

CLC5526,CLC5956

CLC5526/CLC5956/CLC5902 Diversity Receiver Chipset



Literature Number: SNOA391A

Diversity Receiver Chipset CLC5526, CLC5957, and CLC5902

General Description

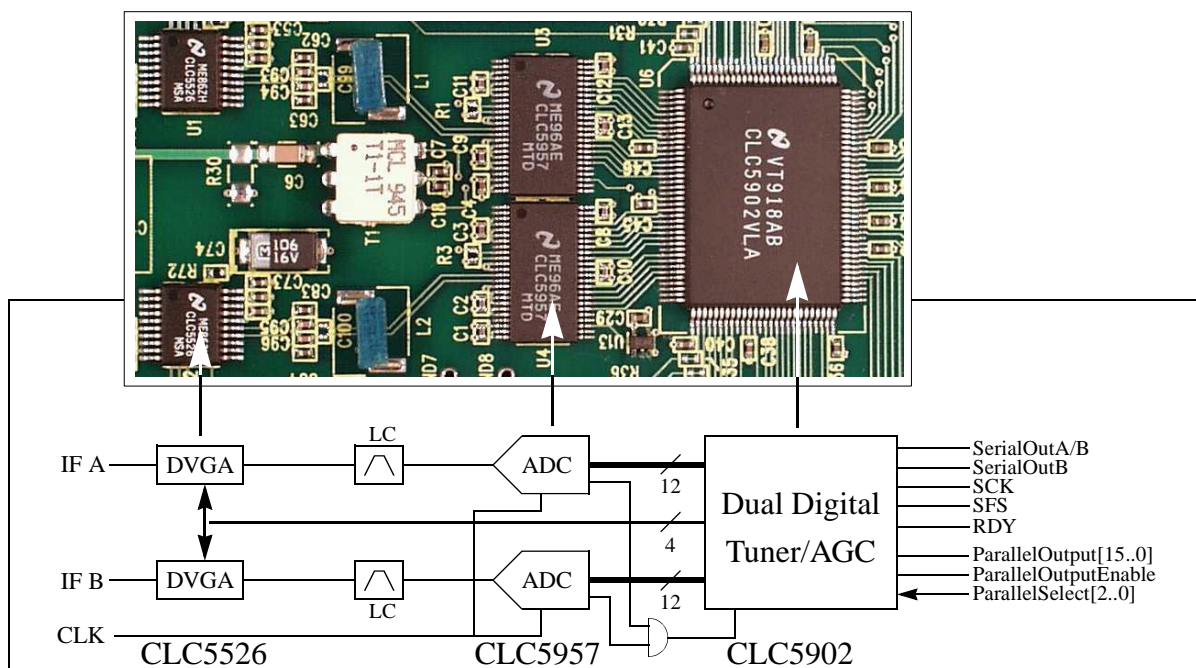
The Diversity Receiver Chipset (DRCS) is a five-chip narrowband receiver solution requiring less than 2.8 square inches of PC board area. The five chips include two CLC5526 Digitally-Controlled Variable Gain Amplifiers (DVGAs), two CLC5957 12-bit 70MSPS Analog-to-Digital Converters (ADCs), and one CLC5902 Dual Digital Tuner/AGC. IF inputs up to 300MHz produce digital quadrature symbols at baseband. Either two channel diversity or independent two channel operation can be supported by the DRCS.

This Diversity Receiver Chipset has been designed to support software configurable narrowband receivers. Direct IF-sampling removes the need for a second LO, mixer, and associated channel filters. All subsequent tuning and channel filtering is performed digitally by the CLC5902. Tuning is accomplished by quadrature mixing the digital input signal with a programmable digital LO signal. The quadrature mixer outputs are then channel-filtered by two sets of programmable FIR filters.

The ADC's 62dB SINAD (in Nyquist bandwidth, 150MHz input) is enhanced by the DVGA and digital processing to provide 120dB dynamic range in a 216kHz bandwidth. The DVGA compresses the input dynamic range prior to the ADC under the control of the AGC processor. Gain adjustment from -12dB to +30dB allows 42dB of compression. The compressed signal is optionally expanded in the digital domain to provide an extended linear output range. System noise sets the realizable dynamic range to 120dBFS in 200kHz.

Features

- 52MSPS Operation
- Two Independent Channels
- Wide Dynamic Range: >120dB
- User Programmable AGC
- Direct IF Sampling to 300MHz
- Channel Filters include a Fourth Order CIC followed by 21-tap and 63-tap Symmetric FIRs
- Flexible output formats include 12 bit Floating Point and 8, 16, 24, or 32 bit Fixed Point
- Serial and Parallel output ports
- JTAG Boundary Scan
- Shutdown/Stand-by Capability
- Meets GSM, EDGE, PCS, DCS, AMPS, DAMPS, and PHS requirements
- Small Footprint
- Low Cost



AGC Operation

Three modes of AGC operation are provided including *Inhibit*, *Free Run*, and *Burst*. Burst mode allows the AGC to run for a pre-determined time before going into a hold condition. This mode could be used in a TDMA system to track a power ramp then hold at the peak value.

AGC operation is based on envelope detection by an absolute value circuit followed by a digital lowpass filter. The filtered signal is applied to a programmable RAM look-up table to allow complete flexibility in setting the AGC threshold (attack point) and deadband (hysteresis). The RAM output is integrated and the resulting error signal drives the DVGAs. Integrator gain is programmable so that the loop time constant can be adjusted. The integrator output can be read and written allowing the DVGAs to be initialized to a specific value for TDMA systems.

Dynamic Range

The Diversity Receiver Chipset dynamic range is determined by the following component contributions.

| Component | Input Dynamic Range (GSM) |
|----------------------------|---|
| CLC5526 DVGA | 42dB Gain Range |
| CLC5526 DVGA | -7.2dB Noise Contribution |
| CLC5957 ADC | 62dBFS SINAD (IF = 150MHz, F _S = 52MHz) |
| CLC5902 Processing Gain | 23.7dB (10*log(52MHz/216kHz)) |
| Total | 120dBFS |

Processing gain comes from the reduction in output bandwidth provided by the channel filters. The channel filter bandwidth and output symbol rate are controlled by

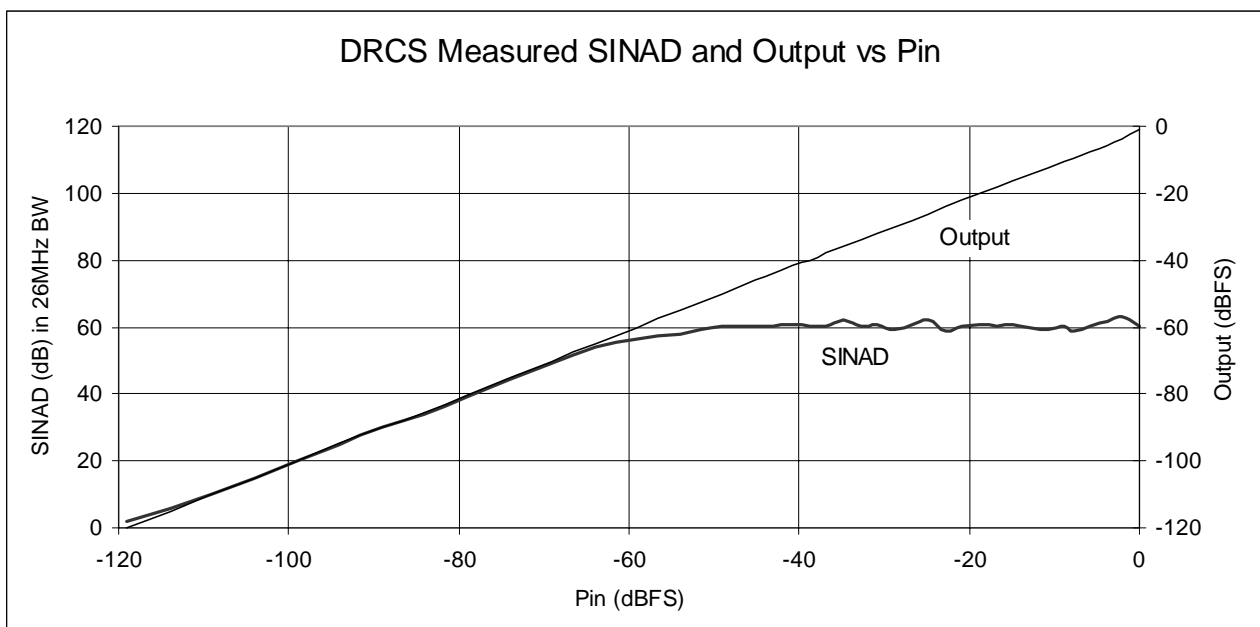
the division of the ADC sample rate (decimation ratio). In a GSM system the desired output symbol rate is 270.83kHz. The FIR channel filter coefficients should be set for a bandwidth of approximately 0.8 times the symbol rate or 216kHz. In this case, the noise will be reduced by a factor of 52MHz/216kHz or 23.7dB. The greater the ratio of ADC sample rate to channel filter bandwidth the better the system noise performance.

The CLC5902 accepts inputs up to 14-bits. AGC operation generates a 3-bit exponent which can scale the 14-bit input words into the 21-bit internal word width. The output of the final FIR filter is 32 bits and either 8, 16, 24, or 32 bits of this data can be selected for output. The output words are available in standard DSP serial formats or 16-bit parallel words. The DVGAs and the CLC5902 can be configured to provide compressed dynamic range or the full linear dynamic range of more than 120dBFS.

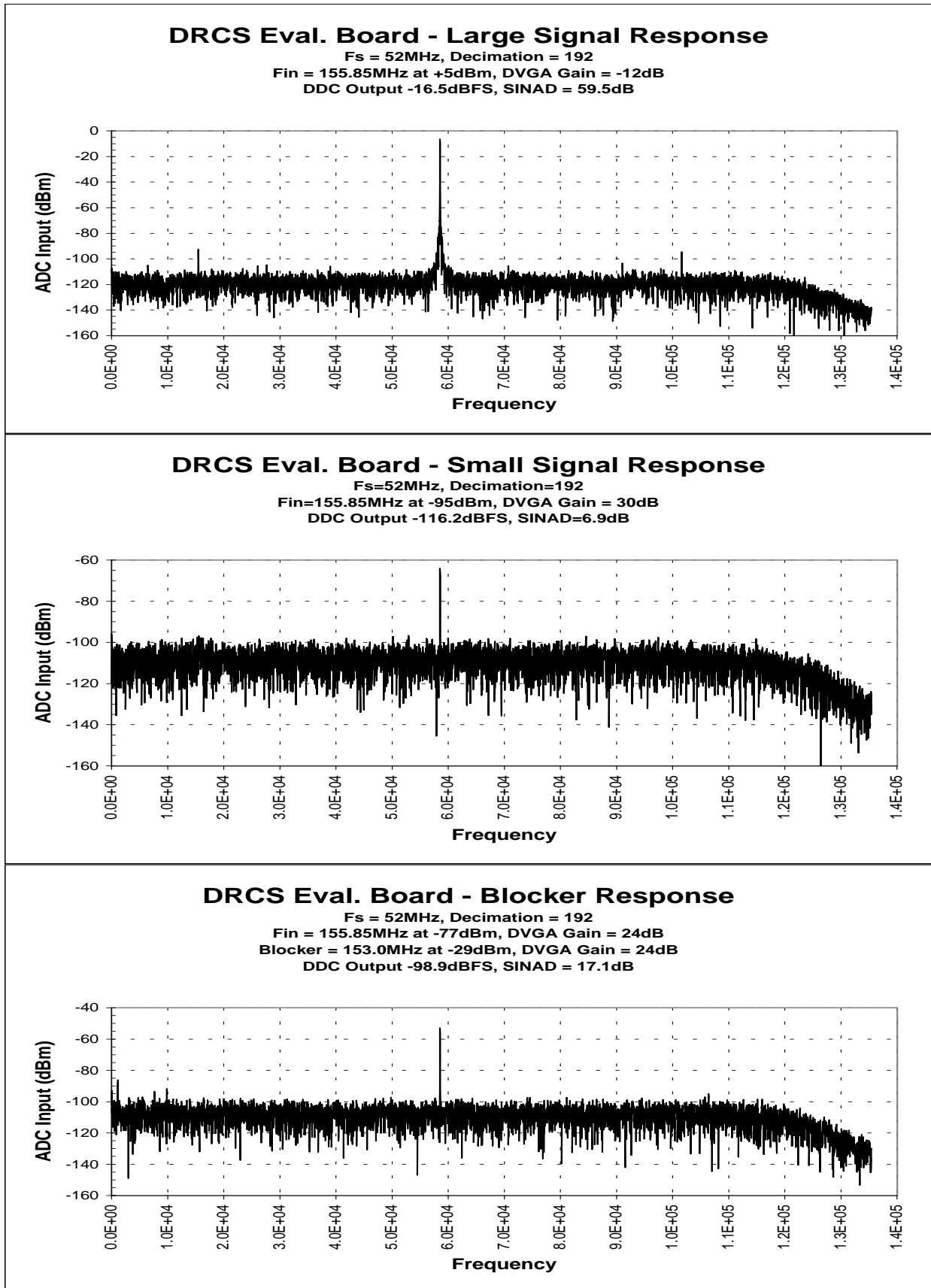
As the input signal increases, the DVGA will attenuate the ADC input signal in 6dB steps. The ADC output is scaled up in 6dB steps to maintain a linear input to output relationship. A representative example of the expanded dynamic range of the Diversity Receiver Chipset is shown in the figure below. The 42dB gain range of the DVGA can be clearly seen in the difference between the ADC output and the CLC5902 output. The zero SINAD point can be seen where Pin = -120dBFS.

System operation

The CLC5957 has a flexible clock input circuit which can accept sine, TTL, or PECL. It also provides a TTL data valid output clock designed to drive the CLC5902. This clock is divided by the CLC5902 to generate the desired output sample rate and to set the channel filter bandwidth. System power requirements include 1.85W at +5V and 0.75W at +3.3V. Shutdown/stand-by modes are available for the DVGAs and the ADCs. The CLC5902 power requirements are reduced when the input clock is stopped.



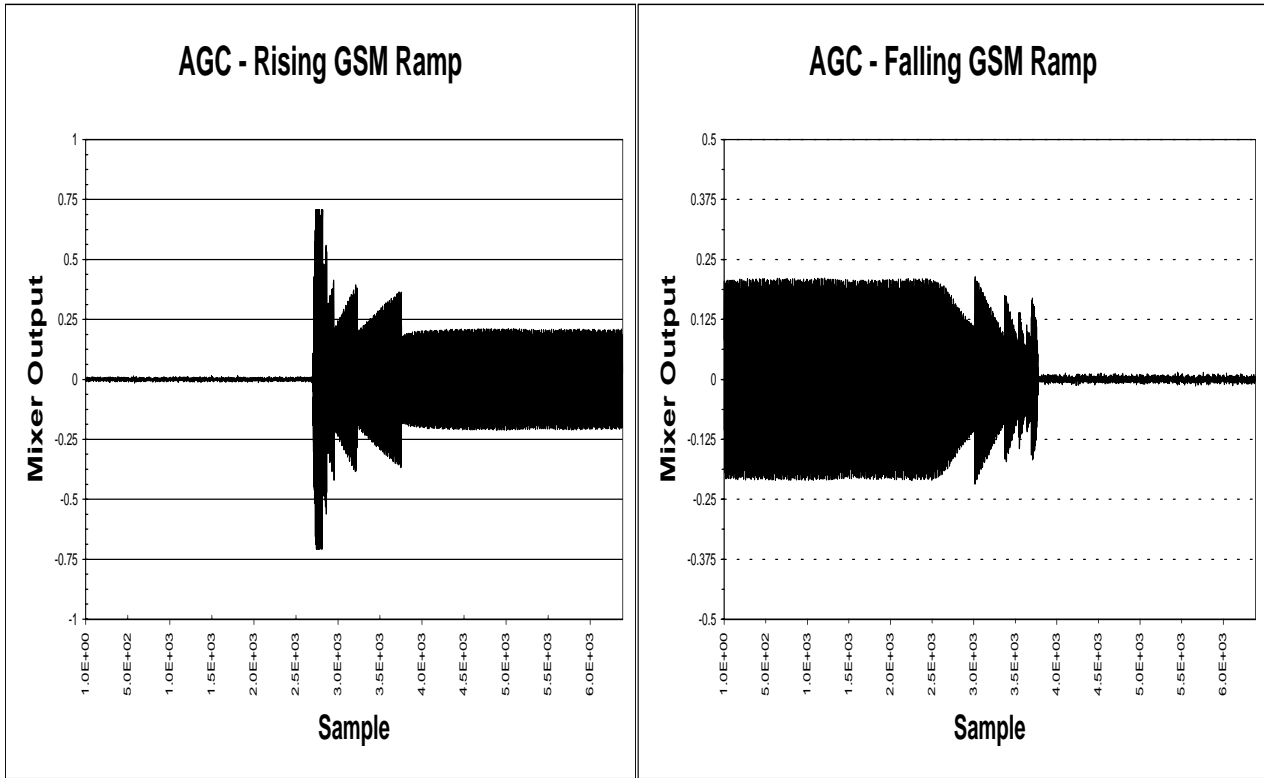
Diversity Receiver Chipset Measured Data:



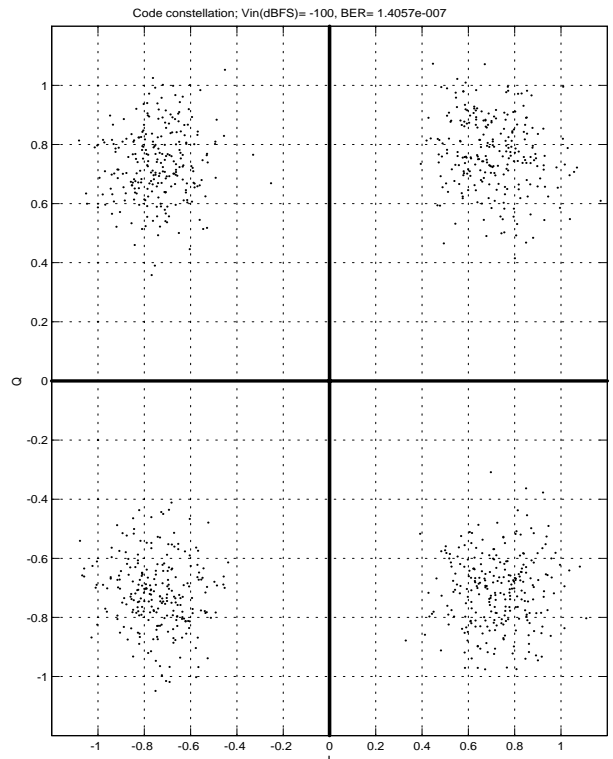
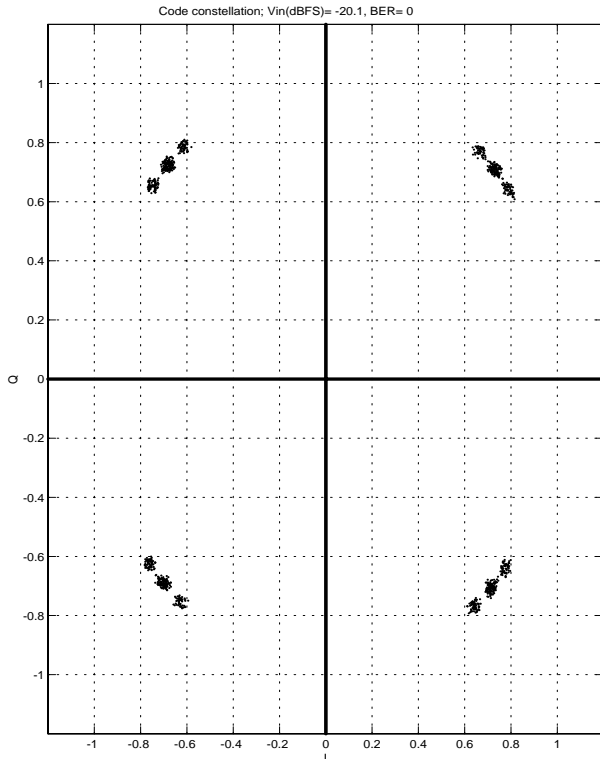
Dynamic AGC Performance (GSM Burst):

30μsec 70dB power ramp at ADC output, $F_s = 52\text{MSPS}$, $F_{in} = 150\text{MHz}$

AGC operation during a burst does not impair equalizer/demodulator operation.



Diversity Receiver Chipset GSM Constellation:



Diversity Receiver Chipset CLC5526, CLC5957, and CLC5902

Customer Design Applications Support

National Semiconductor is committed to design excellence. For sales, literature and technical support, call the National Semiconductor Customer Response Group at 1-800-272-9959 or fax 1-800-737-7018.

Life Support Policy

National's products are not authorized for use as critical components in life support devices or systems without the express written approval of the president of National Semiconductor Corporation. As used herein:

1. Life support devices or systems are devices or systems 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.
2. A critical component is any component of 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 Corporation

1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe

Fax: (+49) 0-180-530 85 86
E-mail: europe.support.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Francais Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.

2501 Miramar Tower
1 Kimberley Road
Tsimshatsui, Hong Kong
Tel: (852) 2737-1800
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.

Tel: 81-043-299-2309
Fax: 81-043-299-2408

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.

National Semiconductor® and  are trademarks of National Semiconductor Corporation. All other trademarks are the property of their respective companies.

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