

LM5039

Application Note 2025 LM5039 Evaluation Board



Literature Number: SNVA423C

LM5039 Evaluation Board

National Semiconductor
Application Note 2025
Ajay Hari
February 17, 2010



Introduction

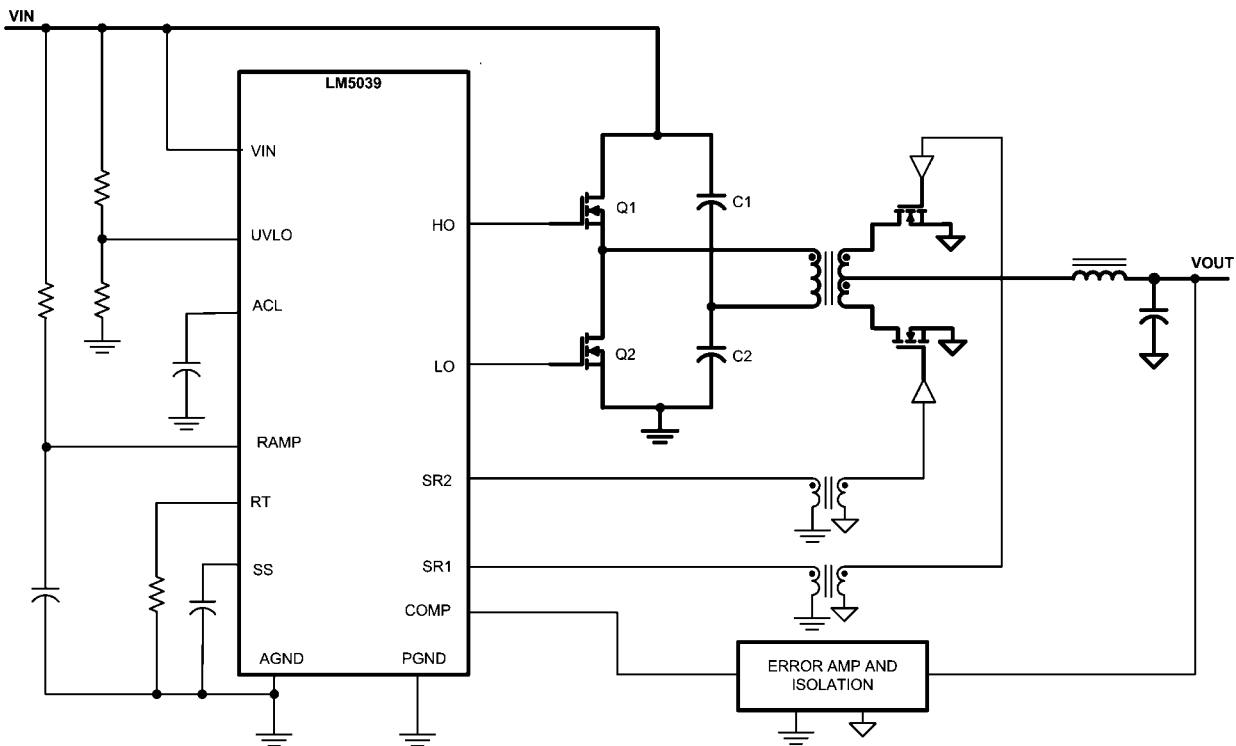
The LM5039 evaluation board is designed to provide the design engineer with a fully functional power converter based on the half-bridge topology to evaluate the LM5039 controller. The evaluation board is provided in an industry standard quarter brick footprint. The performance of the evaluation board is as follows:

- Input Operating Range: 36V to 75V
- Output Voltage: 3.3V
- Measured Efficiency: 89% @ 30A, 92% @ 15A
- Frequency of Operation: 400 kHz
- Board Size: 2.28 x 1.45 x 0.5 inches
- Load Regulation: 0.2%
- Line Regulation 0.1%
- Line UVLO (31V/30V on/off)
- Constant Current Limit

The printed circuit board consists of 6 layers, 2 ounce copper outer layers, and 3 ounce copper inner layers on FR4 material, with a total thickness of 0.062 inches. The unit is designed for continuous operation at rated load at 40°C and a minimum airflow of 200 CFM.

Theory of Operation

Power converters based on the half-bridge topology offer high-efficiency and good power handling capability up to 500W. A simplified half bridge circuit is illustrated below. The capacitors C1 and C2, which form one-half of the bridge, are arranged in series such that the mid-point is at half the input voltage. The other half of the bridge is formed by the switches Q1 and Q2. Switches Q1 and Q2 are turned on alternatively with a pulse-width determined by the input and output voltages and the transformer turns ratio. Each switch, when turned on, applies one-half the input voltage to the primary of the transformer. The resulting secondary voltage is then rectified and filtered with an LC filter to provide a smoothed output voltage. In half-bridge topology, the primary switches are turned on alternatively energizing the windings in such a way that the flux swings back and forth in the first and the third quadrants of the B-H curve. The use of two quadrants allows better utilization of the core resulting in a smaller core volume compared to the single-ended topologies such as a forward converter.



Simplified Half-Bridge Circuit

30112701

The secondary side employs synchronous rectification scheme, which is controlled by the LM5039, during the soft-start, the sync FET body diodes act as the secondary rectifiers. Once, the soft-start is finished, the synchronous rectifiers are engaged with a non-overlap time programmed by the DLY resistor. Feedback from the output is processed by an amplifier and reference, generating an error voltage, which is coupled back to the primary side control through an opto-coupler. The LM5039 controller pulse width modulates the error signal with a ramp signal derived from the line voltage (feed-forward) to reduce the response time. A standard “type III” network is used for the compensator.

Powering and Loading Considerations

When applying power to the LM5039 evaluation board, certain precautions need to be followed. A misconnection can damage the assembly.

PROPER CONNECTIONS

When operated at low input voltages the evaluation board can draw up to 3.5A of current at full load. The maximum rated output current is 30A. Be sure to choose the correct connector and wire size when attaching the source supply and the load. Monitor the current into and out of the evaluation board. Monitor the voltage directly at the output terminals of the evaluation board. The voltage drop across the load connecting wires will give inaccurate measurements. This is especially true for accurate efficiency measurements.

SOURCE POWER

The evaluation board can be viewed as a constant power load. At low input line voltage (36V) the input current can reach 3.5A, while at high input line voltage (72V) the input current will be approximately 1.5A. Therefore, to fully test the LM5039 evaluation board a DC power supply capable of at least 85V and 4A is required. The power supply must have adjustments for both voltage and current.

The power supply and cabling must present low impedance to the evaluation board. Insufficient cabling or a high impedance power supply will droop during power supply ap-

plication with the evaluation board inrush current. If large enough, this droop will cause a chattering condition upon power up. This chattering condition is an interaction with the evaluation board under voltage lockout, the cabling impedance and the inrush current.

LOADING

An appropriate electronic load, with specified operation down to 3.0V minimum, is desirable. The resistance of a maximum load is 0.11Ω. The high output current requires thick cables! If resistor banks are used there are certain precautions to be taken. The wattage and current ratings must be adequate for a 30A, 100W supply. Monitor both current and voltage at all times. Ensure that there is sufficient cooling provided for the load.

AIR FLOW

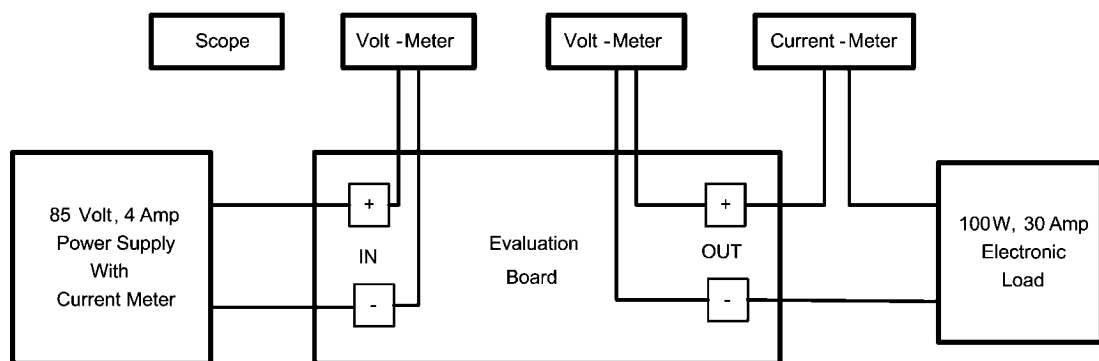
Full power loading should never be attempted without providing the specified 200 CFM of air flow over the evaluation board. A stand-alone fan should be provided.

POWERING UP

Using the ON/OFF pin provided will allow powering up the source supply with the current level set low. It is suggested that the load be kept low during the first power up. Set the current limit of the source supply to provide about 1.5 times the wattage of the load. As you remove the connection from the ON/OFF pin to ground, immediately check for 3.3 volts at the output.

A most common occurrence, that will prove unnerving, is when the current limit set on the source supply is insufficient for the load. The result is similar to having the high source impedance referred to earlier. The interaction of the source supply folding back and the evaluation board going into undervoltage shutdown will start an oscillation, or chatter, that may have undesirable consequences.

A quick efficiency check is the best way to confirm that everything is operating properly. If something is amiss you can be reasonably sure that it will affect the efficiency adversely. Few parameters can be incorrect in a switching power supply without creating losses and potentially damaging heat.



30112702

FIGURE 1.

OVER CURRENT PROTECTION

The evaluation board is not configured with over current protection and will be in continuous current limit condition. Therefore, 200 CFM of airflow is a must during the over current condition.

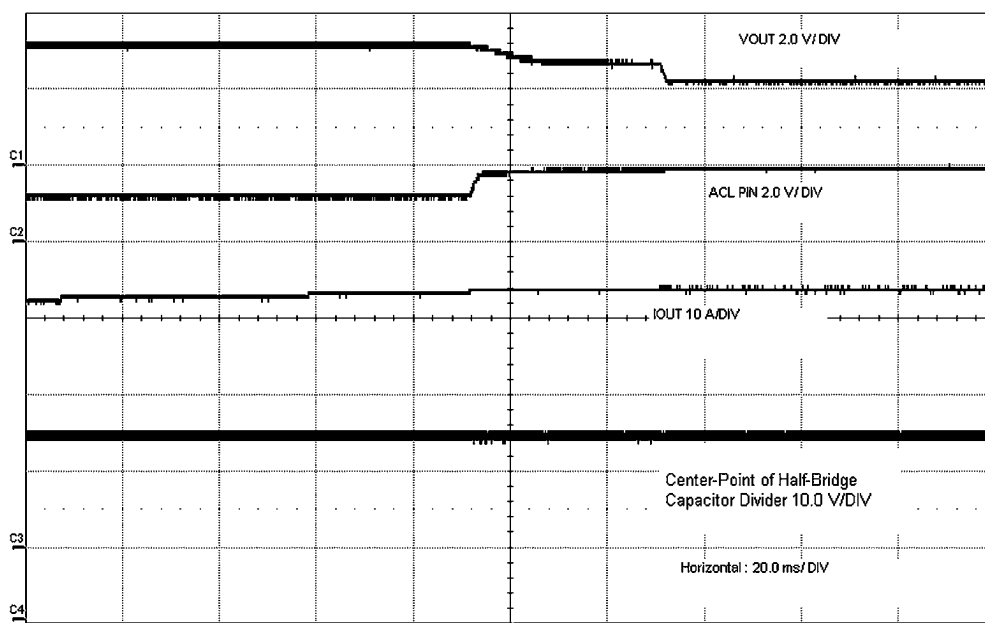
If the customer desires to configure the evaluation board with the hiccup mode enabled, a 4700pF capacitor needs to be connected from RES pin to AGND. In the event of an output overload (approximately 35A) the unit will discharge the soft start capacitor, which disables the power stage. After a delay the softstart is released. The shutdown, delay and slow recharge time of the soft start capacitor reduces the average power consumption of the unit in an overload condition.

Average Current Limit

The major drawback of the half-bridge topology is that during current limit condition, the center-point of the capacitor divider tends to runaway either towards the input voltage rail or towards the ground. This phenomenon saturates the transformer and requires the capacitors in the divider to be rated to at least the input voltage. In an overload condition, the PWM cycle is terminated by the current sense comparator instead of the PWM comparator. This is similar to peak current

mode control, which inherently results in an on-time between both the phases of the half-bridge topology. Any such imbalance, for an extended period, will cause the voltage at the center-point of the capacitor divider to drift either towards the input voltage or the ground. However, in an average current limit scheme, the PWM cycle is terminated through the PWM comparator, by pulling down the PWM control input. Because of its averaging nature, the PWM control input voltage is slow moving and is essentially held at a constant dc voltage. This results in the on-time between the both the phases to be equal and thus balances the center-point of the capacitor divider. Figure 2 shows the current limit waveforms in a soft-short condition and Figure 3 shows the current limit waveforms in a hard-short condition.

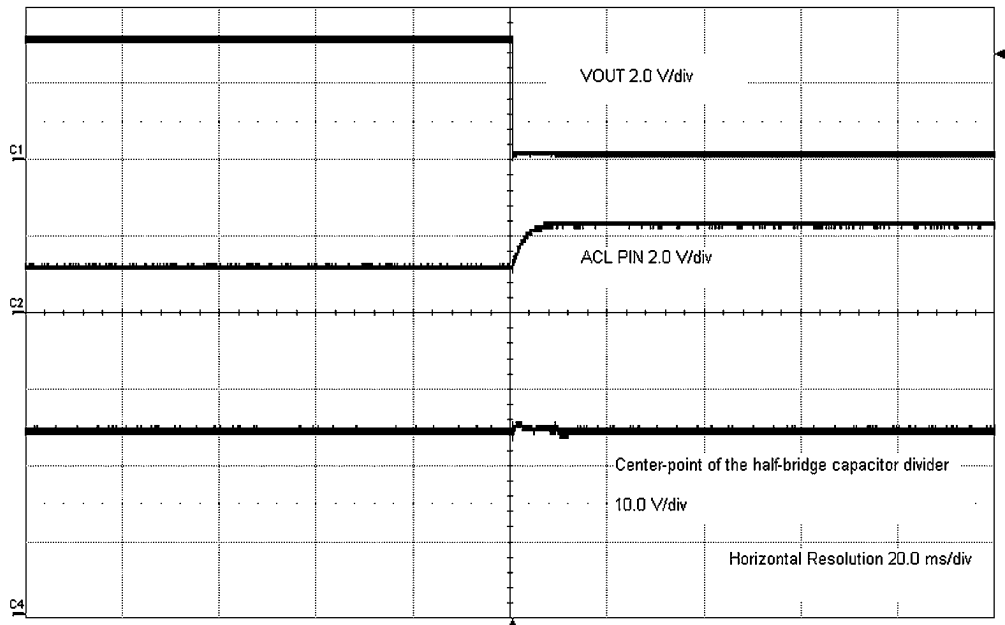
It can be observed from the Figures 2 and 3 that the center-point of the half-bridge capacitor divider is balanced in both soft-short and hard-short conditions. The response of average current limit circuit is same whether the short is soft or hard. During an overload event, the average current limit scheme converts the power supply from a constant voltage source to a constant current source. This scheme is often known as "brickwall current limiting." A V_{OUT} vs I_{OUT} curve, shown in Figure 4, illustrates the brickwall current limiting.



30112703

Trace 1 (C1) Output Voltage
 Trace 2(C2): Voltage on the ACL Capacitor
 Trace 3 (C3): Output current
 Trace 4 (C4): Voltage at the center-point of the half-bridge capacitor divider

FIGURE 2.

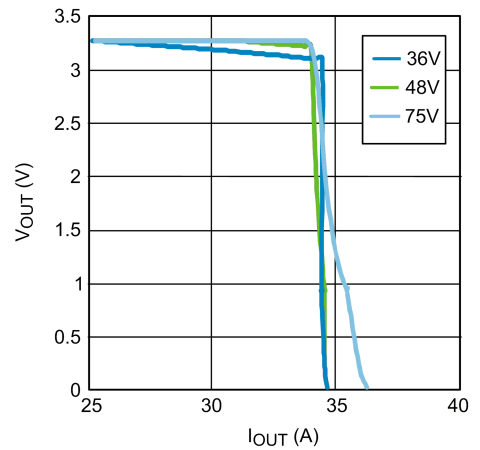


30112704

Trace 1 (C1) Output Voltage
 Trace 2(C2): Voltage on the ACL Capacitor
 Trace 3 (C4): Voltage at the center-point of the half-bridge capacitor divider

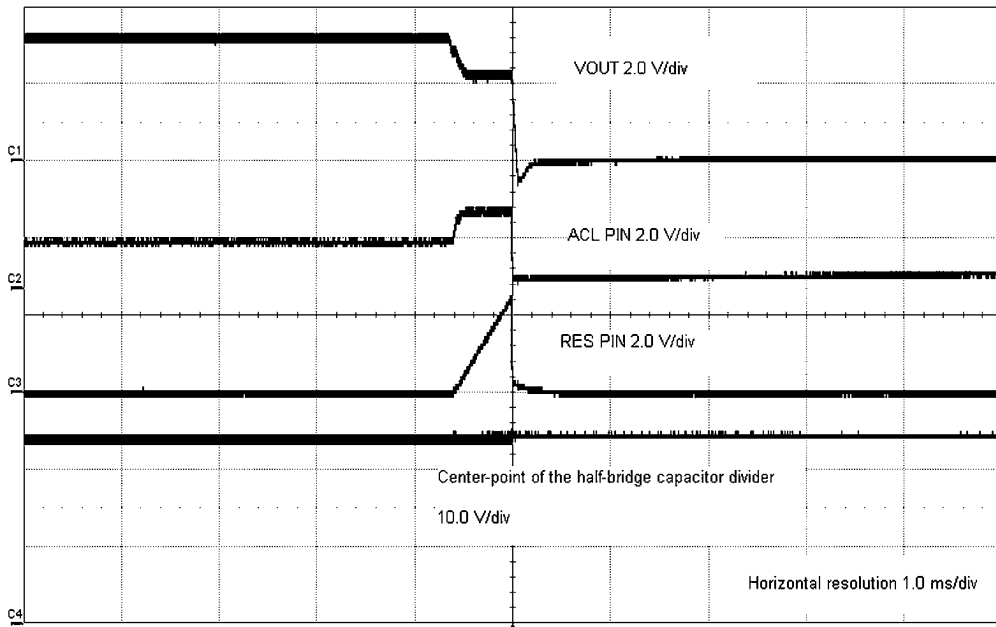
FIGURE 3.

The LM5039 evaluation board is configured to be in constant current limiting. To configure the board for hiccup mode restart, remove the zero ohm resistor from the RES pin to the AGND and install a 4700pF capacitor from the RES pin to the AGND. The RES capacitor should be selected such that the time taken for the RES capacitor to reach 2.5V is greater than the time taken for the average current mode control circuit to be in control. This will ensure that center-point of the half-bridge capacitor is balanced. Figure 5 illustrates a balanced half-bridge capacitor divider at the inception of a hiccup mode restart. While Figure 6 shows the same over multiple hiccup mode restarts. The RES capacitor should be selected such that the time taken for the RES capacitor to reach 2.5V and hence start the hiccup mode is greater than the time taken for the ACL pin to get into control.



30112705

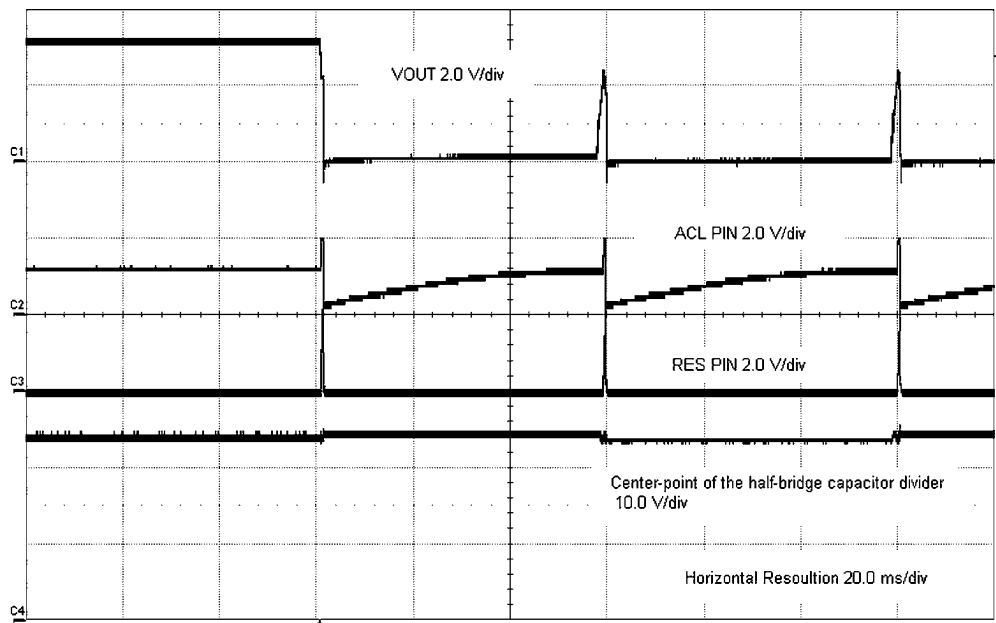
FIGURE 4.



30112706

- Trace 1 (C1): Output voltage
- Trace 2(C2): Voltage on the ACL capacitor
- Trace 3(C3): Voltage on the RES capacitor
- Trace 4(C4): Voltage at the center-point of the half-bridge capacitor divider

FIGURE 5.



30112707

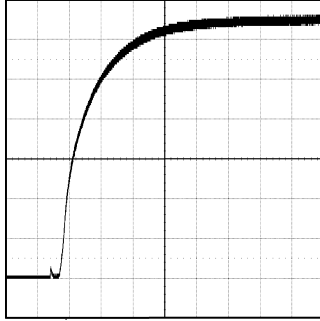
- Trace 1 (C1): Output voltage
- Trace 2(C2): Voltage on the ACL capacitor
- Trace 3(C3): Voltage on the RES capacitor
- Trace 4(C4): Voltage at the center-point of the half-bridge capacitor divider

FIGURE 6.

Other Performance Characteristics

When applying power to the LM5039 evaluation board a certain sequence of events occurs. Soft-start capacitor values and other components allow for a minimal output voltage for a short time until the feedback loop can stabilize without overshoot. Figure 7 shows the output voltage during a typical start-up with a 48V input and a load of 30A. There is no overshoot during start-up.

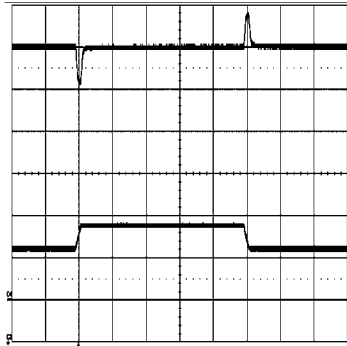
Figure 8 shows the transient response for a load of change from 5A to 25A. The upper trace shows minimal output voltage droop and overshoot during the sudden change in output current shown by the lower trace.



30112708

Conditions: Input Voltage=48V
Output Current=5A
Trace 1: Output Voltage Volts/div=500mV
Horizontal Resolution =2.0 ms/div

FIGURE 7.

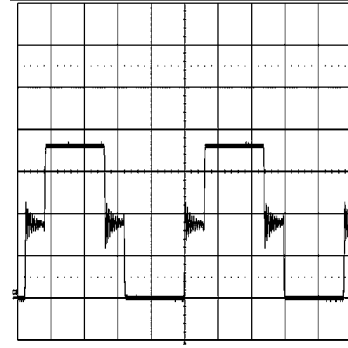


30112709

Conditions: Input Voltage=48V
Output Current=15A to 22.5A
Upper Trace: Output Voltage Volts/div=50mV
Lower Trace: Output Current = 15A to 22.5A to 15A
Horizontal Resolution =0.5 ms/div

FIGURE 8.

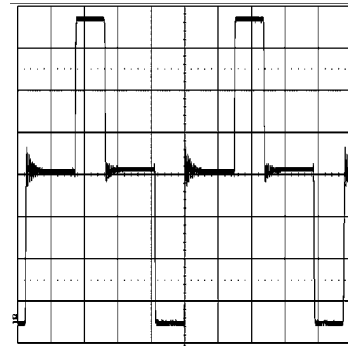
Figures 9 and 10 show the drain voltage of Q1 with a 25A load. Figure 9 represents an input voltage represents an input voltage of 36V and Figure 10 represents an input voltage of 72V.



30112710

Conditions: Input Voltage =36V
Output Current=5A
Trace 1: Q1 Drain Voltage Volts/div=10V
Horizontal Resolution= 1 us/div

FIGURE 9.

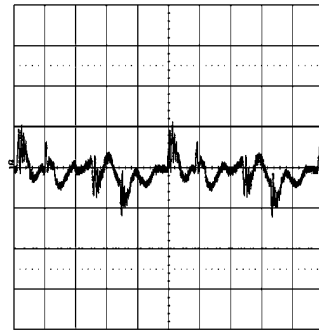


30112721

Conditions: Input Voltage =72V
Output Current=5A
Trace 1: Q1 Drain Voltage Volts/div=10V
Horizontal Resolution= 1 us/div

FIGURE 10.

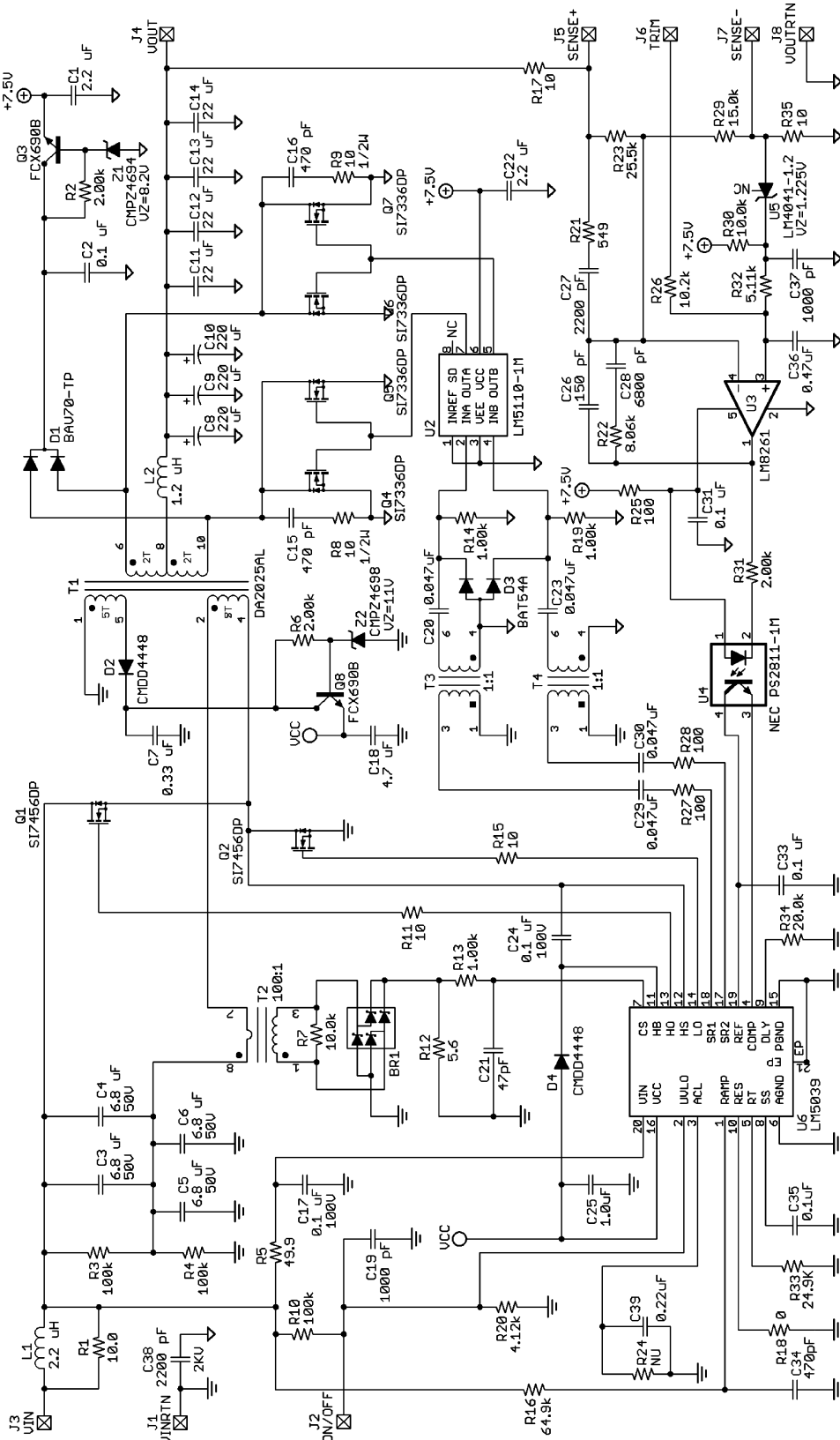
Figure 11 shows typical output ripple seen directly across the output capacitor, for an input voltage of 48V and a load of 30A. This waveform is typical of most loads and input voltages.



30112724

Conditions: Input Voltage =48V
Output Current=5A
Trace 1: Output Voltage Volts/div=20mV
Horizontal Resolution= 1 us/div

FIGURE 11.



30112711

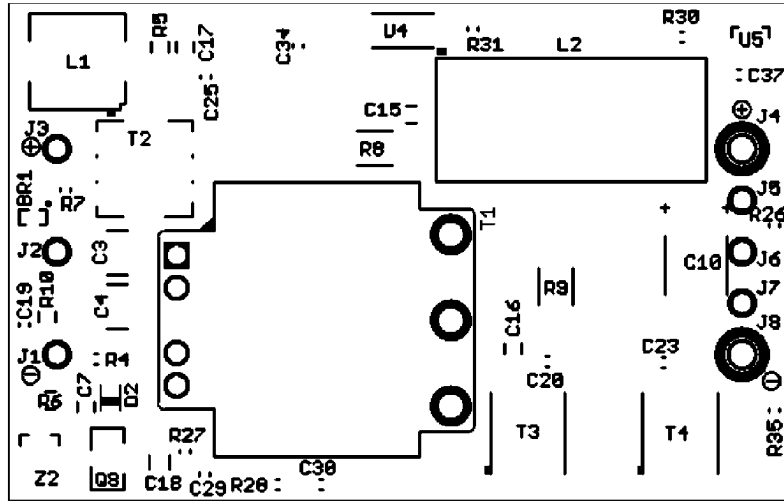
FIGURE 12.

Bill of Materials

#	Designator	Qty	Part #	Description
1	U1	1	NSC LM5039MH	LM5039 Controller
2	U2	1	NSC LM5110-1M	LM5110-1M Dual Driver
3	U3	1	NSC LM8261M5	LM8261M5 Op Amp
4	U5	1	NSC LM4041AIM3-.12	LM4041AIM3-1.2 Ref Amp
5	U4	1	NEC PS2811-1M	Opto-Coupler PS2811-1M
6	C21	1	TDK C1608COG1H470J	Cer Cap 47pF 50V COG
7	C26	1	TDK C1608COG1H151J	Cer Cap 150pF 50V COG
8	C34	1	TDK C1608COG1H471J	Cer Cap 470pF 50V COG
9	C19, C37	2	TDK C1608X7R1H102K	Cer Cap 1000pF 50V X7R
10	C27	2	TDK C1608COG1H222J	Cer Cap 2200pF 50V COG
11	C28	1	TDK C1608COG1H682J	Cer Cap 6800pF 50V COG
12	C20, C23, C29, C30	1	TDK C1608X7R1E473K	Cer Cap 0.047uF 25V COG
13	C2, C33, C31, C35	3	TDK C1608X7R1H104K	Cer Cap 0.1uF 50V X7R
14	C25	2	TDK C1608X7R1C105K	Cer Cap 1.0uF 16V X7R
15	C36	3	TDK C1608X7R1C474K	Cer Cap 0.47uF 50V X7R
16	C32	1	Vishay CRCW06030000Z0TA	Res 0 Ohm 0.1W,5%
17	C39	2	TDK C2012x714224K	Cer Cap 0.22uF 25V COG
18	C15, C16	2	KEMT C0805C471M5RAC	Cer Cap 470pF 50V COG
19	C17, C24	2	TDK C2012X7R2A104K	Cer Cap 0.1uF 100V X7R
20	C7	1	TDK C2012X7R1H334K	Cer Cap 0.33uF 50V X7R
21	C1, C22	2	TDK C2012X7R1C225K	Cer Cap 2.2uF 16V X7R
22	C18	1	TDK C3216X7R1C475K	Cer Cap 4.7uF 16V X7R
23	C11-C14	4	TDK C3216X5R0J226M	Cer Cap 22uF 6.3V X5R
24	C38	1	TDK C4532X7R3D222K	Cer Cap 2200pF 2000V X7R
25	C3-C6	4	TDK C4532X7R1H685M	Cer Cap 6.8uF 50V X7R
26	C8-C10	3	Sanyo 6TPE220MI	POSCAP 220uF 6.3V
27	R12	1	Vishay CRCW06035R60FKTA	Res 5.6 Ohm 0.1W 1%
28	R17, R35	2	Vishay CRCW060310R0F	Res 10 Ohm 0.1W 1%
29	R25, R27, R28	3	Vishay CRCW06031000F	Res 100 Ohm 0.1W 1%
30	R21	1	Vishay CRCW06035490F	Res 549 Ohm 0.1W 1%
31	R13-14, R18-19	4	Vishay CRCW06031001F	Res 1K Ohm 0.1W 1%
32	R24	1	NU	NU
33	R31	1	Vishay CRCW06032001F	Res 2.0K Ohm 0.1W 1%
34	R20	1	Vishay CRCW06034121F	Res 4.12K Ohm 0.1W 1%
35	R32	1	Vishay CRCW06035111F	Res 5.11K Ohm 0.1W 1%
36	R22	1	Vishay CRCW06038061F	Res 8.06K Ohm 0.1W 1%
37	R7, R30	2	Vishay CRCW06031002F	Res 10K Ohm 0.1W 1%
38	R26	1	Vishay CRCW06031022F	Res 10.2K Ohm 0.1W 1%
39	R33	1	Vishay CRCW06032492F	Res 24.9K Ohm 0.1W 1%
40	R29	1	Vishay CRCW06031502F	Res 15K Ohm 0.1W 1%
41	R34	1	Vishay CRCW06032002F	Res 20K Ohm 0.1W 1%
42	R23	1	Vishay CRCW06032552F	Res 25.5K Ohm 0.1W 1%
43	R3, R4	2	Vishay CRCW06031003F	Res 100K Ohm 0.1W 1%
44	R1, R11, R15	3	Vishay CRCW080510R0F	Res 10 OHM 1/10W 1%
45	R5	1	Vishay CRCW080549R9F	Res 49.9 OHM 1/10W 1%
46	R2	1	Vishay CRCW08052001F	Res 2K OHM 1/10W 1%
47	R6	1	Vishay CRCW08051002F	Res 10K OHM 1/10W 1%

48	R16	1	Vishay CRCW08056492F	Res 64.9K OHM 1/10W 1%
49	R10	2	Vishay CRCW08051003F	Res 100K OHM 1/10W 1%
50	R8, R9	2	Vishay CRCW201010R0F	Res 10 OHM 1%
51	D1	1	BAV70-TP	Schottky, Diode, 75V 150mA
52	D2, D4	2	Central CMDD4448	Diode, 75V 250mA
53	D3	1	BAT54A	Schottky Diode, 30V 200mA
54	BR1	1	BAT54BRW	Diodes, Rectifier, Bridge, 30V
55	Z1	1	Central CMPZ4694	Zener 8.2V 5%
56	Z2	1	Central CMPZ4698	Zener 11V 5%
57	Q1, Q2	2	Vishay Si7456DP	N-FET 100V 25m ohm
58	Q4-7	4	Vishay Si7336ADP	N-FET 30V 3m ohm
59	Q3, Q8	2	ZETEX FCX690B	NPN, ZETEX 45V 2A
60	L1	1	TDK RLF7030T-2R2M5R4	Inductor 2.2uH 5.4A
61	L2	1	Coilcraft SER2010-122MX	Inductor 1.2uH 37A
62	T1	1	Coilcraft DA2025-AL	Transformer 8:5:2:2
63	T2	1	Pulse Engr P8208	Current XFR 100:1, 10A
64	T3, T4	2	Coilcraft DA2319-ALB	Gate XFR 1:1
65	J1-3, J5-7	6	Mill-Max 3104-2-00-80-00-00-08-0.	Test Pin, Brick
66	J4, J8	2	Mill-Max 3231-2-00-01-00-00-08-0	Test Pin, Brick

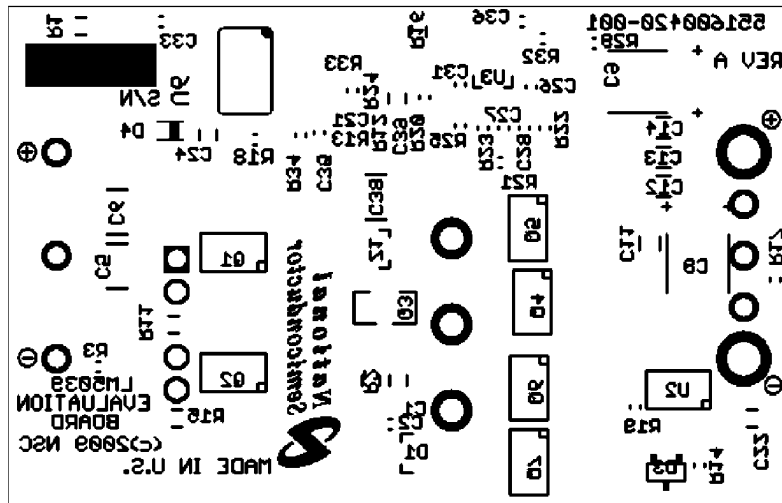
PCB Layouts



TOP SILKSCREEN (.PLC) LAYER AS VIEWED FROM TOP
880600420-001

Top Silk

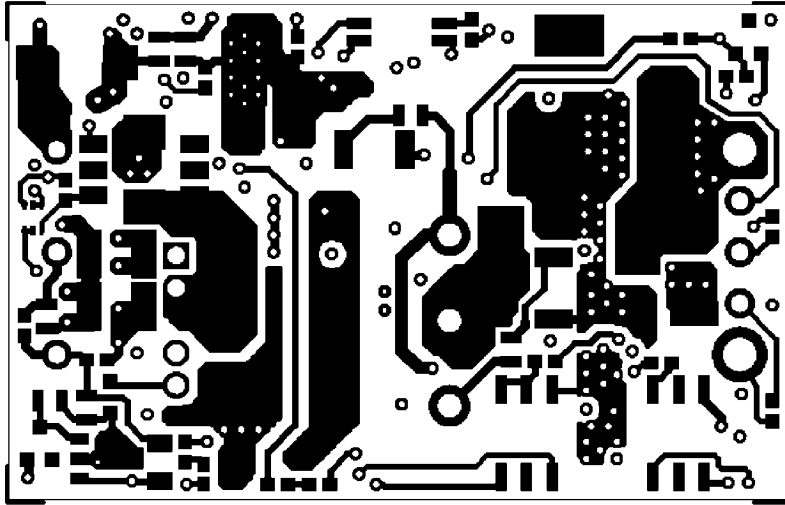
30112713



BOTTOM SILKSCREEN (.PLS) AS VIEWED FROM TOP
880600420-001

Bottom Silk

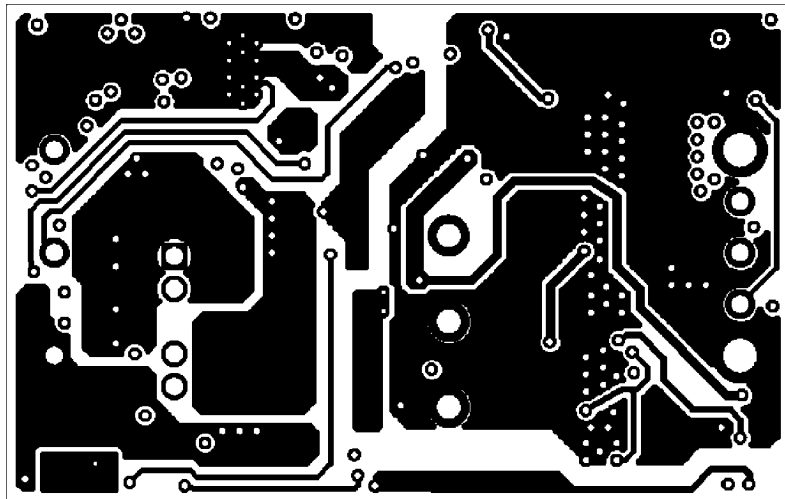
30112714



TOP (.CMP) LAYER AS VIEWED FROM TOP
880600420-001

Top Side

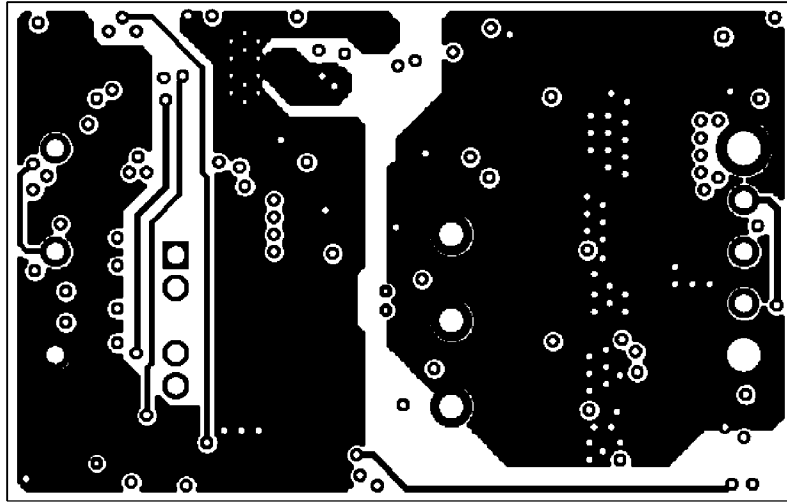
30112715



LAYER 2 (.LY2) AS VIEWED FROM TOP
880600420-001

Layer 2

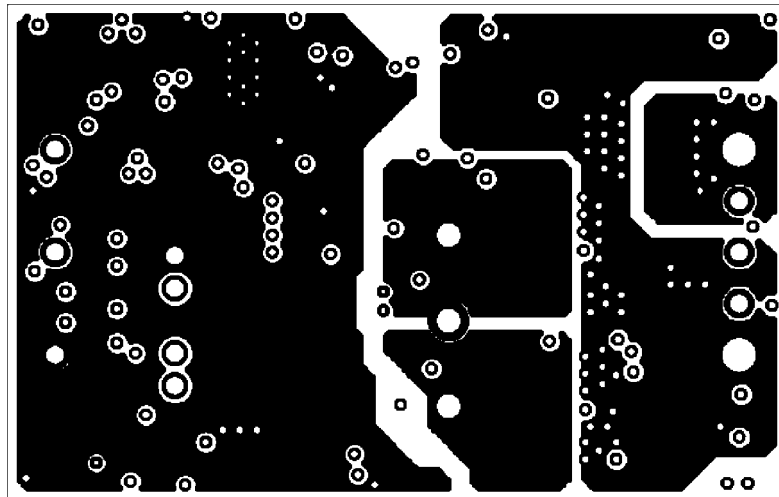
30112716



LAYER 3 (.LY3) AS VIEWED FROM TOP
880600420-001

Layer 3

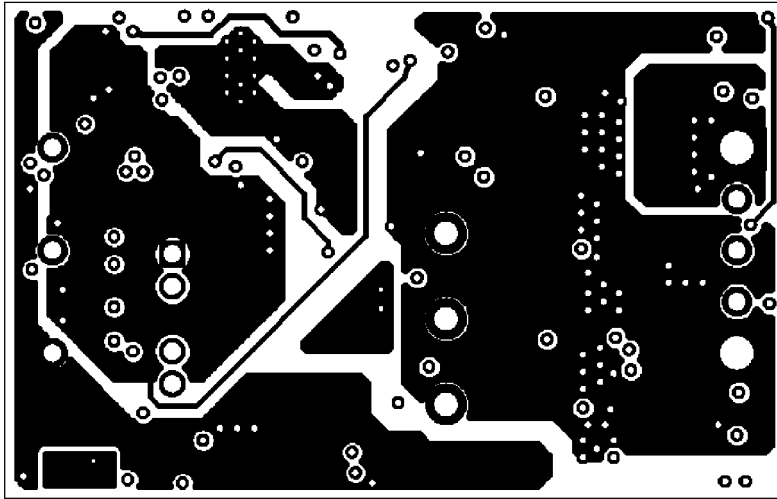
30112717



LAYER 4 (.LY4) AS VIEWED FROM TOP
880600420-001

Layer 4

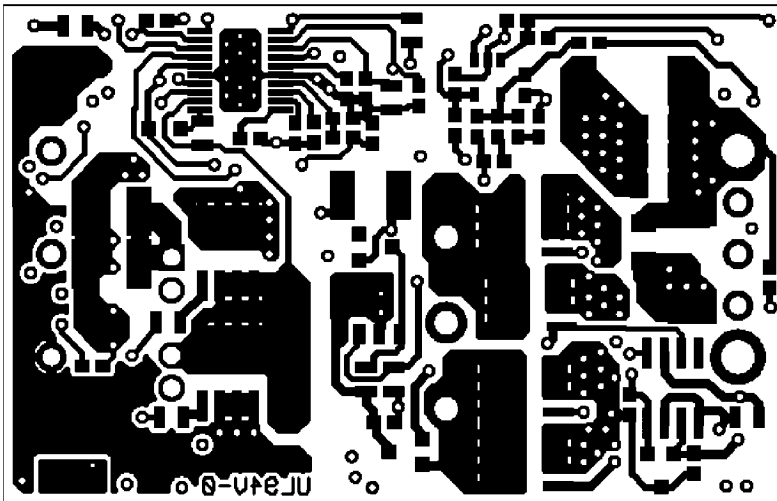
30112718



LAYER 5 (.LY5) AS VIEWED FROM TOP
880600420-001

Layer 5

30112719



BOTTOM (.SOL) LAYER AS VIEWED FROM TOP
880600420-001

Bottom

30112720

Notes

For more National Semiconductor product information and proven design tools, visit the following Web sites at:
www.national.com

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

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© 2010 National Semiconductor Corporation

For the most current product information visit us at www.national.com



National Semiconductor
Americas Technical
Support Center
 Email: support@nsc.com
 Tel: 1-800-272-9959

National Semiconductor Europe
Technical Support Center
 Email: europe.support@nsc.com

National Semiconductor Asia
Pacific Technical Support Center
 Email: ap.support@nsc.com

National Semiconductor Japan
Technical Support Center
 Email: 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	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Mobile Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Communications and Telecom	www.ti.com/communications
Computers and Peripherals	www.ti.com/computers
Consumer Electronics	www.ti.com/consumer-apps
Energy and Lighting	www.ti.com/energy
Industrial	www.ti.com/industrial
Medical	www.ti.com/medical
Security	www.ti.com/security
Space, Avionics and Defense	www.ti.com/space-avionics-defense
Transportation and Automotive	www.ti.com/automotive
Video and Imaging	www.ti.com/video

TI E2E Community Home Page

e2e.ti.com

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

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Texas Instruments:](#)

[LM5039EVAL/NOPB](#)