

# 100331

*100331 Low Power Triple D Flip-Flop*



Literature Number: SNOS116

# 100331 Low Power Triple D Flip-Flop

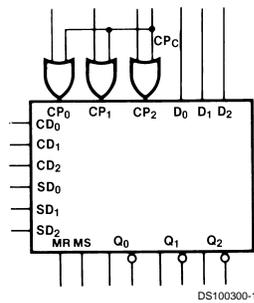
## General Description

The 100331 contains three D-type, edge-triggered master/slave flip-flops with true and complement outputs, a Common Clock ( $CP_C$ ), and Master Set (MS) and Master Reset (MR) inputs. Each flip-flop has individual Clock ( $CP_n$ ), Direct Set ( $SD_n$ ) and Direct Clear ( $CD_n$ ) inputs. Data enters a master when both  $CP_n$  and  $CP_C$  are LOW and transfers to a slave when  $CP_n$  or  $CP_C$  (or both) go HIGH. The Master Set, Master Reset and individual  $CD_n$  and  $SD_n$  inputs override the Clock inputs. All inputs have 50 k $\Omega$  pull-down resistors.

## Features

- 35% power reduction of the 100131
- 2000V ESD protection
- Pin/function compatible with 100131
- Voltage compensated operating range = -4.2V to -5.7V
- Available to industrial grade temperature range
- Available to Standard Microcircuit Drawing (SMD) 5962-9153601

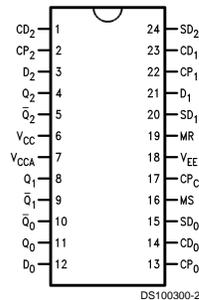
## Logic Symbol



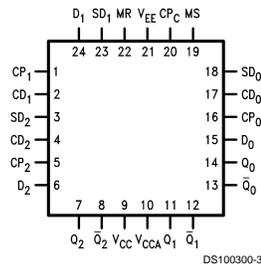
Pin Names	Description
$CP_0$ - $CP_2$	Individual Clock Inputs
$CP_C$	Common Clock Input
$D_0$ - $D_2$	Data Inputs
$CD_0$ - $CD_2$	Individual Direct Clear Inputs
$SD_n$	Individual Direct Set Inputs
MR	Master Reset Input
MS	Master Set Input
$Q_0$ - $Q_2$	Data Outputs
$\bar{Q}_0$ - $\bar{Q}_2$	Complementary Data Outputs

## Connection Diagrams

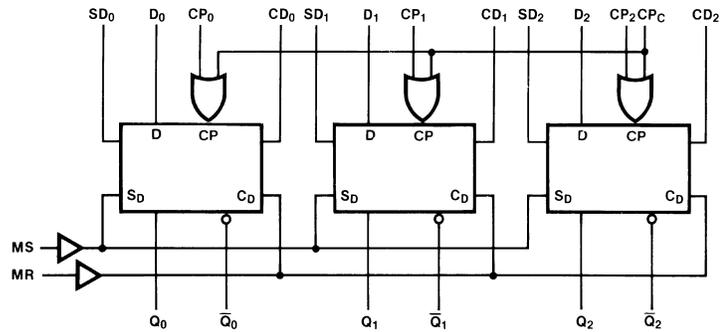
24-Pin DIP



24-Pin Quad Cerpak



## Logic Diagram



DS100300-5

## Truth Tables

### Synchronous Operation

(Each Flip-Flop)

Inputs					Outputs
$D_n$	$CP_n$	$CP_c$	MS $SD_n$	MR $CD_n$	$Q_n(t+1)$
L	↗	L	L	L	L
H	↗	L	L	L	H
L	L	↗	L	L	L
H	L	↗	L	L	H
X	L	L	L	L	$Q_n(t)$
X	H	X	L	L	$Q_n(t)$
X	X	H	L	L	$Q_n(t)$

H = HIGH Voltage Level  
 L = LOW Voltage Level  
 X = Don't Care  
 U = Undefined  
 t = Time before CP Positive Transition  
 t + 1 = Time after CP Positive Transition  
 ↗ = LOW to HIGH Transition

### Asynchronous Operation

(Each Flip-Flop)

Inputs					Outputs
$D_n$	$CP_n$	$CP_c$	MS $SD_n$	MR $CD_n$	$Q_n(t+1)$
X	X	X	H	L	H
X	X	X	L	H	L
X	X	X	H	H	U

## Absolute Maximum Ratings (Note 1)

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

Above which the useful life may be impaired	
Storage Temperature ( $T_{STG}$ )	-65°C to +150°C
Maximum Junction Temperature ( $T_J$ )	
Ceramic	+175°C
Pin Potential to	
Ground Pin ( $V_{EE}$ )	-7.0V to +0.5V

Input Voltage (DC)	$V_{EE}$ to +0.5V
Output Current	
(DC Output HIGH)	-50 mA
ESD (Note 2)	≤ 2000V

## Recommended Operating Conditions

Case Temperature ( $T_C$ )	
Military	-55°C to +125°C
Supply Voltage ( $V_{EE}$ )	-5.7V to -4.2V

**Note 1:** Absolute maximum ratings are those values beyond which the device may be damaged or have its useful life impaired. Functional operation under these conditions is not implied.

**Note 2:** ESD testing conforms to MIL-STD-883, Method 3015.

## Military Version

### DC Electrical Characteristics

$V_{EE} = -4.2V$  to  $-5.7V$ ,  $V_{CC} = V_{CCA} = GND$ ,  $T_C = -55^\circ C$  to  $+125^\circ C$

Symbol	Parameter	Min	Max	Units	$T_C$	Conditions	Notes	
$V_{OH}$	Output HIGH Voltage	-1025	-870	mV	0°C to +125°C	$V_{IN} = V_{IH}$ (Max) or $V_{IL}$ (Min)	Loading with 50Ω to -2.0V	(Notes 3, 4, 5)
		-1085	-870	mV	-55°C			
$V_{OL}$	Output LOW Voltage	-1830	-1620	mV	0°C to +125°C			
		-1830	-1555	mV	-55°C			
$V_{OHC}$	Output HIGH Voltage	-1035		mV	0°C to +125°C	$V_{IN} = V_{IH}$ (Min) or $V_{IL}$ (Max)	Loading with 50Ω to -2.0V	(Notes 3, 4, 5)
		-1085		mV	-55°C			
$V_{OLC}$	Output LOW Voltage		-1610	mV	0°C to +125°C			
			-1555	mV	-55°C			
$V_{IH}$	Input HIGH Voltage	-1165	-870	mV	-55°C to +125°C	Guaranteed HIGH Signal for all Inputs	(Notes 3, 4, 5, 6)	
$V_{IL}$	Input LOW Voltage	-1830	-1475	mV	-55°C to +125°C	Guaranteed LOW Signal for all Inputs	(Notes 3, 4, 5, 6)	
$I_{IL}$	Input LOW Current	0.50		μA	-55°C to +125°C	$V_{EE} = -4.2V$ $V_{IN} = V_{IL}$ (Min)	(Notes 3, 4, 5)	
$I_{IH}$	Input HIGH Current		240	μA	0°C to +125°C	$V_{EE} = -5.7V$ $V_{IN} = V_{IH}$ (Max)	(Notes 3, 4, 5)	
			340	μA	-55°C			
$I_{EE}$	Power Supply Current	-130	-50	mA	-55°C to +125°C	Inputs Open	(Notes 3, 4, 5)	

**Note 3:** F100K 300 Series cold temperature testing is performed by temperature soaking (to guarantee junction temperature equals -55°C), then testing immediately without allowing for the junction temperature to stabilize due to heat dissipation after power-up. This provides "cold start" specs which can be considered a worst case condition at cold temperatures.

**Note 4:** Screen tested 100% on each device at -55°C, +25°C, and +125°C, Subgroups, 1, 2, 3, 7 and 8.

**Note 5:** Sampled tested (Method 5005, Table I) on each manufactured lot at -55°C, +25°C, and +125°C, Subgroups A1, 2, 3, 7 and 8.

**Note 6:** Guaranteed by applying specified input condition and testing  $V_{OH}/V_{OL}$ .

## AC Electrical Characteristics

$V_{EE} = -4.2V$  to  $-5.7V$ ,  $V_{CC} = V_{CCA} = GND$

Symbol	Parameter	$T_C = -55^\circ C$		$T_C = +25^\circ C$		$T_C = +125^\circ C$		Units	Conditions	Notes
		Min	Max	Min	Max	Min	Max			
$f_{max}$	Toggle Frequency	400		400		400		MHz	Figures 2, 3	(Note 10)
$t_{PLH}$ $t_{PHL}$	Propagation Delay CP <sub>C</sub> to Output	0.50	2.20	0.60	2.00	0.50	2.40	ns	Figures 1, 3	(Notes 7, 8, 9)
$t_{PLH}$ $t_{PHL}$	Propagation Delay CP <sub>n</sub> to Output	0.50	2.20	0.60	2.00	0.50	2.40	ns		
$t_{PLH}$ $t_{PHL}$	Propagation Delay CD <sub>n</sub> , SD <sub>n</sub> to Output	0.50	2.20	0.60	2.00	0.50	2.40	ns	CP <sub>n</sub> , CP <sub>C</sub> = L Figures 1, 4	
$t_{PLH}$ $t_{PHL}$		0.50	2.40	0.60	2.10	0.50	2.50			
$t_{PLH}$ $t_{PHL}$	Propagation Delay MS, MR to Output	0.70	2.70	0.80	2.60	0.80	2.90	ns	CP <sub>n</sub> , CP <sub>C</sub> = L	
$t_{PLH}$ $t_{PHL}$		0.70	2.90	0.80	2.80	0.80	3.10		CP <sub>n</sub> , CP <sub>C</sub> = H	
$t_{TLH}$ $t_{THL}$	Transition Time 20% to 80%, 80% to 20%	0.20	1.40	0.20	1.40	0.20	1.40	ns	Figures 1, 3, 4	
$t_s$	Setup Time								Figure 5	(Note 10)
	D <sub>n</sub>	1.00		0.80		0.90		ns	Figure 4	
	CD <sub>n</sub> , SD <sub>n</sub> (Release Time)	1.50		1.30		1.60				
	MS, MR (Release Time)	2.50		2.30		2.50				
$t_h$	Hold Time D <sub>n</sub>	1.50		1.30		1.60		ns	Figure 5	
$t_{pw(H)}$	Pulse Width HIGH CP <sub>n</sub> , CP <sub>C</sub> , CD <sub>n</sub> , SD <sub>n</sub> , MR, MS	2.00		2.00		2.00		ns	Figures 3, 4	

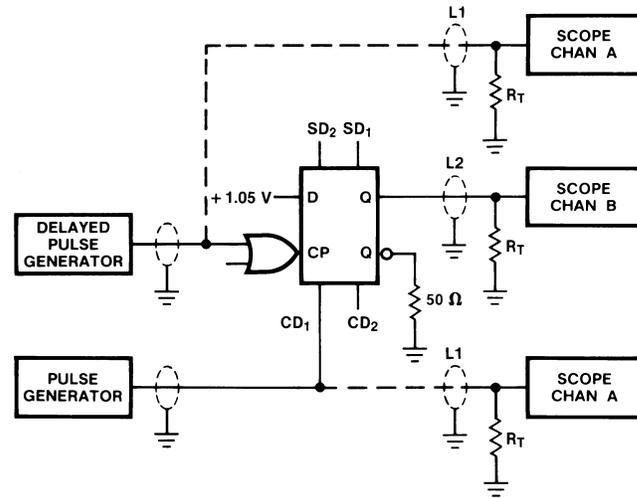
**Note 7:** F100K 300 Series cold temperature testing is performed by temperature soaking (to guarantee junction temperature equals  $-55^\circ C$ ), then testing immediately without allowing for the junction temperature to stabilize due to heat dissipation after power-up. This provides "cold start" specs which can be considered a worst case condition at cold temperatures.

**Note 8:** Screen tested 100% on each device at  $+25^\circ C$ . Temperature only, Subgroup A9.

**Note 9:** Sample tested (Method 5005, Table I) on each Mfg. lot at  $+25^\circ C$ , Subgroup A9, and at  $+125^\circ C$ , and  $-55^\circ C$  Temp., Subgroups A10 and A11.

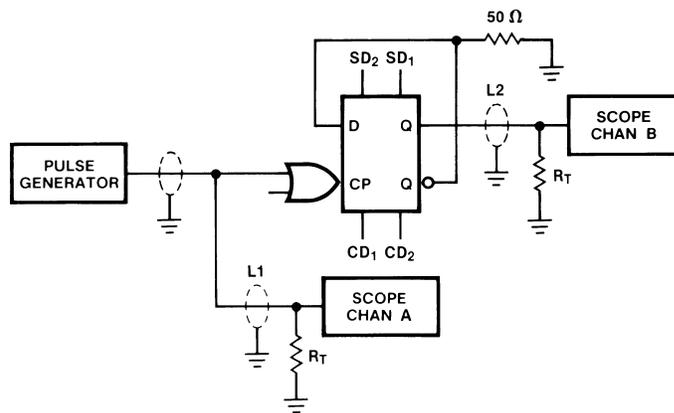
**Note 10:** Not tested at  $+25^\circ C$ ,  $+125^\circ C$  and  $-55^\circ C$  Temperature (design characterization data).

## Test Circuits



DS100300-6

FIGURE 1. AC Test Circuit



DS100300-7

### Notes:

$V_{CC}, V_{CCA} = +2V, V_{EE} = -2.5V$

L1 and L2 = Equal length 50 $\Omega$  impedance lines

$R_T = 50\Omega$  terminator internal to scope

Decoupling 0.1  $\mu F$  from GND to  $V_{CC}$  and  $V_{EE}$

All unused outputs are loaded with 50 $\Omega$  to GND

$C_L$  = Fixture and stray capacitance  $\leq 3$  pF

FIGURE 2. Toggle Frequency Test Circuit

## Switching Waveforms

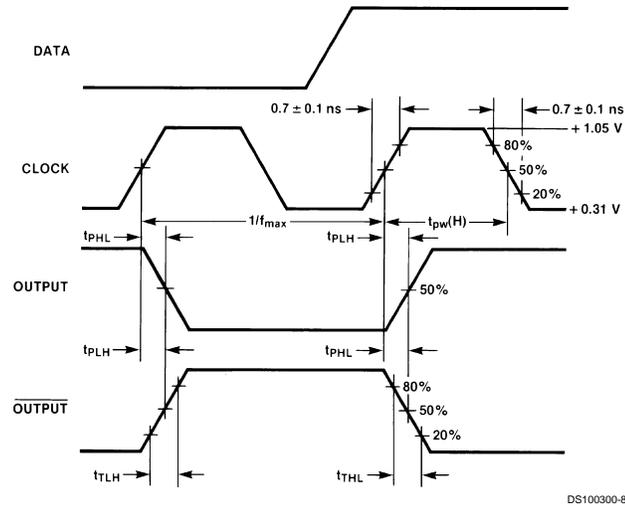


FIGURE 3. Propagation Delay (Clock) and Transition Times

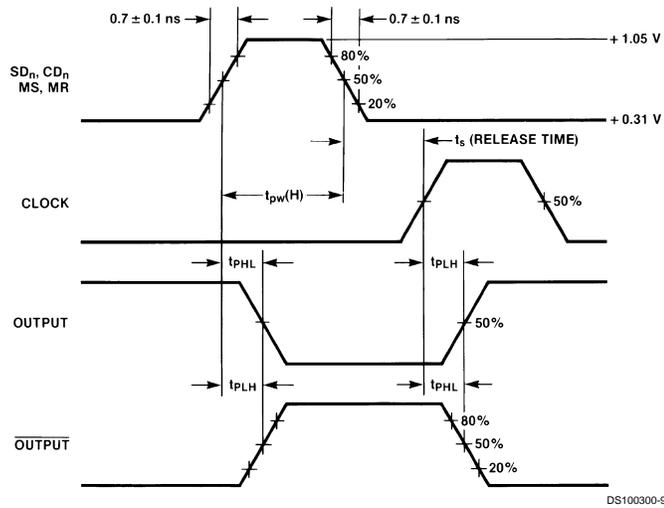


FIGURE 4. Propagation Delay (Resets)

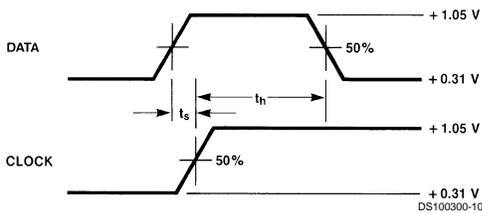
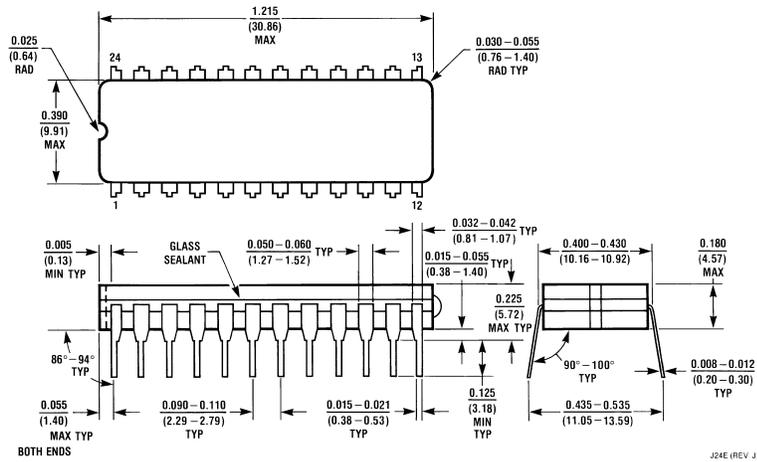


FIGURE 5. Data Setup and Hold Time

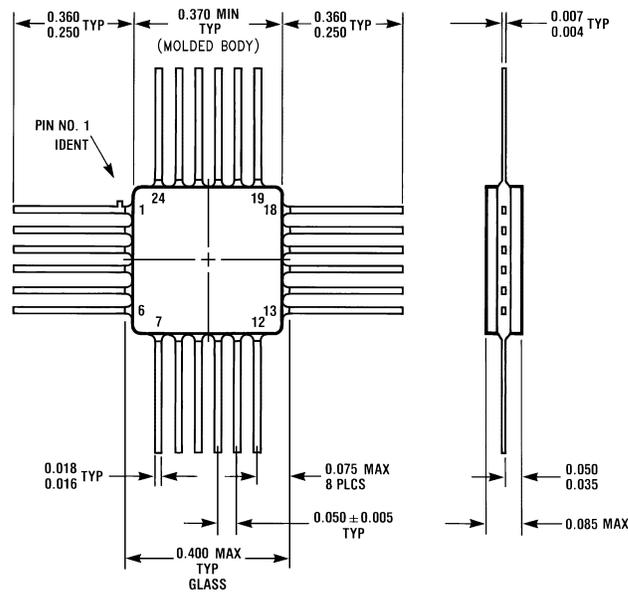
**Note 11:**  $t_s$  is the minimum time before the transition of the clock that information must be present at the data input.

**Note 12:**  $t_h$  is the minimum time after the transition of the clock that information must remain unchanged at the data input.

**Physical Dimensions** inches (millimeters) unless otherwise noted



**24-Lead Ceramic Dual-In-Line Package (0.400" Wide) (D)**  
NS Package Number J24E



**24-Lead Quad Cerpak (F)**  
NS Package Number W24B

**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 in 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**  
Americas  
Tel: 1-800-272-9959  
Fax: 1-800-737-7018  
Email: support@nsc.com

[www.national.com](http://www.national.com)

**National Semiconductor Europe**  
Fax: +49 (0) 1 80-530 85 86  
Email: europe.support@nsc.com  
Deutsch Tel: +49 (0) 1 80-530 85 85  
English Tel: +49 (0) 1 80-532 78 32  
Français Tel: +49 (0) 1 80-532 93 58  
Italiano Tel: +49 (0) 1 80-534 16 80

**National Semiconductor Asia Pacific Customer Response Group**  
Tel: 65-2544466  
Fax: 65-2504466  
Email: sea.support@nsc.com

**National Semiconductor Japan Ltd.**  
Tel: 81-3-5620-6175  
Fax: 81-3-5620-6179

## 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	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Mobile Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

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

TI E2E Community Home Page

[e2e.ti.com](http://e2e.ti.com)

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