

9316,DM9316

9316/DM9316 Synchronous 4-Bit Counters



Literature Number: SNOS379A

9316/DM9316 Synchronous 4-Bit Counters

General Description

These synchronous, presettable counters feature an internal carry look-ahead for application in high-speed counting designs. The 9316 is a 4-bit binary counter. The carry output is decoded by means of a NOR gate, thus preventing spikes during the normal counting mode of operation. Synchronous operation is provided by having all flip-flops clocked simultaneously so that the outputs change coincident with each other when so instructed by the count-enables inputs and internal gating. This mode of operating eliminates the output counting spikes which are normally associated with asynchronous (ripple clock) counters. A buffered clock input triggers the four flip-flops on the rising (positive-going) edge of the clock input waveform.

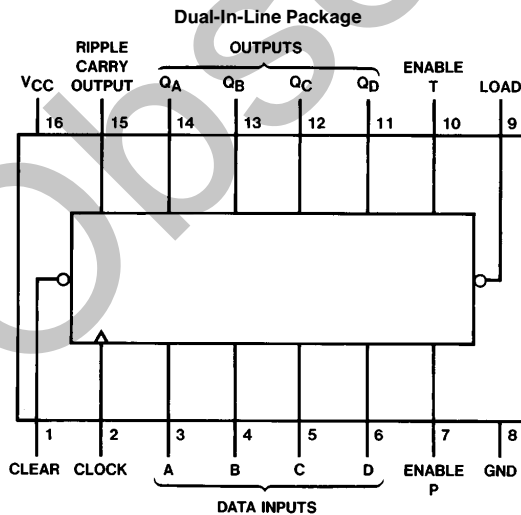
These counters are fully programmable; that is, the outputs may be preset to either level. As presetting is synchronous, setting up a low level at the load input disables the counter and causes the outputs to agree with the setup data after the next clock pulse regardless of the levels of the enable input. Low-to-high transitions at the load input are perfectly acceptable regardless of the logic levels on the clock or enable inputs. The clear function is asynchronous and a low level at the clear input sets of the flip-flop outputs low regardless of the levels of clock, load, or enable inputs.

The carry look-ahead circuitry provides for cascading counters for n-bit synchronous applications without additional gating. Instrumental in accomplishing this function are two count-enable inputs and a ripple carry output. Both count-enable inputs (P and T) must be high to count, and input T is fed-forward to enable the ripple carry output. The ripple carry output thus enabled will produce a high-level output pulse with a duration approximately equal to the high-level portion of the Q_A output. This high-level overflow ripple carry pulse can be used to enable successive cascaded stages. High-to-low level transitions at the enable P or T inputs may occur regardless of the logic level in the clock.

Features

- Internal look-ahead for fast counting
- Carry output for n-bit cascading
- Synchronous counting
- Load control line
- Diode-clamped inputs
- Typical clock frequency 35 MHz
- Pin-for-pin replacements popular 54/74 counters 5416A/7416A (binary)
- Alternate Military/Aerospace device (9316) is available. Contact a National Semiconductor Sales Office/Distributor for specifications.

Connection Diagram



TL/F/6606-1

Absolute Maximum Ratings (Note)

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

Supply Voltage	7V
Input Voltage	5.5V
Operating Free Air Temperature Range	
Military	–55°C to +125°C
Commercial	0°C to +70°C
Storage Temperature Range	–65°C to +150°C

Note: The “Absolute Maximum Ratings” are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the “Electrical Characteristics” table are not guaranteed at the absolute maximum ratings. The “Recommended Operating Conditions” table will define the conditions for actual device operation.

Recommended Operating Conditions

Symbol	Parameter	Military			Commercial			Units
		Min	Nom	Max	Min	Nom	Max	
V _{CC}	Supply Voltage	4.5	5	5.5	4.75	5	5.25	V
V _{IH}	High Level Input Voltage	2			2			V
V _{IL}	Low Level Input Voltage			0.8			0.8	V
I _{OH}	High Level Output Current			–0.8			–0.8	mA
I _{OL}	Low Level Output Current			16			16	mA
f _{CLK}	Clock Frequency (Note 6)	0		25	0		25	MHz
t _w	Pulse Width (Note 6)	Clock	25		25			ns
		Clear	20		20			
t _{SU}	Setup Time (Note 6)	Data	20		20			ns
		Enable P	20		20			
		Load	25		25			
		Clear	20		20			
t _H	Any Hold Time (Notes 1 & 6)	0			0			ns
T _A	Free Air Operating Temperature	–55		125	0		70	°C

Electrical Characteristics over recommended operating free air temperature range (unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ (Note 2)	Max	Units
V _I	Input Clamp Voltage	V _{CC} = Min, I _I = –12 mA			–1.5	V
V _{OH}	High Level Output Voltage	V _{CC} = Min, I _{OH} = Max V _{IL} = Max, V _{IH} = Min	2.4	3.4		V
V _{OL}	Low Level Output Voltage	V _{CC} = Min, I _{OL} = Max V _{IH} = Min, V _{IL} = Max		0.2	0.4	V
I _I	Input Current @ Max Input Voltage	V _{CC} = Max, V _I = 5.5V			1	mA
I _{IH}	High Level Input Current	V _{CC} = Max V _I = 2.4 V	Clock		80	μA
			Enable T		80	
			Other		40	
I _{IL}	Low Level Input Current	V _{CC} = Max V _I = 0.4V	Clock		–3.2	μA
			Enable T		–3.2	
			Other		–1.6	
I _{OS}	Short Circuit Output Current	V _{CC} = Max (Note 3)	MIL	–20	–57	mA
			COM	–18	–57	
I _{CCH}	Supply Current with Outputs High	V _{CC} = Max (Note 4)	MIL	59	85	mA
			COM	59	94	
I _{CCL}	Supply Current with Outputs Low	V _{CC} = Max (Note 5)	MIL	63	91	mA
			COM	63	101	

Note 1: The minimum HOLD time is as specified or as long as the CLOCK input takes to rise from 0.8V to 2V, whichever is longer.

Note 2: All typicals are at V_{CC} = 5V, T_A = 25°C.

Note 3: Not more than one output should be shorted at a time.

Note 4: I_{CCH} is measured with the LOAD input high, then again with the LOAD input low, with all other inputs high and all outputs open.

Note 5: I_{CCL} is measured with the CLOCK input high, then again with the CLOCK input low, with all other inputs low and all outputs open.

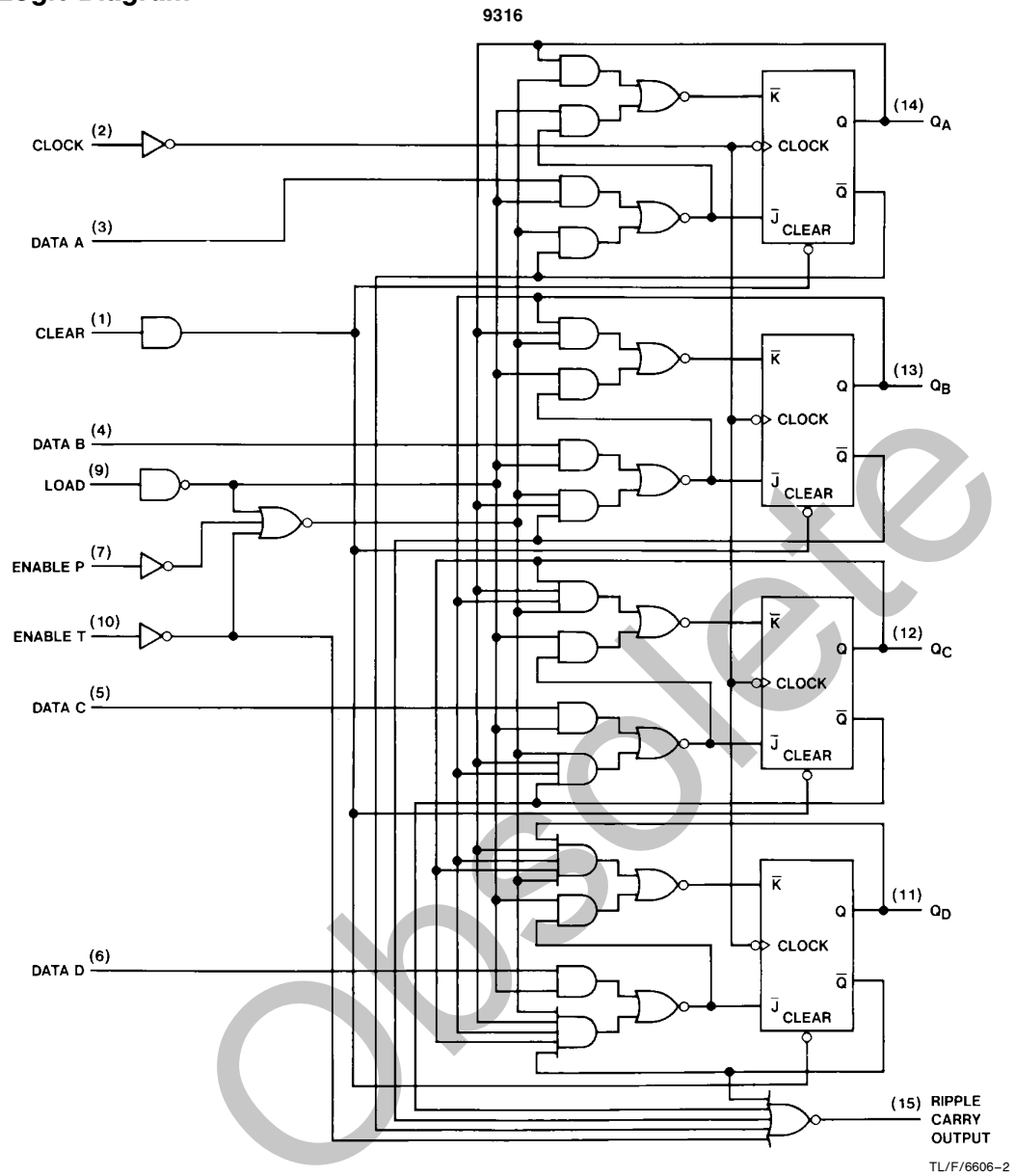
Note 6: T_A = 25°C and V_{CC} = 5V.

Switching Characteristics at $V_{CC} = 5V$ and $T_A = 25^\circ C$ (See Section 1 for Test Waveforms and Output Load)

Symbol	Parameter	From (Input) To (Output)	$R_L = 400\Omega, C_L = 15\text{ pF}$		Units
			Min	Max	
f_{MAX}	Maximum Clock Frequency		25		MHz
t_{PLH}	Propagation Delay Time Low to High Level Output	Clock to RC		27	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clock to RC		24	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Clock to Q		20	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clock to Q		23	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	Clock to Q		21	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clock to Q		25	ns
t_{PLH}	Propagation Delay Time Low to High Level Output	ENT to RC		15	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	ENT to RC		16	ns
t_{PHL}	Propagation Delay Time High to Low Level Output	Clear to Q		36	ns

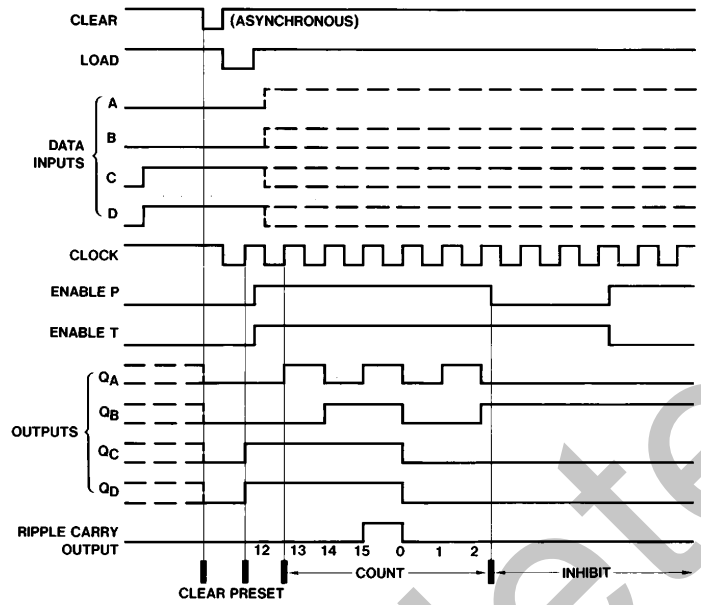
Obsoleted

Logic Diagram



Timing Diagram

9316 Synchronous Binary Counters Typical Clear, Preset, Count and Inhibit Sequences

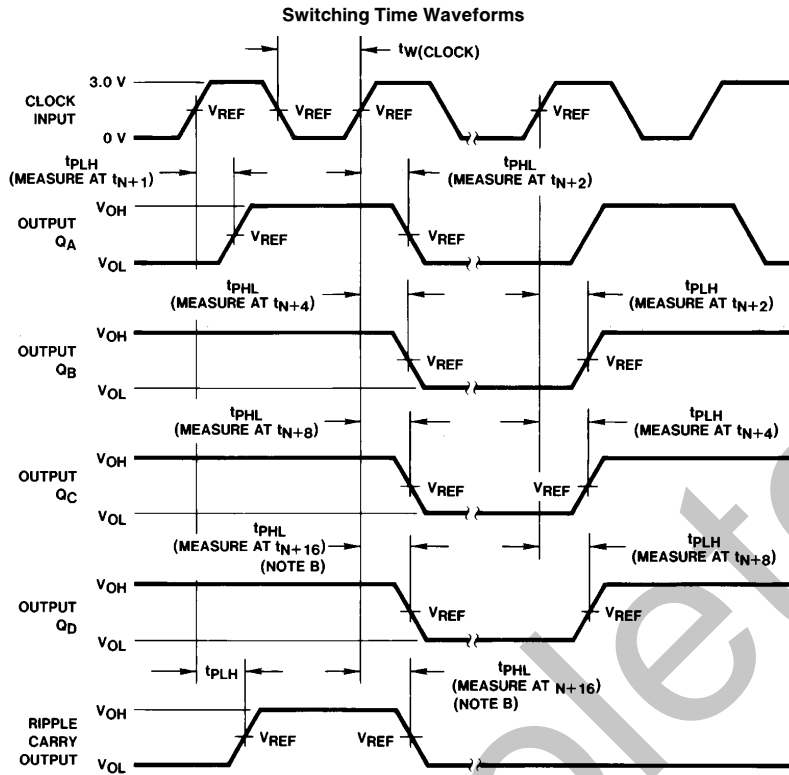


TL/F/6606-3

Sequence:

- (1) Clear outputs to zero.
- (2) Preset to binary twelve.
- (3) Count to thirteen, fourteen, fifteen, zero, one, and two.
- (4) Inhibit

Parameter Measurement Information



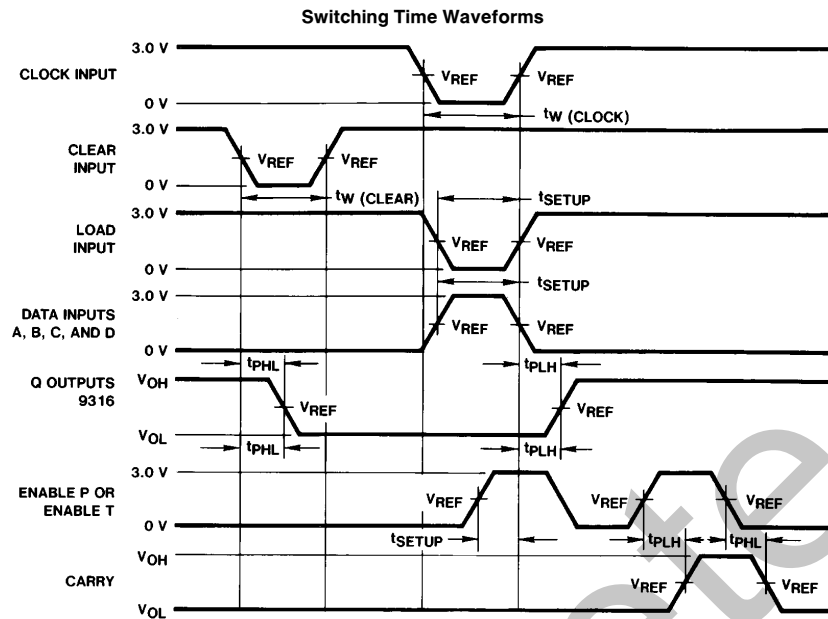
TL/F/6606-4

Note A: The input pulses are supplied by a generator having the following characteristics: PRR \leq 1 MHz, duty cycle \leq 50%, $Z_{\text{OUT}} \approx 50 \Omega$, $t_r \leq 10$ ns, $t_f \leq 10$ ns. Vary PRR to measure t_{MAX} .

Note B: Outputs Q_D and carry are tested at $t_n + 16$ for 9316/8316, where t_n is the bit time when all outputs are low.

Note C: $V_{\text{REF}} = 1.5\text{V}$.

Parameter Measurement Information (Continued)



TL/F/6606-5

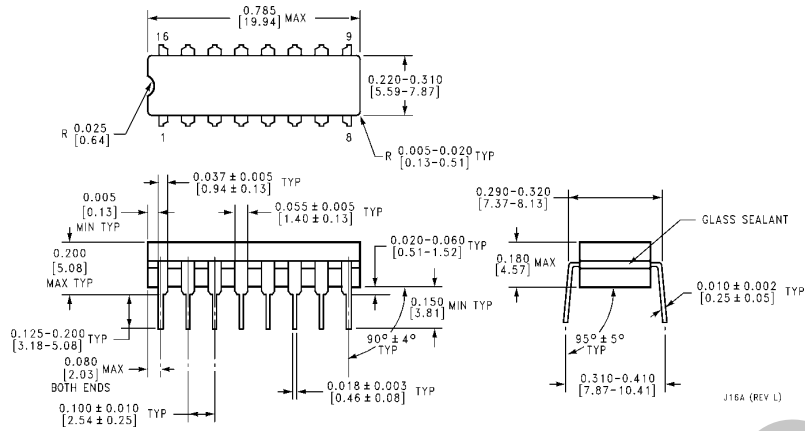
Note A: The input pulses are supplied by generators having the following characteristics: $PRR \leq 1$ MHz, duty cycle $\leq 50\%$, $Z_{OUT} \approx 50\Omega$, $t_r \leq 10$ ns, $t_f \leq 10$ ns.

Note B: Enable P and Enable T setup times are measured at $t_n + 16$ for 8316/9316.

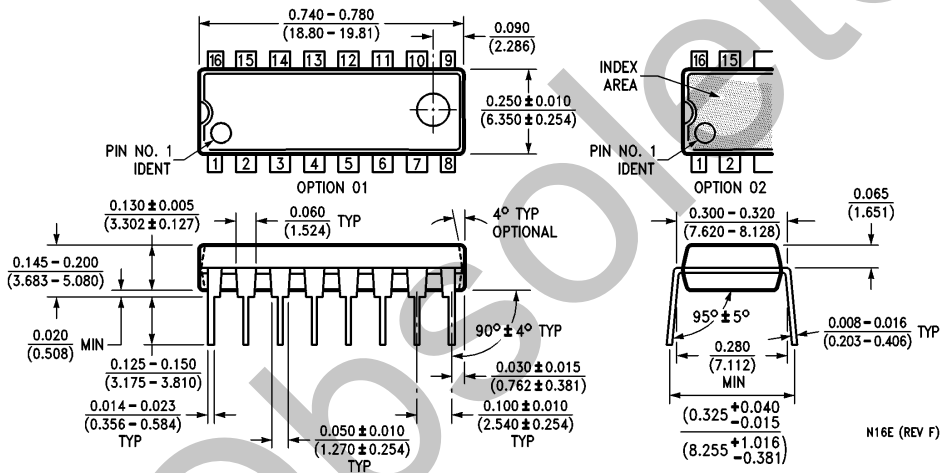
Note C: $V_{REF} = 1.5V$.

Obsolete

Physical Dimensions inches (millimeters)

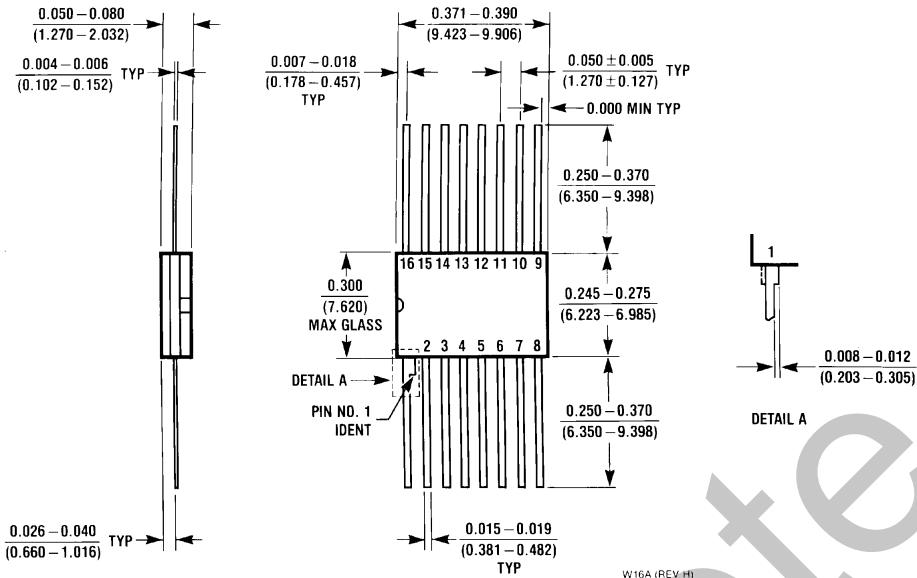


16-Lead Ceramic Dual-In-Line Package (J)
Order Number 9316DMQB or DM9316J
NS Package Number J16A



16-Lead Molded Dual-In-Line Package (N)
Order Number DM9316N
NS Package Number N16E

Physical Dimensions inches (millimeters) (Continued)



16-Lead Ceramic Flat Package (W)
Order Number 9316FMQB or DM9316W
NS Package Number W16A

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
 Email: cnjwge@tevm2.nsc.com
 Deutsch Tel: (+49) 0-180-530 85 85
 English Tel: (+49) 0-180-532 78 32
 Français Tel: (+49) 0-180-532 93 58
 Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
 13th Floor, Straight Block,
 Ocean Centre, 5 Canton Rd.
 Tsimshatsui, Kowloon
 Hong Kong
 Tel: (852) 2737-1600
 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.

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