

## CGS2535V/CGS2535TV Commercial Quad 1 to 4 Clock Drivers/Industrial Quad 1 to 4 Clock Drivers

Check for Samples: [CGS2535TV](#), [CGS2535V](#)

### FEATURES

- **Ensured:**
  - **1.0 ns Rise and Fall Times While Driving 12 Inches of 50Ω Microstrip Terminated with 25 pF**
  - **350 ps Pin-to-Pin Skew ( $t_{OSLH}$  and  $t_{OSHL}$ )**
- **650 ps Part-to-Part Variation on Positive or Negative Transition @ 5V  $V_{CC}$**
- **Operates with Either 3.3V or 5.0V Supply**
- **Inputs 5V Tolerant with  $V_{CC}$  in 3.3V Range**
- **Symmetric Output Current Drive: 24 mA  $I_{OH}/I_{OL}$**
- **Industrial Temperature Range  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$**
- **Symmetric Package Orientation**
- **Large Fanout for Memory Driving Applications**
- **Ensured 2 kV ESD Protection**
- **Implemented on TI's ABT Family Process**
- **28-pin PLCC for Optimum Skew Performance**

### DESCRIPTION

These Clock Generation and Support clock drivers are specifically designed for driving memory arrays requiring large fanouts while operating at high speeds.

The CGS2535 is a non-inverting 4 to 16 driver with CMOS I/O structures. The CGS2535 specification ensured part-to-part skew variation.

### Connection Diagrams

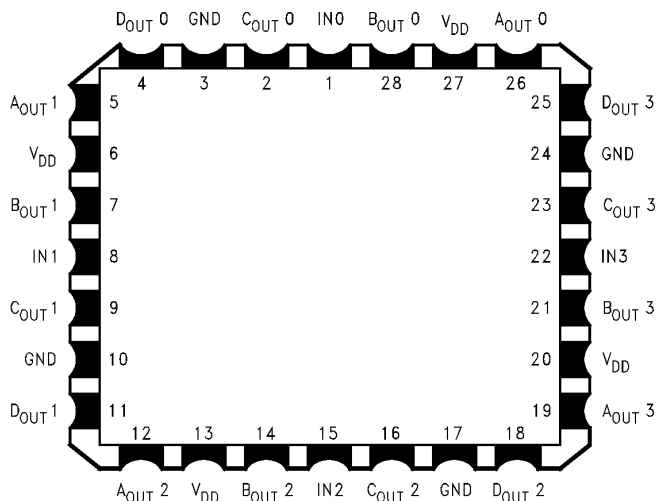


Figure 1. Pin Assignment for 28-Pin PLCC

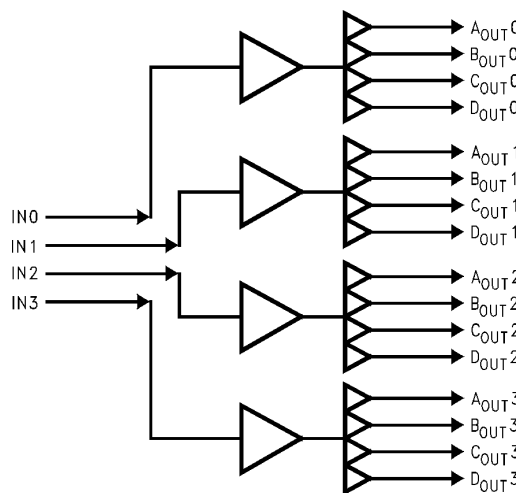


Figure 2. CGS2535

### Truth Table

Input	Output
In (0–3)	ABCD Out (0–3)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### Absolute Maximum Ratings<sup>(1)</sup>

Supply Voltage ( $V_{CC}$ )		7.0V
Input Voltage ( $V_i$ )		7.0V
Input Current		–30 mA
Current Applied to Output (High/Low)		Twice the Rated $I_{OH}/I_{OL}$
Operating Temp.	Industrial grade	–40°C to +85°C
	Comm. grade	0°C to +70°C
Storage Temperature Range (–65°C to +150°C)	Airflow	Typical $\theta_{JA}$
	0 LFM	62°C/W
	225 LFM	43°C/W
	500 LFM	34°C/W
	900 LFM	27°C/W

(1) The Absolute Maximum Ratings are those values beyond which the safety of the device cannot be ensured. The device should not be operated at these limits. The parametric values defined in the DC and AC Electrical Characteristics tables are not ensured at the absolute maximum ratings. The Recommended Operating Conditions will define the conditions for actual device operation.

### Recommended Operating Conditions

Supply Voltage		$V_{CC}$ 4.75V to 5.25V
		$V_{CC}$ 3.0V to 3.6V
Maximum Input Rise/Fall Time	(0.8V to 2.0V)	5 ns
Free Air Operating Temperature	Commercial	0°C to + 70°C
	Industrial	–40°C to + 85°C

## DC Electrical Characteristics

Over recommended operating free air temperature range. All typical values are measured at  $V_{CC} = 5V$ ,  $T_A = 25^\circ C$ .

Symbol	Parameter	Conditions	$V_{CC}$ (V)	Min	Typ	Max	Units
$V_{IH}$	Input High Level Voltage		3.0	2.1			V
			4.5	3.15			
			5.5	3.85			
$V_{IL}$	Input Low Level Voltage		3.0			0.9	V
			4.5			1.35	
			5.5			1.65	
$V_{IK}$	Input Clamp Voltage	$I_I = -18$ mA	4.5			-1.2	V
$V_{OH}$	High Level Output Voltage	$I_{OH} = -50$ $\mu A$	3.0	2.9			V
			4.5	4.4			
			5.5	5.4			
		$I_{OH} = -24$ mA	3.0	2.46			V
			4.5	3.76			
			5.5	4.76			
$V_{OL}$	Low Level Output Voltage	$I_{OL} = 50$ $\mu A$	3.0			0.1	V
			4.5			0.1	
			5.5			0.1	
		$I_{OL} = 24$ mA	3.0			0.44	V
			4.5			0.44	
			5.5			0.44	
$I_I$	Input Current @ Max Input Voltage	$V_{IH} = 7V$	5.5			7	$\mu A$
		$V_{IH} = V_{CC}$	3.6			1	
$I_{IH}$	High Level Input Current	$V_{IH} = V_{CC}$	5.5			5	$\mu A$
$I_{IL}$	Low Level Input Current	$V_{IL} = 0V$	5.5	-5			$\mu A$
$I_{OLD}$	Minimum Dynamic Output Current <sup>(1)</sup>	$V_{OLD} = 1.65V$ (max)	5.5	75			mA
		$V_{OLD} = 0.9V$ (max)	3.0 <sup>(2)</sup>	36			
$I_{OHD}$	Minimum Dynamic Output Current <sup>(1)</sup>	$V_{OHD} = 3.85V$ (min)	5.5	-75			mA
		$V_{OHD} = 2.1V$ (min)	3.0 <sup>(2)</sup>	-25			
$I_{CC}$	Supply Current		3.6			75	$\mu A$
			5.5			235	
$C_{IN}$	Input Capacitance		5.0		5		pF

(1) Maximum test duration 2.0 ms, one output loaded at a time.

(2) At  $V_{CC} = 3.3V$ ,  $I_{OLD} = 55$  mA min; @  $V_{CC} = 3.6V$ ,  $I_{OLD} = 64$  mA min  
 At  $V_{CC} = 3.3V$ ,  $I_{OHD} = -58$  mA min; @  $V_{CC} = 3.6V$ ,  $I_{OHD} = -66$  mA min

**AC Electrical Characteristics**<sup>(1)(2)(3)</sup>

Over recommended operating free air temperature specified. All typical values are measured at  $V_{CC} = 5V$ ,  $T_A = 25^\circ C$ .

Symbol	Parameter	$V_{CC}$ (V) <sup>(4)</sup>	CGS2535						Units
			$T_A = +25^\circ C$			$T_A = -40^\circ C$ to $+85^\circ C$ <sup>(5)</sup>			
			$C_L = 50$ pF, $R_L = 500\Omega$			$C_L = 50$ pF, $R_L = 500\Omega$			
			Min	Typ	Max	Min	Typ	Max	
$f_{max}$	Frequency Maximum	3.0					100		MHz
		5.0					125		
$t_{PLH}$	Low-to-High Propagation Delay CK to $O_n$ @ 1 MHz <sup>(6)</sup>	3.3			4.5	2.5		4.5	ns
		5.0			3.5	2.0		3.5	
$t_{PHL}$	High-to-Low Propagation Delay CK to $O_n$ @ 1 MHz <sup>(6)</sup>	3.3			4.5	2.5		4.5	ns
		5.0			3.5	2.0		3.5	
$t_{PLH}$	Low-to-High Propagation Delay CK to $O_n$ @ 66.67 MHz <sup>(6)(7)</sup>	3.3			5.0	2.5		5.0	ns
		5.0			4.5	2.0		4.5	
$t_{PHL}$	High-to-Low Propagation Delay CK to $O_n$ @ 66.67 MHz <sup>(6)(7)</sup>	3.3			5.0	2.5		5.0	ns
		5.0			4.5	2.0		4.5	
$t_{OSLH}$	Maximum Skew Common Edge Output-to-Output Variation <sup>(1)(3)</sup>	3.3		150	350		300	350	ps
		5.0		150	350		300	350	
$t_{OSHL}$	Maximum Skew Common Edge Output-to-Output Variation <sup>(1)(3)</sup>	3.3		150	350		300	350	ps
		5.0		150	350		300	350	
$t_{rise}$	Rise/Fall Time (from 0.8V/2.0V to 2.0V/0.8V) <sup>(8)</sup>	3.3			3.5			3.5	ns
		5.0			3.0			3.0	
$t_{fall}$	Rise/Fall Time (from 0.8V/2.0V to 2.0V/0.8V) <sup>(7)(9)</sup>	3.3			0.8			1.0	ns
		5.0			0.4			0.6	
$t_{rise}$	Rise/Fall Time (from 0.8V/2.0V to 2.0V/0.8V) <sup>(7)(10)</sup>	3.3			1.0			1.0	ns
		5.0			0.7			0.9	
$t_{High}$	Pulse Width Duration High <sup>(2)(3)(7)</sup>	3.3	4.0			4.0			ns
		5.0	4.0			4.0			
$t_{Low}$	Pulse Width Duration Low <sup>(2)(3)(7)</sup>	3.3	4.0			4.0			ns
		5.0	4.0			4.0			
$t_{PVLH}$	Part-to-Part Variation of Low-to-High Transitions @ 1 MHz <sup>(6)</sup>	3.3			650			1.0	ns
		5.0			650			650	
$t_{PVHL}$	Part-to-Part Variation of High-to-Low Transitions @ 1 MHz <sup>(6)</sup>	3.3			650			1.0	ns
		5.0			650			650	
$t_{PVLH}$	Part-to-Part Variation of Low-to-High Transitions @ 66.67 MHz <sup>(6)(7)</sup>	3.3			1.0			1.0	ns
		5.0			1.0			1.0	
$t_{PVHL}$	Part-to-Part Variation of High-to-Low Transitions @ 66.67 MHz <sup>(6)(7)</sup>	3.3			1.0			1.0	ns
		5.0			1.0			1.0	

- (1) Output-to-Output Skew is defined as the absolute value of the difference between the actual propagation delay for any outputs within the same packaged device and output bank. The specifications apply to any outputs switching in the same direction either LOW to HIGH ( $t_{OSLH}$ ) or HIGH to LOW ( $t_{OSHL}$ ).
- (2) Time high is measured with outputs at 2.0V or above. Time low is measured with outputs at 0.8V or below. Input waveform characteristics for  $t_{High}$ ,  $t_{Low}$  measurement:  $f = 66.67$  MHz, duty cycle = 50%.
- (3) The input waveform has a rise and fall time transition time of 2.5 ns (10% to 90%).
- (4) Voltage Range 5.0 is  $5.0V \pm 0.25V$ , 3.3 is  $3.3V \pm 0.3V$ .
- (5) Industrial range ( $-40^\circ C$  to  $+85^\circ C$ ) limits apply to the commercial temperature range ( $0^\circ C$  to  $+70^\circ C$ ).
- (6) All 16 outputs switching simultaneously.
- (7) Ensured by design.
- (8) These Rise and Fall times are measured with  $C_L = 50$  pF,  $R_L = 500\Omega$  (see [Figure 4](#)).
- (9) These Rise and Fall times are measured with  $C_L = 25$  pF,  $R_L = 500\Omega$  (see [Figure 4](#)), and are ensured by design.
- (10) These Rise and Fall times are measured driving 12 inches of 50 $\Omega$  microstrip terminated with equivalent  $C_L = 25$  pF (see [Figure 5](#)), and are ensured by design.

Timing Information

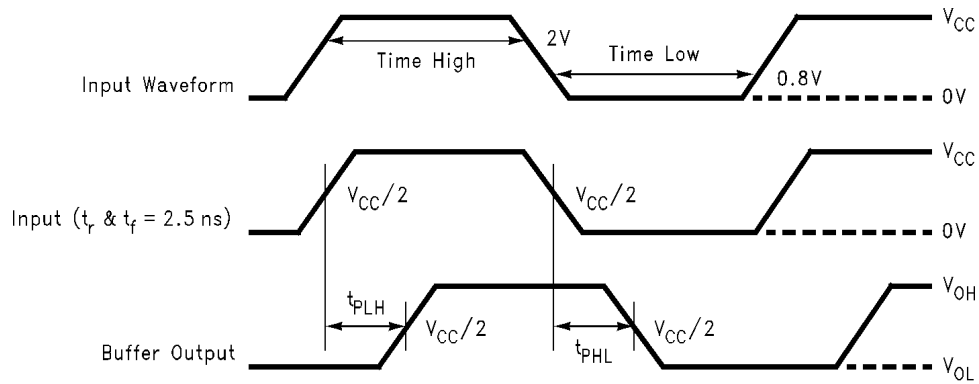
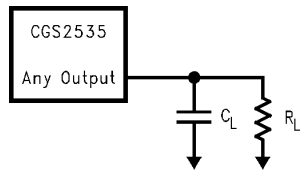


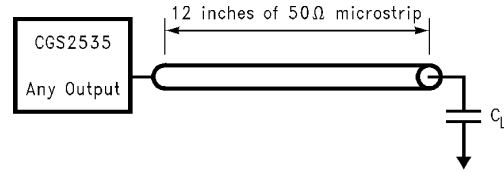
Figure 3.



These Rise and Fall times are measured with  $C_L = 50 \text{ pF}$ ,  $R_L = 500\Omega$  (see Figure 4).

These Rise and Fall times are measured with  $C_L = 25 \text{ pF}$ ,  $R_L = 500\Omega$  (see Figure 4), and are ensured by design.

Figure 4. A.C. Load  
 $C_L = \text{Total Load Including Probes}$



These Rise and Fall times are measured driving 12 inches of  $50\Omega$  microstrip terminated with equivalent  $C_L = 25 \text{ pF}$  (see Figure 5), and are ensured by design.

Figure 5. A.C. Load  
 $C_L = \text{Total Load Including Probes}$

## CGS2534/35/36/37

### MEMORY ARRAY DRIVING

In order to minimize the total load on the address bus, quite often memory arrays are driven by buffers while having the inputs of the buffers tied together. Although this practice was feasible in the conventional memory designs, in today's high speed, large buswidth designs which require address fetching at higher speeds, this technique produces many undesired results such as cross-talk and over/undershoot.

CGS2534/35/36/37 Quad 1 to 4 clock drivers were designed specifically to address these application issues on high speed, large memory arrays systems.

These drivers are optimized to drive large loads, with 3.5 ns propagation delays. These drivers produce less noise while reducing the total capacitive loading on the address bus by having only four inputs tied together (see [Figure 6](#), point A). This helps to minimize the overshoot and undershoot by having only four outputs being switched simultaneously.

Also this larger fan-out helps to save board space since for every one of these drivers, two conventional buffers were typically being used.

Another feature associated with these clock drivers is a 350 ps pin-to-pin skew specification. The minimum skew specification allows high speed memory system designers to optimize the performance of their memory subsystem by operating at higher frequencies without having concerns about output-to-output (bank-to-bank) synchronization problems which are associated with driving high capacitive loads (Point B).

The diagram below depicts a “2534/35/36/37” a memory subsystem operating at high speed with large memory capacity. The address bus is common to both the memory and the CPU and I/Os.

These drivers can operate beyond 125 MHz, and are also available in 3V–5V TTL/CMOS versions with large current drive .

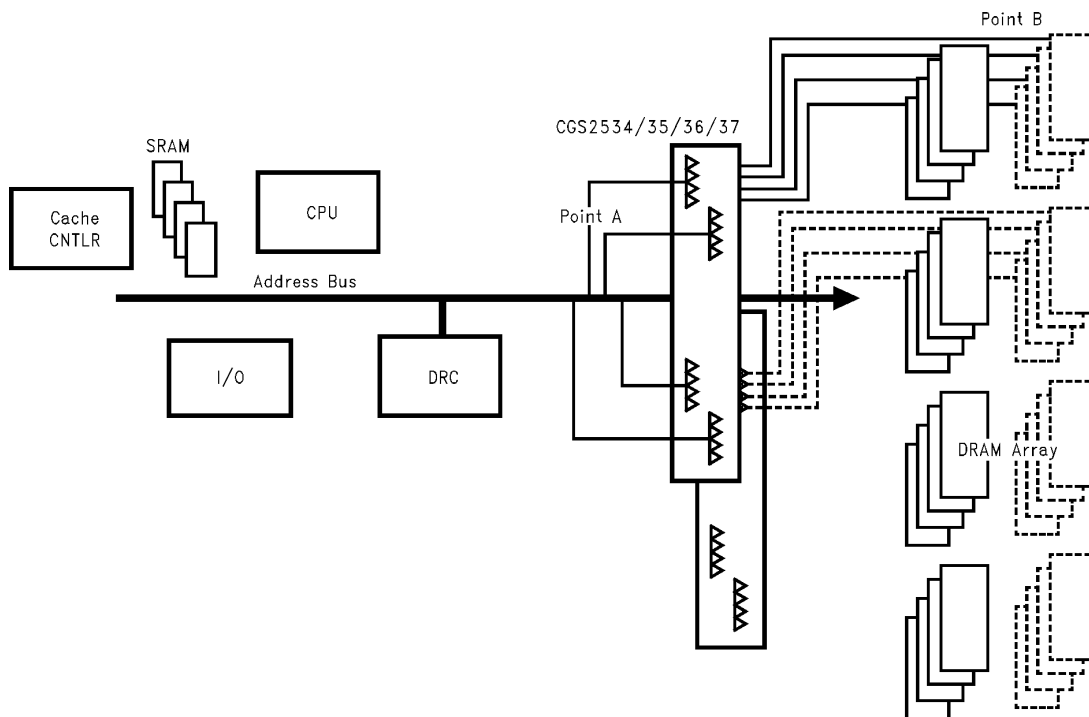
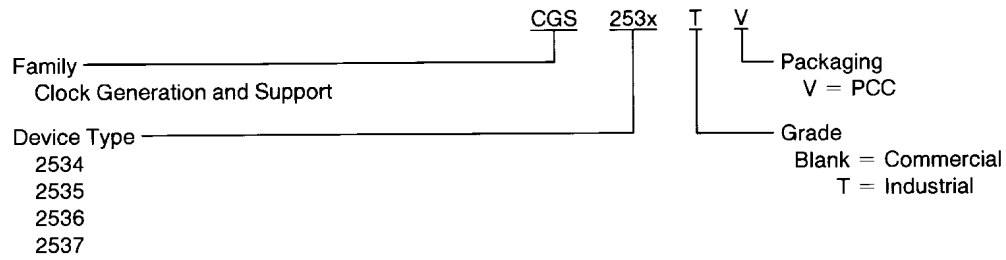


Figure 6. “2534/35/36/37”

Device	V <sub>CC</sub>	I/O	Output Configuration
2534	5	TTL	Inverting quad 1–4
2535	3 or 5	CMOS	Non-inverting quad 1–4
2536	3 or 5	CMOS	Inverting, Non-inverting, ÷2
2537	5	TTL	Inverting quad 1–4 with series 8Ω output resistors

**Part Numbering Information**



---

## REVISION HISTORY

Changes from Revision B (April 2013) to Revision C	Page
• Changed layout of National Data Sheet to TI format .....	<a href="#">7</a>

---



## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license 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 significant portions 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. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### 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 Applications 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

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
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>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

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