

LMH7324

Application Note 1683 LMH7324 High Speed Comparator Evaluation Board



Literature Number: SNOA494

LMH7324 High Speed Comparator Evaluation Board

National Semiconductor
Application Note 1683
Gerrit Sergers
September 2007



General Description

This board is designed to demonstrate the LMH7324 quad comparator with RSPECL outputs. It will facilitate the evaluation of the LMH7324 configured as a window detector. The board detects the level of the incoming signal and presents the outcome in a 3-bit presentation. One bit indicates that the signal is below the lowest window level, another bit indicates that the signal is above the highest window level, and the third bit indicates that the incoming signal is just between both set levels. All three outputs are fed to SMA connectors mounted at the edge of the board. The impedance of the output track is 50Ω which makes it easy to connect these signals to any scope or analyzer by the use of a 50Ω coaxial cable. Each comparator of the LMH7324 has individual positive supplies for the input and output circuits. The negative supply is common for all input and output circuitry. This setup will work with a supply of ±2.5V as a minimum supply, with the window voltage centered at ground. If a setup with only one positive supply voltage is used, jumper J1 (see *Figure 7*) has to be placed between both positive supply connections. To examine the possibility of two separate supplies for the input and the output stage the jumper has to be removed and an extra supply has to be connected.

Basic Operation

REFERENCE LEVELS

The circuit is built around the four comparators of one LMH7324. Two reference levels are created using four resistors and two capacitors (R3, R6, R7, R9 and C9, C12 see *Figure 7*) The 'ref high' level is a positive voltage referred to the ground level and the 'ref low' level is a negative voltage referred to ground. The input connector (con2) is also referenced to ground which means that any AC signal at the input will vary around the ground level, which is in the center of the reference levels.

COMPARATORS

The comparators B and C form the window detector, while the comparator A is a level detector indicating that the input voltage exceeds the 'ref high' voltage in the positive direction. The comparator D is a level detector indicating that the input signal exceeds the 'ref low' voltage in the negative direction. The outputs are connected to a 50Ω connector via a 50Ω track. All three outputs are 'active low' as can be seen in *Table 1*.

TABLE 1. Four Comparators Output

V _{IN}	\overline{QA}	\overline{QB}	\overline{QC}	\overline{QD}
High	0	1	0	1
In Window	1	0	0	1
Low	1	0	1	0

The window detector output is formed by the OR-function of combining both \overline{Q} outputs of comparators B and C. Outputs which have an ECL (Emitter Coupled Logic) structure can be wired together to form an OR function. The overall truth table is shown in *Table 2*:

TABLE 2. Truth Table

V _{IN}	Con1	Con3	Con4
High	0	1	1
In Window	1	0	1
Low	1	1	0

OUTPUTS

Every output has a Q and \overline{Q} connection and both outputs have been made active by a resistor connected to the V_{EE} terminal. An ECL output becomes active when current flows out of the emitters of the output stage. This can be done by connecting a resistor to a 'termination' voltage (VT) which is 2V below the V_{CCO}. When using the VT solution every output resistor has to be 50Ω (R1, R2, R4, R5, R10, R11, R12). Another possibility is to connect a resistor to the most negative supply voltage. In case of a connection to V_{EE}, the resistor must have a value which causes a current that complies with the 'Normal Operating' conditions as mentioned in the datasheet. This demo board is designed for a supply voltage of 5V for the V_{CCO} with a resistor to V_{EE} with a value of 240Ω (R4 = 360 while R1, R2, R5, R10, R11, R12 = 240). In case the V_{CCO} is raised to 12V all output resistors to V_{EE} should be replaced with 500Ω resistors except R4 which should be 750Ω. All three output signals are connected via a 50Ω track and a combined capacitor and jumper which are connected in parallel. A customer can now make a choice between a DC or an AC coupled output signal. In the case of a DC coupled output be aware of the offset voltage which causes an extra DC current into a connected scope or analyzer with 50Ω input impedance.

SUPPLY VOLTAGES

This demo board can operate with a simple dual supply of ±2.5V. The output voltages are now about 1.35V and 1.0V and comply with LVDS and RSPECL levels. In the case of a single supply voltage of +5V the output levels are 3.85V and 3.5V, which is only RSPECL level compliant. In a single supply configuration be aware that the detection window starts at V_{EE} level, which is actually the ground level. The LMH7324 is ground sensing but in this configuration the input signals cannot extend more than 200 mV below the ground level. Every comparator has a separate connection for the V_{CCI}, V_{CCO} and the V_{EE}. The supply pins are decoupled with a small capacitance of 10 nF to the ground plane. Since the outputs are referenced to the V_{CCO} the output resistors are decoupled to this supply pin. For better low frequency decoupling a 47 μF capacitor is placed at the supply connector (con5). The supplies V_{CCI} and V_{CCO} can be shortened by a jumper (J1) in case both positive supply voltages are the same value.

Layout Considerations

The layout is done with a four layer board which makes it easy to keep the design compact with small 50Ω tracks. The advantage of this is that such tracks route easily and connect perfectly to small components. At the same time the length and number of supply lines are reduced, while decoupling to these supplies is easy and direct. Signals are routed on the top and bottom layer, making it easy to measure them.

Measurement Hints and Results

Measurements can be done at the output connectors by connecting a scope or analyzer to the test board. The outputs are capable of driving a 50Ω load. This board offers the possibility of making the output DC or AC coupled. When DC coupling is used be aware of the DC offset voltage present on the output signals. When working with a high supply voltage on the V_{CCO} it is possible to damage the output stage of the device or the input impedance of the equipment. To show what signals can be expected sample measurement results are shown in the following figures. Measurements were taken at different frequencies and waveforms. In the first instance measurements were taken at a frequency of 5 MHz with a sawtooth waveform. The supply voltages are +2.5V and -2.5V. This means that both thresholds are at the same level of approximately 50 mV. There are three results shown: one with the input signal crossing only the upper level (see Figure 1) and one while the input signal is only crossing the lowest level (see Figure 2). The third plot shows the waveforms when the input signal crosses the complete window from below the lowest level until above the upper level (see Figure 3).

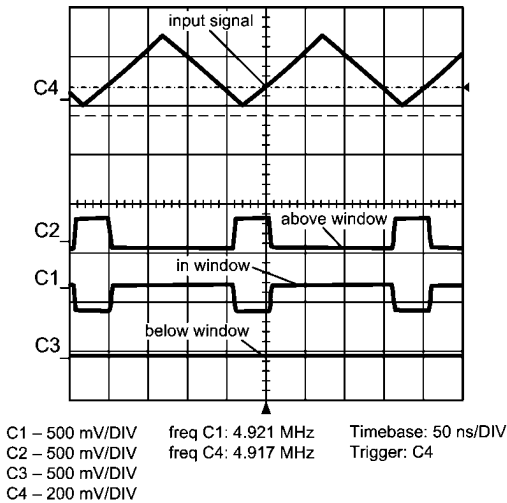


FIGURE 1. 5 MHz Crossing Upper Level

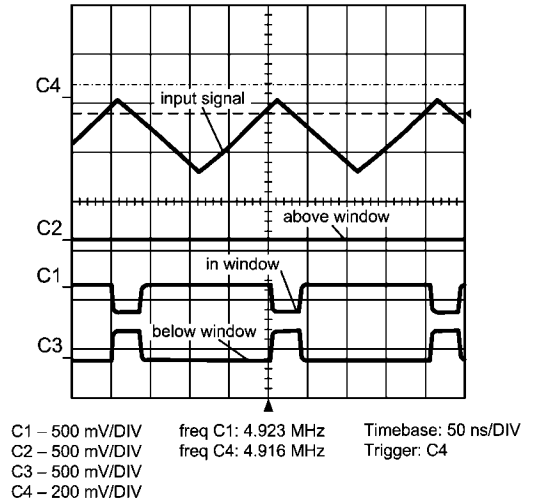


FIGURE 2. 5 MHz Crossing Lower Level

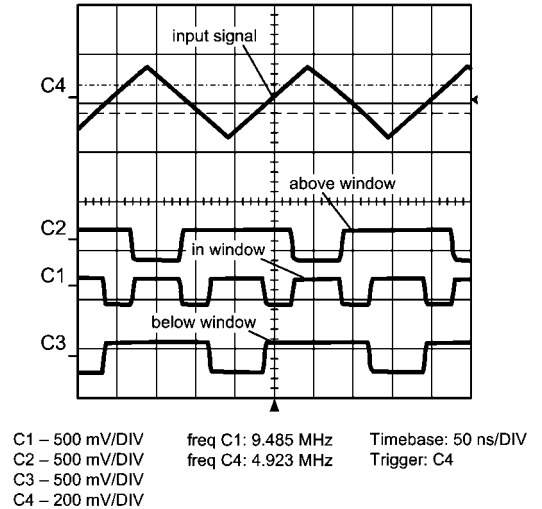
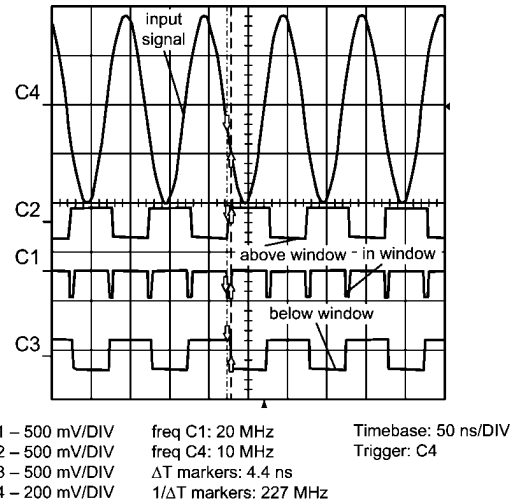


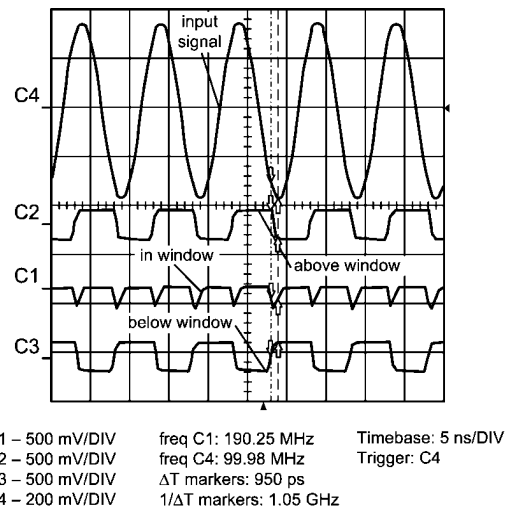
FIGURE 3. 5 MHz Crossing Whole Window

Higher frequencies will make the pulses much shorter, especially when a sine wave is used and the signal rises far above the window levels. This situation would make the time that the signal crosses the window levels very short, because a sine wave has the highest dV/dt at the transition points. *Figures 5, 4 and Figure 6* show the measurements taken when a sine wave is used. In *Figure 4* a sine wave of 10 MHz is used and it just crosses both levels of the window. This creates a reasonable pulse width for both the detection signals “above window” and “below window.” The added hysteresis works since no oscillations can be seen although the input signal crosses the levels very slowly and with low overdrive. When using a signal with the same frequency but with a much greater amplitude, the time it takes for the signal to cross the window becomes much shorter as can be seen in *Figure 5*. Note that the frequency of the detection signal “in window” doubles compared to the input frequency. Also the crossing time through the window is very short and, for this example, it is equal to one period of a frequency of 227 MHz (see marker indication in plot). This means that the detection signal “in window” is the most critical of the three detection signals and will be the first to incur problems due to frequency limits. The setup of *Figure 6* uses an input frequency of 100 MHz with a big overdrive at the window levels. This results in a very small pulse for the detection signal “in window” which is equal to one period of a 1.05 GHz signal (see markers indication in plot). All signals are measured using a cable with a length of 1 meter connected to a four channel oscilloscope. All channels are AC coupled and terminated with 50Ω.



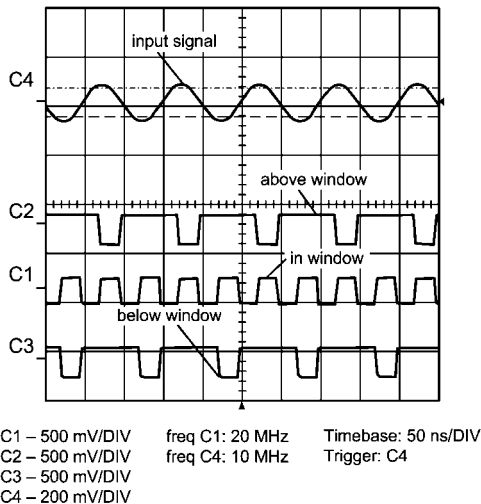
30031104

FIGURE 5. 10 MHz Far Above Thresholds



30031102

FIGURE 6. 100 MHz Far Above Thresholds



30031103

FIGURE 4. 10 MHz Just Above Thresholds

Board Schematic

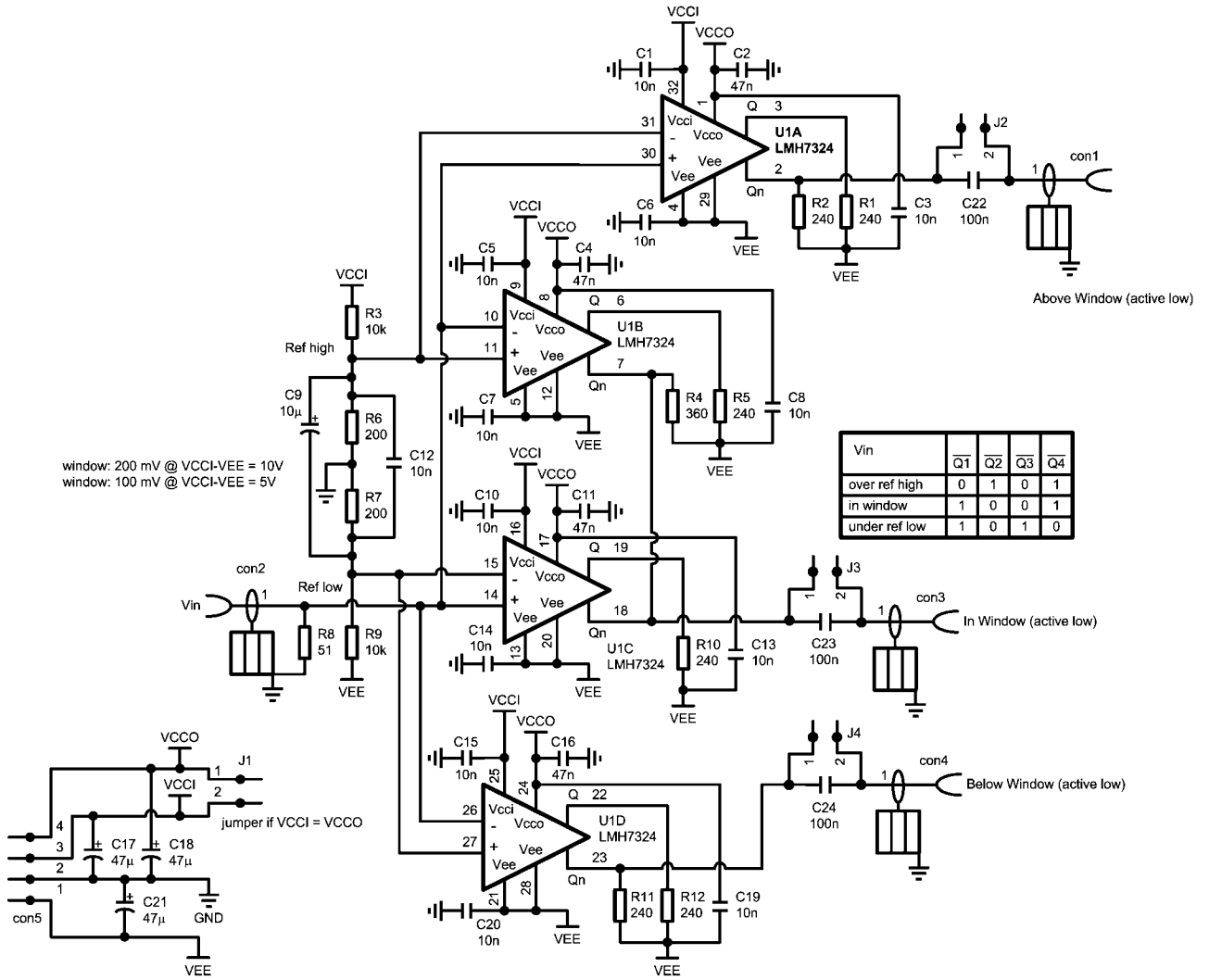
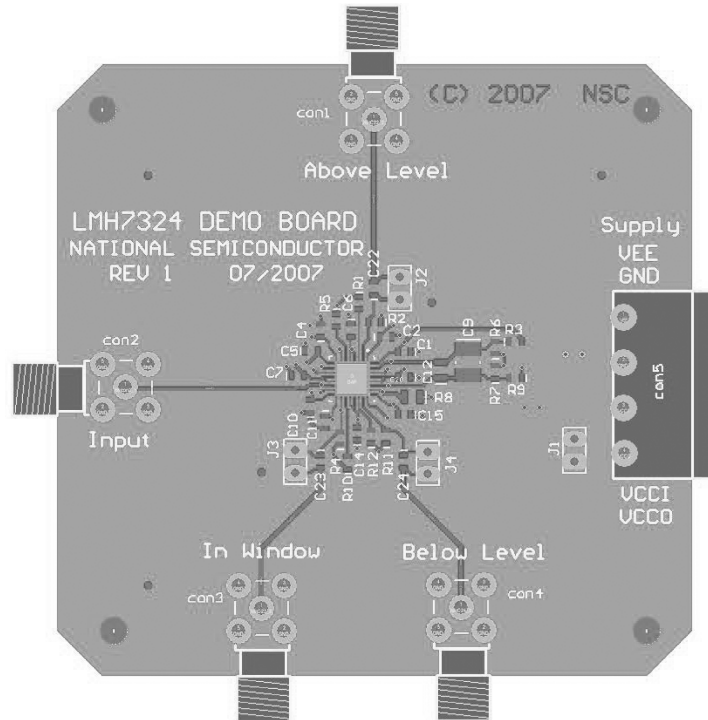


FIGURE 7. Schematic Diagram

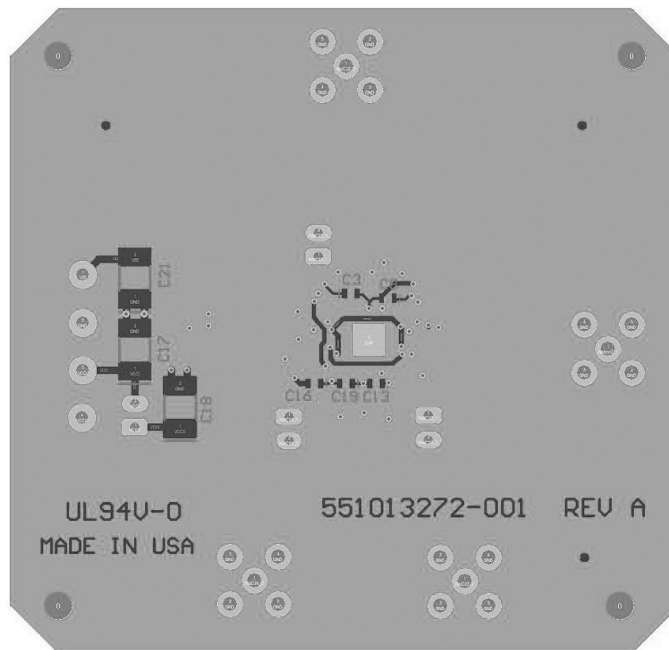
30031101

Board Layout



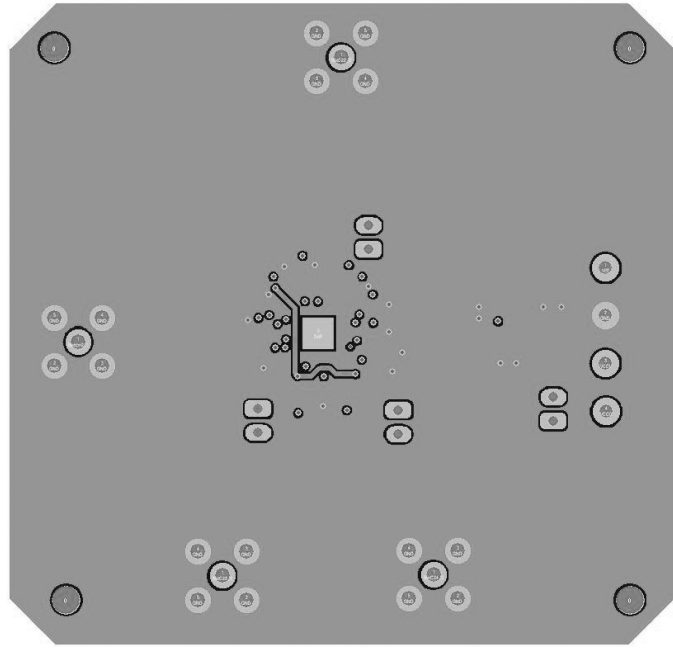
30031111

FIGURE 8. Top Side



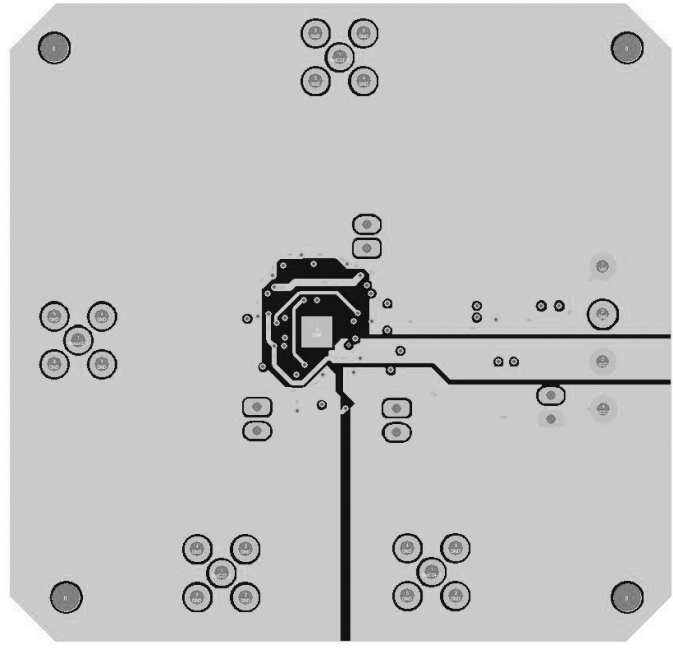
30031108

FIGURE 9. Bottom Side



30031109

FIGURE 10. Mid Layer 1



30031110

FIGURE 11. Mid Layer 2

Notes

AN-1683

Notes

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© 2007 National Semiconductor Corporation

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



National Semiconductor Americas Customer Support Center
 Email: new.feedback@nsc.com
 Tel: 1-800-272-9959

National Semiconductor Europe Customer Support Center
 Fax: +49 (0) 180-530-85-86
 Email: europe.support@nsc.com
 Deutsch Tel: +49 (0) 69 9508 6208
 English Tel: +49 (0) 870 24 0 2171
 Français Tel: +33 (0) 1 41 91 8790

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

National Semiconductor Japan Customer Support Center
 Fax: 81-3-5639-7507
 Email: jpn.feedback@nsc.com
 Tel: 81-3-5639-7560

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