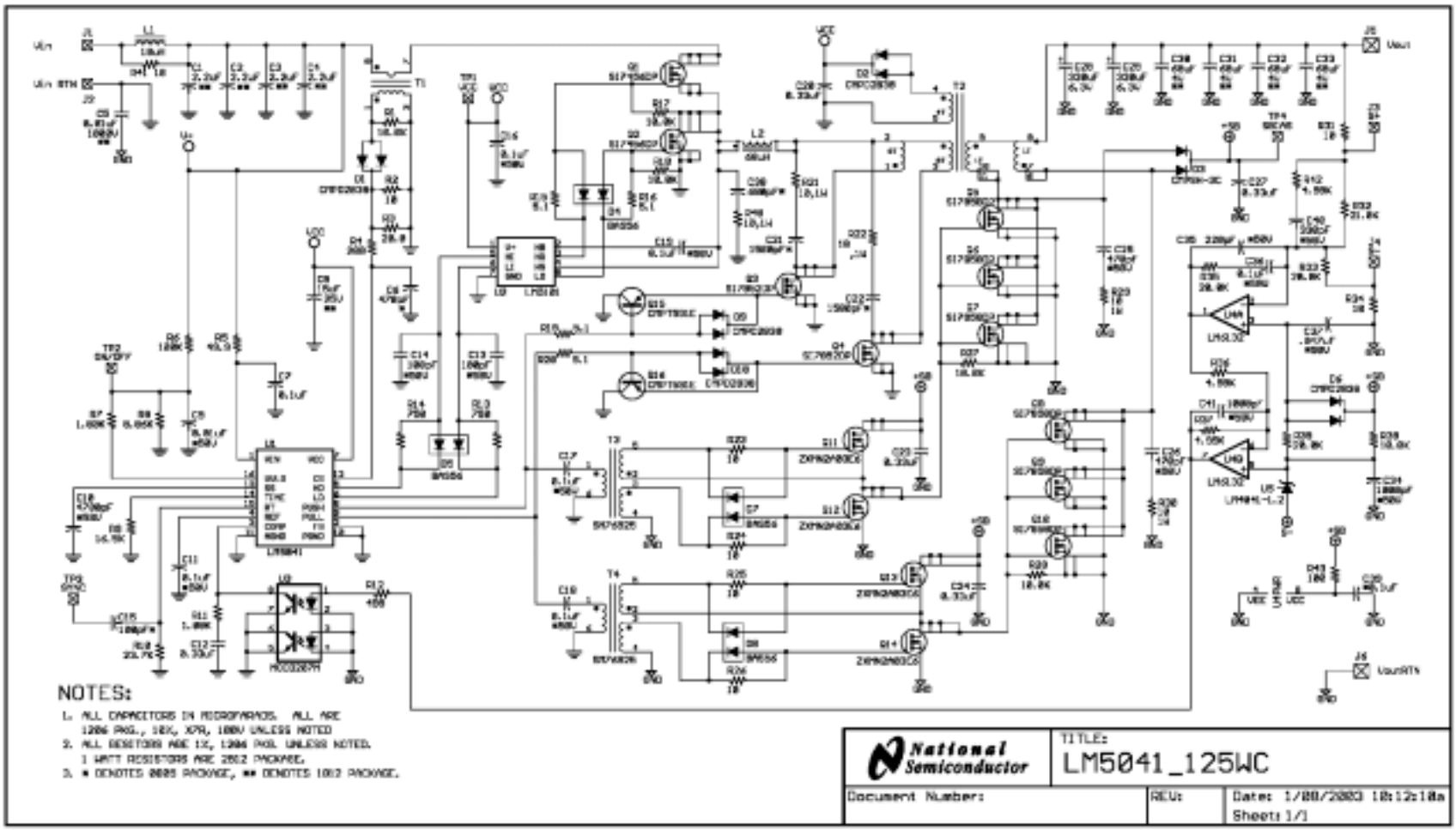
- SOIC – 8
- LLP - 10

National Semiconductor
The Sight & Sound of Information

Application Converter Performance

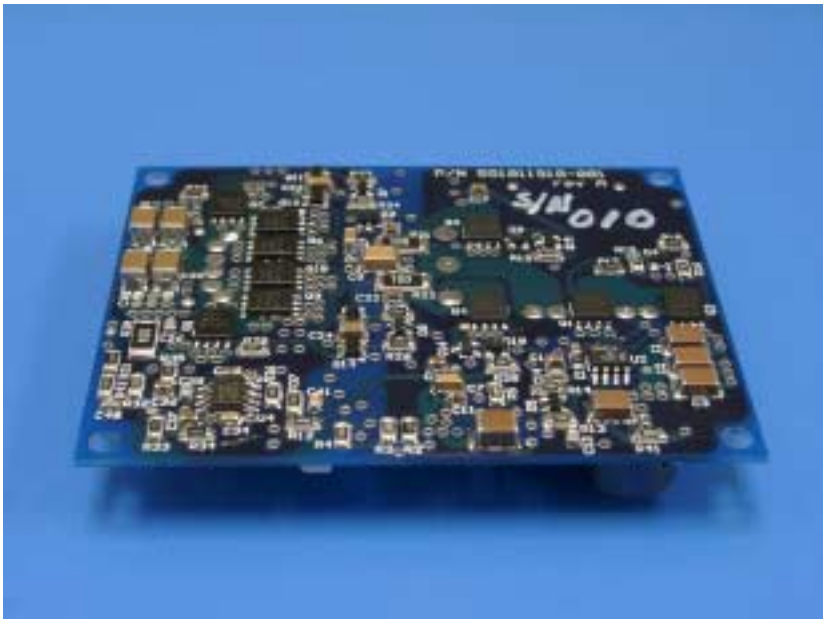
Input Range: 35 to 80V
Output Voltage: 2.5V
Output Current: 0 to 50A
Measured Efficiency:
89% @ 50A and 91% @20A
Board Size: 2.3 x 3.0 x 0.5
Load Regulation: 1%
Line Regulation: 0.1%
Line UVLO, Current Limit

LM5041 / LM5100 Demo Board
2.5V @ 50A Cascaded DC-DC Converter



Demonstration Converter Photo

Top View



Bottom View

National Semiconductor
The Sight & Sound of Information

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		**Applications**	
Audio	www.ti.com/audio	Communications and Telecom	www.ti.com/communications
Amplifiers	amplifier.ti.com	Computers and Peripherals	www.ti.com/computers
Data Converters	dataconverter.ti.com	Consumer Electronics	www.ti.com/consumer-apps
DLP® Products	www.dlp.com	Energy and Lighting	www.ti.com/energy
DSP	dsp.ti.com	Industrial	www.ti.com/industrial
Clocks and Timers	www.ti.com/clocks	Medical	www.ti.com/medical
Interface	interface.ti.com	Security	www.ti.com/security
Logic	logic.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Power Mgmt	power.ti.com	Transportation and Automotive	www.ti.com/automotive
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap		
Wireless Connectivity	www.ti.com/wirelessconnectivity		
	TI E2E Community Home Page		e2e.ti.com

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265