

# TUSB9260

## USB 3.0 TO SATA BRIDGE

# Data Manual



PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Literature Number: SLLS962D  
December 2009–Revised May 2011

## Contents

<b>1</b>	<b>MAIN FEATURES</b> .....	<b>5</b>
1.1	TUSB9260 Features .....	5
1.2	Target Applications .....	5
<b>2</b>	<b>INTRODUCTION</b> .....	<b>6</b>
2.1	System Overview .....	6
2.2	Device Block Diagram .....	6
<b>3</b>	<b>OPERATION</b> .....	<b>8</b>
3.1	General Functionality .....	8
3.2	Firmware Support .....	9
3.3	GPIO/PWM LED Designations .....	9
3.4	Power Up and Reset Sequence .....	10
<b>4</b>	<b>SIGNAL DESCRIPTIONS</b> .....	<b>11</b>
<b>5</b>	<b>CLOCK CONNECTIONS</b> .....	<b>15</b>
5.1	Clock Source Requirements .....	15
5.2	Clock Source Selection Guide .....	15
5.3	Oscillator .....	16
5.4	Crystal .....	16
<b>6</b>	<b>ELECTRICAL SPECIFICATIONS</b> .....	<b>17</b>
6.1	Absolute Maximum Ratings .....	17
6.2	Recommended Operating Conditions .....	17
6.3	DC Electrical Characteristics for 3.3-V Digital I/O .....	17
<b>7</b>	<b>POWER CONSUMPTION</b> .....	<b>18</b>

## List of Figures

2-1	Device Block Diagram.....	<a href="#">7</a>
5-1	Typical Crystal Connections .....	<a href="#">15</a>

## List of Tables

3-1	GPIO/PWM LED Designations .....	<a href="#">9</a>
4-1	I/O Definitions .....	<a href="#">11</a>
4-2	Clock and Reset Signals .....	<a href="#">11</a>
4-3	SATA Interface Signals .....	<a href="#">11</a>
4-4	USB Interface Signals .....	<a href="#">12</a>
4-5	Serial Peripheral Interface (SPI) Signals .....	<a href="#">12</a>
4-6	JTAG, GPIO, and PWM Signals .....	<a href="#">13</a>
4-7	Power and Ground Signals .....	<a href="#">14</a>
5-1	Oscillator Specification .....	<a href="#">16</a>
5-2	Crystal Specification .....	<a href="#">16</a>
7-1	SuperSpeed USB Power Consumption .....	<a href="#">18</a>
7-2	High Speed USB Power Consumption .....	<a href="#">18</a>

---

## USB 3.0 TO SATA BRIDGE

Check for Samples: [TUSB9260](#)

---

### 1 MAIN FEATURES

#### 1.1 TUSB9260 Features

- **Universal Serial Bus (USB)**
  - **SuperSpeed USB 3.0 Compliant - TID 34000007**
    - **Integrated Transceiver Supports SS/HS/FS Signaling**
  - **Best in Class Adaptive Equalizer**
    - **Allows for Greater Jitter Tolerance in the Receiver**
  - **USB Class Support**
    - **USB Attached SCSI Protocol (UASP)**
    - **USB Mass Storage Class Bulk-Only Transport (BOT)**
    - **Support for Error Conditions Per the 13 Cases (Defined in the BOT Specification)**
    - **USB Bootability Support**
    - **USB Human Interface Device (HID)**
  - **Supports Firmware Update Via USB, Using a TI Provided Application**
- **SATA Interface**
  - **Serial ATA Specification Revision 2.6**
    - **gen1i, gen1m, gen2i, and gen2m**
  - **Support for Mass-Storage Devices Compatible With the ATA/ATAPI-8 Specification**
- **Integrated ARM Cortex M3 Core**
  - **Customizable Application Code Loaded From EEPROM Via SPI Interface**
  - **Two Additional SPI Port Chip Selects for Peripheral Connection**
  - **Up to 12 GPIOs for End-User Configuration**
    - **2 GPIOs Have PWM Functionality for LED Blink Speed Control**
  - **Serial Communications Interface for Debug (UART)**
- **General Features**
  - **Can Operate from Either a Single Low Cost Crystal or Clock Oscillator**
    - **Supports 40 MHz**
  - **A JTAG Interface is Used for IEEE1149.1 and IEEE1149.6 Boundary Scan**
  - **Available in a Fully RoHS Compliant Package**

#### 1.2 Target Applications

- **External HDD/SSD**
- **External DVD**
- **External CD**
- **HDD-Based Portable Media Player**

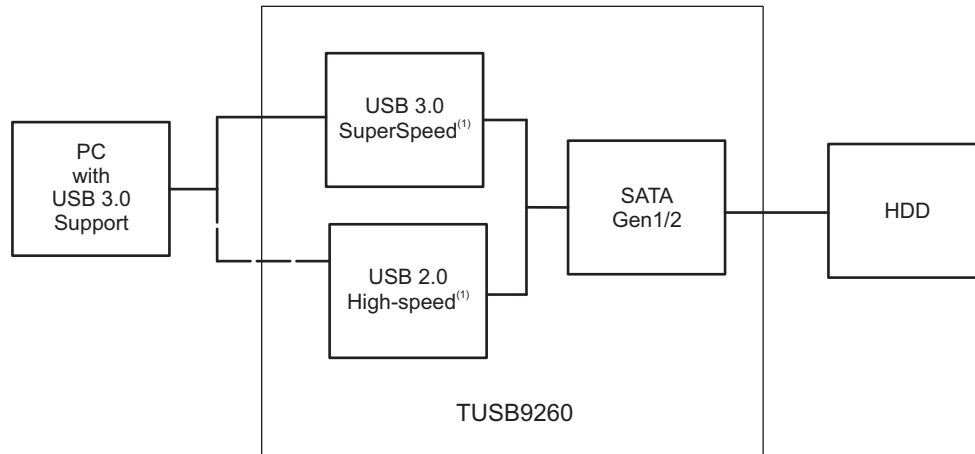


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

## 2 INTRODUCTION

### 2.1 System Overview

The TUSB9260 is an ARM cortex M3 microcontroller based USB 3.0 to serial ATA bridge. It provides the necessary hardware and firmware to implement a USB attached SCSI protocol (UASP) compliant mass storage device suitable for bridging hard disk drives (HDD), solid state disk drives (SSD), optical drives and other compatible SATA 1.5-Gbps or SATA 3.0-Gbps devices to a USB 3.0 bus. In addition to UASP support, the firmware implements the mass storage class bulk-only transport (BOT), and USB human in-interface device (HID) interfaces.



(1) USB connection is made at either SuperSpeed or High-Speed depending on the upstream connection support.

### 2.2 Device Block Diagram

The major functional blocks are as follows:

- Cortex M3 microcontroller subsystem including the following peripherals:
  - Time interrupt modules, including watchdog timer
  - Universal asynchronous receive/transmit (SCI)
  - Serial peripheral interface (SPI)
  - General purpose input/output (GPIO)
  - PWM for support of PWM outputs (PWM)
- USB 3.0 core (endpoint controller) and integrated SuperSpeed PHY
- AHCI compliant SATA controller and integrated SATA PHY
  - Supporting gen1i, gen1m, gen2i, and gen2m
- Chip level clock generation and distribution
- Support for JTAG 1149.1 and 1149.6

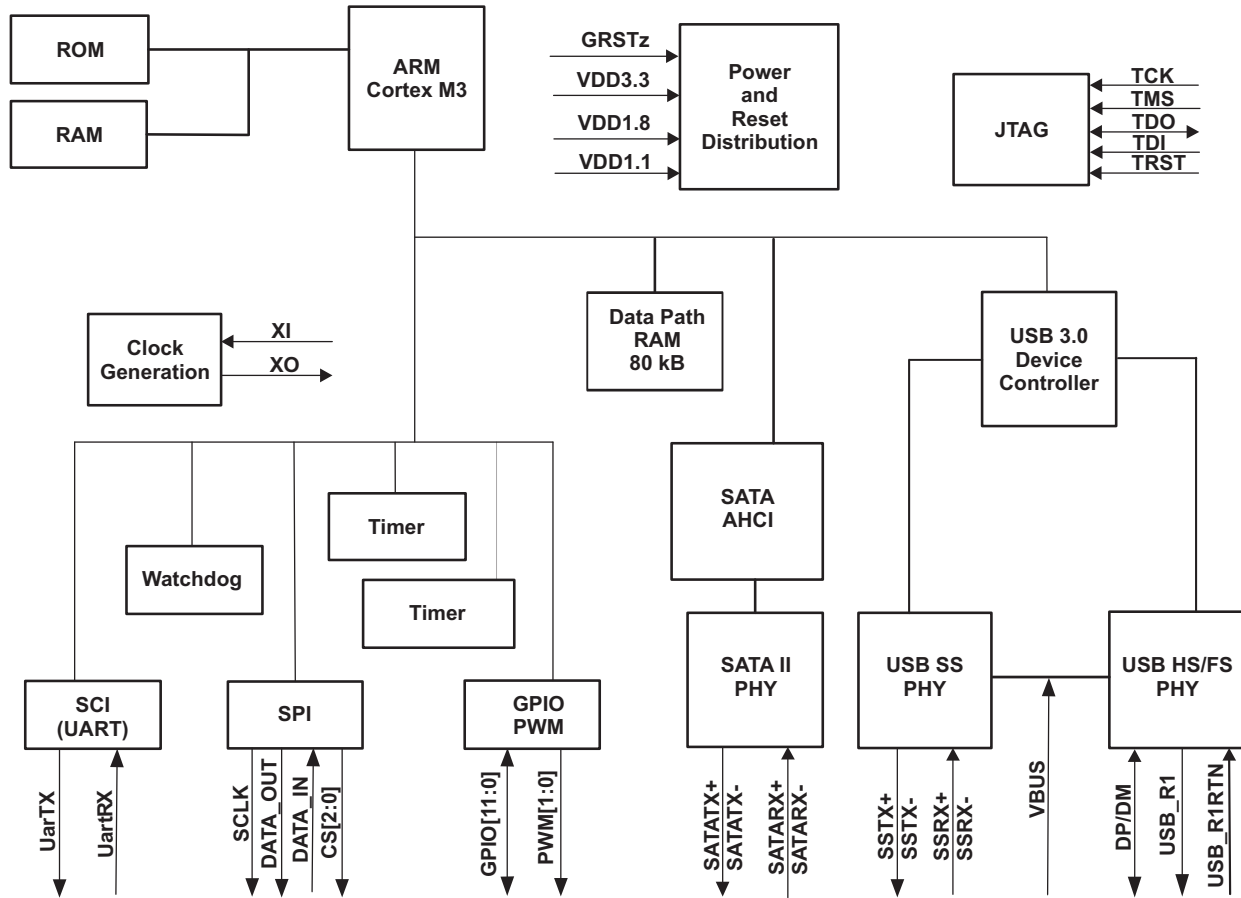


Figure 2-1. Device Block Diagram

## 3 OPERATION

### 3.1 General Functionality

The TUSB9260 ROM contains boot code that executes after a global reset which performs the initial con-figuration required to load a firmware image from an attached SPI flash memory to local RAM. In the ab-sence of an attached SPI flash memory or a valid image in the SPI flash memory, the firmware will idle and wait for a connection from a USB host through its HID interface which is also configured from the boot code. The latter can be accomplished using a custom application or driver to load the firmware from a file resident on the host system.

Once the firmware is loaded it configures the SATA advanced host controller interface host bus adapter (AHCI) and the USB device controller. In addition, the configuration of the AHCI includes a port reset which initiates an out of band (OOB) TX sequence from the AHCI link layer to determine if a device is connected, and if so negotiate the connection speed with the device (3.0 Gbps or 1.5 Gbps).

The configuration of the USB device controller includes creation of the descriptors and configuration of the device endpoints for support of UASP and USB mass storage class bulk-only transport (BOT). In addition, the firmware provides any other custom configuration required for application specific implementation, for example a HID interface for user initiated backup.

After USB device controller configuration is complete, if a SATA device was detected during the AHCI con-figuration the firmware connects the device to the USB bus when VBUS is detected. According to the USB 3.0 specification, the TUSB9260 will initially try to connect at SuperSpeed, if successful it will enter U0; otherwise, after the training time out it will enable the DP pull up and connect as a USB 2.0 high-speed or full-speed device depending on the speed supported by host or hub port.

When connected, the firmware presents the BOT interface as the primary interface and the UASP inter-face as the secondary interface. If the host stack is UASP aware, it can enable the UASP interface using a SET\_INTERFACE request for alternate interface 1.

Following speed negotiation, the device should transmit a device to host (D2H) FIS with the device signature. This first D2H FIS is received by the link layer and copied to the port signature register. When firmware is notified of the device connection it queries the device for capabilities using the IDENTIFY DEVICE command. Firmware then configures the device as appropriate for its interface and features supported, for example an HDD that supports native command queuing (NCQ).

The configuration of the USB device controller includes creation of the descriptors, configuration of the device endpoints for support of UASP and USB mass storage class bulk-only transport (BOT), allocation of memory for the transmit request blocks (TRBs), and creation of the TRBs necessary to transmit and receive packet data over the USB. In addition, the firmware provides any other custom configuration required for application specific implementation, for example a HID interface for user initiated backup.

After USB device controller configuration is complete, if a SATA device was detected during the AHCI configuration the firmware connects the device to the USB bus when VBUS is detected. According to the USB 3.0 specification, the TUSB9260 will initially try to connect at SuperSpeed, if successful it will enter U0; otherwise, after the training time out it will enable the DP pull up and connect as a USB 2.0 high-speed or full-speed device depending on the speed supported by host or hub port.

When connected as a SuperSpeed device, the firmware presents the UASP interface as the primary interface, and the BOT interface as a secondary interface. If the host stack is not UASP aware, it can enable the BOT interface using a SET\_INTERFACE request for alternate interface 1.



### 3.2 Firmware Support

Default firmware support is provided for the following:

- USB 3.0 SuperSpeed and USB 2.0 High-Speed and Full-Speed
- USB Attached SCSI Protocol (UASP)
- USB Mass Storage Class (MSC) Bulk-Only Transport (BOT)
  - Including the 13 Error Cases
- USB Mass Storage Specification for Bootability
- USB Device Class Definition for Human Interface Devices (HID)
  - Firmware Update and Custom Functionality (e.g. One-Touch Backup)
- Serial ATA Advanced Host Controller Interface (AHCI)
- General Purpose Input/Output (GPIO)
  - LED Control and Custom Functions (e.g. One-Touch Backup Control)
- Pulse Width Modulation (PWM)
  - LED Dimming Control
- Serial Peripheral Interface (SPI)
  - Firmware storage and storing Custom Device Descriptors
- Serial Communications Interface (SCI)
  - Debug Output Only

### 3.3 GPIO/PWM LED Designations

The default firmware provided by TI drives the GPIO and PWM outputs as listed in the table below.

**Table 3-1. GPIO/PWM LED Designations**

GPIO0	SW heartbeat	
GPIO1/GPIO5	USB3 power state (U0-U3)	00: U3 state or default 01: U2 state 10: U1 state 11: U0 state
GPIO2	HS/FS suspend	
GPIO3	Push button input on customer board	
GPIO4	Not used	
GPIO6	FS/HS connected	
GPIO7	SS connected	
PWM0	Disk activity	
PWM1	U3 or HS/FS suspend state (fades high and low)	
GPIO10 (SPICS1)	Not used	
GPIO11 (SPICS2)	Not used	

The LED's on the TUSB9260 Product Development Kit (PDK) board are connected as in the table above. Please see the TUSB9260 PDK Guide ([SLLA303](#)) for more information on GPIO LED connection and usage. This EVM is available for purchase, contact TI for ordering information.

### 3.4 Power Up and Reset Sequence

The TUSB9260 does not have specific power sequencing requirements with respect to the core power (VDD), I/O power (VDD33), or analog power (VDDA11, VDDA33, VDDA18, and VDDR18). The core power (VDD) or IO power (VDD33) may be powered up for an indefinite period of time while others are not powered up if all of these constraints are met:

- All maximum ratings and recommended operating conditions are observed.
- All warnings about exposure to maximum rated and recommended conditions are observed, particularly junction temperature. These apply to power transitions as well as normal operation.
- Bus contention while VDD33 is powered up must be limited to 100 hours over the projected life-time of the device.
- Bus contention while VDD33 is powered down may violate the absolute maximum ratings.

A supply bus is powered up when the voltage is within the recommended operating range. It is powered down when it is below that range, either stable or in transition.

A minimum reset duration of 1 ms is required. This is defined as the time when the power supplies are in the recommended operating range to the de-assertion of GRSTz.

## 4 SIGNAL DESCRIPTIONS

**Table 4-1. I/O Definitions**

I/O TYPE	DESCRIPTION
I	Input
O	Output
I/O	Input - Output
PU	Internal pull-up resistor
PD	Internal pull-down resistor
PWR	Power signal

**Table 4-2. Clock and Reset Signals**

TERMINAL		I/O	DESCRIPTION		
NAME	PIN NO.				
GRSTz	4	I PU	Global power reset. This reset brings all of the TUSB9260 internal registers to their default states. When GRSTz is asserted, the device is completely nonfunctional.		
XI	52	I	Crystal input. This terminal is the crystal input for the internal oscillator. The input may alternately be driven by the output of an external oscillator. When using a crystal a 1-M $\Omega$ feedback resistor is required between XI and XO.		
XO	54	O	Crystal output. This terminal is the crystal output for the internal oscillator. If XI is driven by an external oscillator this pin may be left unconnected. When using a crystal a 1-M $\Omega$ feedback resistor is required between X1 and XO.		
FREQSEL[1:0]	31, 30	I PU	Frequency select. These terminals indicate the oscillator input frequency and are used to configure the correct PLL multiplier. The field encoding is as follows:		
			<b>FREQSEL[1]</b>	<b>FREQSEL[0]</b>	<b>INPUT CLOCK FREQUENCY</b>
			0	0	Reserved
			0	1	Reserved
			1	0	Reserved
1	1	40 MHz			

**Table 4-3. SATA Interface Signals<sup>(1)</sup>**

TERMINAL		I/O	DESCRIPTION
NAME	PIN NO.		
SATA_TXP	57	O	Serial ATA transmitter differential pair (positive)
SATA_TXM	56	O	Serial ATA transmitter differential pair (negative)
SATA_RXP	60	I	Serial ATA receiver differential pair (positive)
SATA_RXM	59	I	Serial ATA receiver differential pair (negative)

- (1) Note that the default firmware and reference design for the TUSB9260 have the SATA TXP/TXM swapped for ease of routing in the reference design. If you plan to use the TI default firmware please review the reference design in the TUSB9260 DEMO User's Guide ([SLLU131](#)) for proper SATA connection.

**Table 4-4. USB Interface Signals**

TERMINAL		I/O	DESCRIPTION
NAME	PIN NO.		
USB_SSTXP	43	O	USB SuperSpeed transmitter differential pair (positive)
USB_SSTXM	42	O	USB SuperSpeed transmitter differential pair (negative)
USB_SSRXP	46	I	USB SuperSpeed receiver differential pair (positive)
USB_SSRXM	45	I	USB SuperSpeed receiver differential pair (negative)
USB_DP	36	I/O	USB High-speed differential transceiver (positive)
USB_DM	35	I/O	USB High-speed differential transceiver (negative)
USB_VBUS	33	I	USB bus power
USB_R1	39	O	Precision resistor reference. A 10-k $\Omega$ $\pm$ 1% resistor should be connected between R1 and R1RTN.
USB_R1RTN	40	I	Precision resistor reference return

**Table 4-5. Serial Peripheral Interface (SPI) Signals**

TERMINAL		I/O	DESCRIPTION
NAME	PIN NO.		
SPI_SCLK	17	O PU	SPI clock
SPI_DATA_IN	18	I PU	SPI master data in
SPI_DATA_OUT	20	O PU	SPI master data out
SPI_CS0	21	O PU	Primary SPI chip select for Flash RAM
SPI_CS2/ GPIO11	23	I/O PU	SPCI chip select for additional peripherals. When not used for SPI chip select this pin may be used as general purpose I/O.
SPI_CS1/ GPIO10	22	I/O PU	SPCI chip select for additional peripherals. When not used for SPI chip select this pin may be used as general purpose I/O.

**Table 4-6. JTAG, GPIO, and PWM Signals**

TERMINAL		I/O	DESCRIPTION
NAME	PIN NO.		
JTAG_TCK	25	I PD	JTAG test clock
JTAG_TDI	26	I PU	JTAG test data in
JTAG_TDO	27	O PD	JTAG test data out
JTAG_TMS	28	I PU	JTAG test mode select
JTAG_TRSTz	29	I PD	JTAG test reset
GPIO9/UART_TX	6	I/O PU	GPIO/UART transmitter. This terminal can be configured as a GPIO or as the transmitter for a UART channel. This pin defaults to a general purpose output.
GPIO8/UART_RX	5	I/O PU	GPIO/UART receiver. This terminal can be configured as a GPIO or as the receiver for a UART channel. This pin defaults to a general purpose output.
GPIO7	16	I/O PD	Configurable as general purpose input/outputs
GPIO6	15	I/O PD	
GPIO5	14	I/O PD	
GPIO4	13	I/O PD	
GPIO3	11	I/O PD	
GPIO2	10	I/O PD	
GPIO1	9	I/O PD	
GPIO0	8	I/O PD	
PWM0	2	O PD <sup>(1)</sup>	Pulse Width Modulation (PWM). Can be used to drive status LED's.
PWM1	3	O PD <sup>(1)</sup>	

(1) PWM pull down resistors are disabled by default. A firmware modification is required to turn them on. All other internal pull up/down resistors are enabled by default.

**Table 4-7. Power and Ground Signals**

TERMINAL		I/O	DESCRIPTION
NAME	PIN NO.		
VDDR18	48, 62	PWR	1.8-V power rail
VDDA18	37	PWR	1.8-V analog power rail
VDD	1, 12, 19, 32, 38, 41, 44, 47, 49, 55, 58, 61, 63, 64	PWR	1.1-V power rail
VDD33	7, 24, 50, 51	PWR	3.3-V power rail
VDDA33	34	PWR	3.3-V analog power rail
VSSOSC	53	PWR	Oscillator ground. If using a crystal, this should not be connected to PCB ground plane. If using an oscillator, this should be connected to PCB ground. See the Clock Source Requirements section for more details.
VSS	65	PWR	Ground - Thermal Pad

## 5 CLOCK CONNECTIONS

### 5.1 Clock Source Requirements

The TUSB9260 supports an external oscillator source or a crystal unit. If a clock is provided to XI instead of a crystal, XO is left open and VSSOSC should be connected to the PCB ground plane. Otherwise, if a crystal is used, the connection needs to follow the guidelines below.

Since XI and XO are coupled to other leads and supplies on the PCB, it is important to keep them as short as possible and away from any switching leads. It is also recommended to minimize the capacitance between XI and XO. This can be accomplished by connecting the VSSOSC lead to the two external capacitors CL1 and CL2 and shielding them with the clean ground lines. The VSSOSC should not be connected to PCB ground when using a crystal.

Load capacitance ( $C_{load}$ ) of the crystal varying with the crystal vendors is the total capacitance value of the entire oscillation circuit system as seen from the crystal. It includes two external capacitors CL1 and CL2 in [Figure 5-1](#). The trace length between the decoupling capacitors and the corresponding power pins on the TUSB9260 needs to be minimized. It is also recommended that the trace length from the capacitor pad to the power or ground plane be minimized.

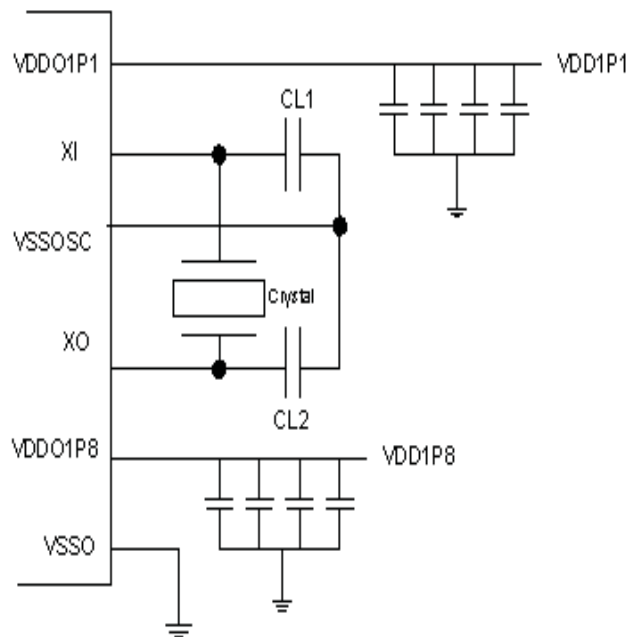


Figure 5-1. Typical Crystal Connections

### 5.2 Clock Source Selection Guide

Reference clock jitter is an important parameter. Jitter on the reference clock will degrade both the transmit eye and receiver jitter tolerance no matter how clean the rest of the PLL is, thereby impairing system performance. Additionally, a particularly jittery reference clock may interfere with PLL lock detection mechanism, forcing the Lock Detector to issue an Unlock signal. A good quality, low jitter reference clock is required to achieve compliance with supported USB3.0 standards. For example, USB3.0 specification requires the random jitter (RJ) component of either RX or TX to be 2.42 ps (random phase jitter calculated after applying jitter transfer function - JTF). As the PLL typically has a number of additional jitter components, the Reference Clock jitter must be considerably below the overall jitter budget.

### 5.3 Oscillator

XI should be tied to the 1.8-V clock source and XO should be left floating.

VSSOSC should be connected to the PCB ground plane.

A 40-MHz clock can be used.

**Table 5-1. Oscillator Specification**

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
C <sub>XI</sub>	XI input capacitance	VDDIO = 1.8 V, T <sub>J</sub> = 25°C	0.414		pF
V <sub>IL</sub>	Low-level input voltage			0.35 x VDDR18	V
V <sub>IH</sub>	High-level input voltage	0.65 x VDDR18			V
T <sub>tosc_i</sub>	Frequency tolerance	Operational temperature	–50	50	ppm
T <sub>duty</sub>	Duty cycle		45	55	%
T <sub>R</sub> /T <sub>F</sub>	Rise/Fall time	20% - 80 %		6	ns
R <sub>J</sub>	Reference clock R <sub>J</sub>	JTF (1 sigma) <sup>(1)(2)</sup>		0.8	ps
T <sub>J</sub>	Reference clock T <sub>J</sub>	JTF (total p-p) <sup>(2)(3)</sup>		25	ps
T <sub>p-p</sub>	Reference clock jitter	(absolute p-p) <sup>(4)</sup>		50	ps

- (1) Sigma value assuming Gaussian distribution  
(2) After application of JTF  
(3) Calculated as 14.1 x R<sub>J</sub> + D<sub>J</sub>  
(4) Absolute phase jitter (p-p)

### 5.4 Crystal

A parallel, 20-pF load capacitor should be used if a crystal source is used.

VSSOSC should not be connected to the PCB ground plane.

A 40-MHz crystal can be used.

**Table 5-2. Crystal Specification**

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT	
T <sub>tosc_i</sub>	Frequency tolerance	Operational temperature	–50	50	ppm	
	Frequency stability	1 year aging	–50	50	ppm	
C <sub>L</sub>	Load capacitance		12	20	24	pF



## 6 ELECTRICAL SPECIFICATIONS

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)

	VALUE	UNIT
VDDR18/ VDDA18 Steady-state supply voltage	–0.3 to 2.45	V
VDD Steady-state supply voltage	–0.3 to 1.4	V
VDD33/ VDDA33 Steady-state supply voltage	–0.3 to 3.8	V

### 6.2 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

	MIN	NOM	MAX	UNIT
VDDR18 Digital 1.8 supply voltage	1.71	1.8	1.89	V
VDDA18 Analog 1.8 supply voltage	1.62	1.8	1.89	V
VDD Digital 1.1 supply voltage	1.045	1.1	1.155	V
VDD33 Digital 3.3 supply voltage	3	3.3	3.6	V
VDDA33 Analog 3.3 supply voltage	3	3.3	3.6	V
VBUS Voltage at VBUS PAD	0		1.155	V
T <sub>A</sub> Operating free-air temperature range	0		70	°C
T <sub>J</sub> Operating junction temperature range	0		105	°C
HBM ESD			1000	V
CDM ESD			500	V

### 6.3 DC Electrical Characteristics for 3.3-V Digital I/O

over operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>DRIVER</b>					
T <sub>R</sub> Rise time	5 pF			1.5	ns
T <sub>F</sub> Fall time	5 pF			1.53	ns
I <sub>OL</sub> Low-level output current	VDD33 = 3.3 V, T <sub>J</sub> = 25°C		6		mA
I <sub>OH</sub> High-level output current	VDD33 = 3.3 V, T <sub>J</sub> = 25°C		–6		mA
V <sub>OL</sub> Low-level output voltage	I <sub>OL</sub> = 2 mA			0.4	V
V <sub>OH</sub> High-level output voltage	I <sub>OL</sub> = –2 mA	2.4			V
V <sub>O</sub> Output voltage		0		VDD33	V
<b>RECEIVER</b>					
V <sub>I</sub> Input voltage		0		VDD33	V
V <sub>IL</sub> Low-level input voltage		0		0.8	V
V <sub>IH</sub> High-level input voltage		2			V
V <sub>hys</sub> Input hysteresis		200			mV
t <sub>T</sub> Input transition time (T <sub>R</sub> and T <sub>F</sub> )				10	ns
I <sub>I</sub> Input current	V <sub>I</sub> = 0 V to VDD33			12	μA
C <sub>I</sub> Input capacitance	VDD33 = 3.3 V, T <sub>J</sub> = 25°C		0.384		pF

## 7 POWER CONSUMPTION

All transfers are to a SATA Gen II SSD. A SATA Gen I target yields an approximate 10-mA power savings on the 1.1-V rail.

**Table 7-1. SuperSpeed USB Power Consumption**

POWER RAIL	TYPICAL ACTIVE CURRENT (mA) <sup>(1)</sup>	TYPICAL IDLE CURRENT (mA) <sup>(2)</sup>
VDD11 <sup>(3)</sup>	319	308
VDD18 <sup>(4)</sup>	58	58
VDD33 <sup>(5)</sup>	6	6

- (1) Transferring data via SS USB to a SSD SATA Gen II device. No SATA power management, U0 only.  
 (2) SATA Gen II SSD attached no active transfer. No SATA power management, U0 only.  
 (3) All 1.1-V power rails connected together.  
 (4) All 1.8-V power rails connected together.  
 (5) All 3.3-V power rails connected together.

**Table 7-2. High Speed USB Power Consumption**

POWER RAIL	TYPICAL ACTIVE CURRENT (mA) <sup>(1)</sup>	TYPICAL IDLE CURRENT (mA) <sup>(2)</sup>
VDD11 <sup>(3)</sup>	197	193
VDD18 <sup>(4)</sup>	45	36
VDD33 <sup>(5)</sup>	14	14

- (1) Transferring data via HS USB to a SSD SATA Gen II device. No SATA power management.  
 (2) SATA Gen II SSD attached no active transfer. No SATA power management.  
 (3) All 1.1-V power rails connected together.  
 (4) All 1.8-V power rails connected together.  
 (5) All 3.3-V power rails connected together.

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
TUSB9260PVP	ACTIVE	HTQFP	PVP	64	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

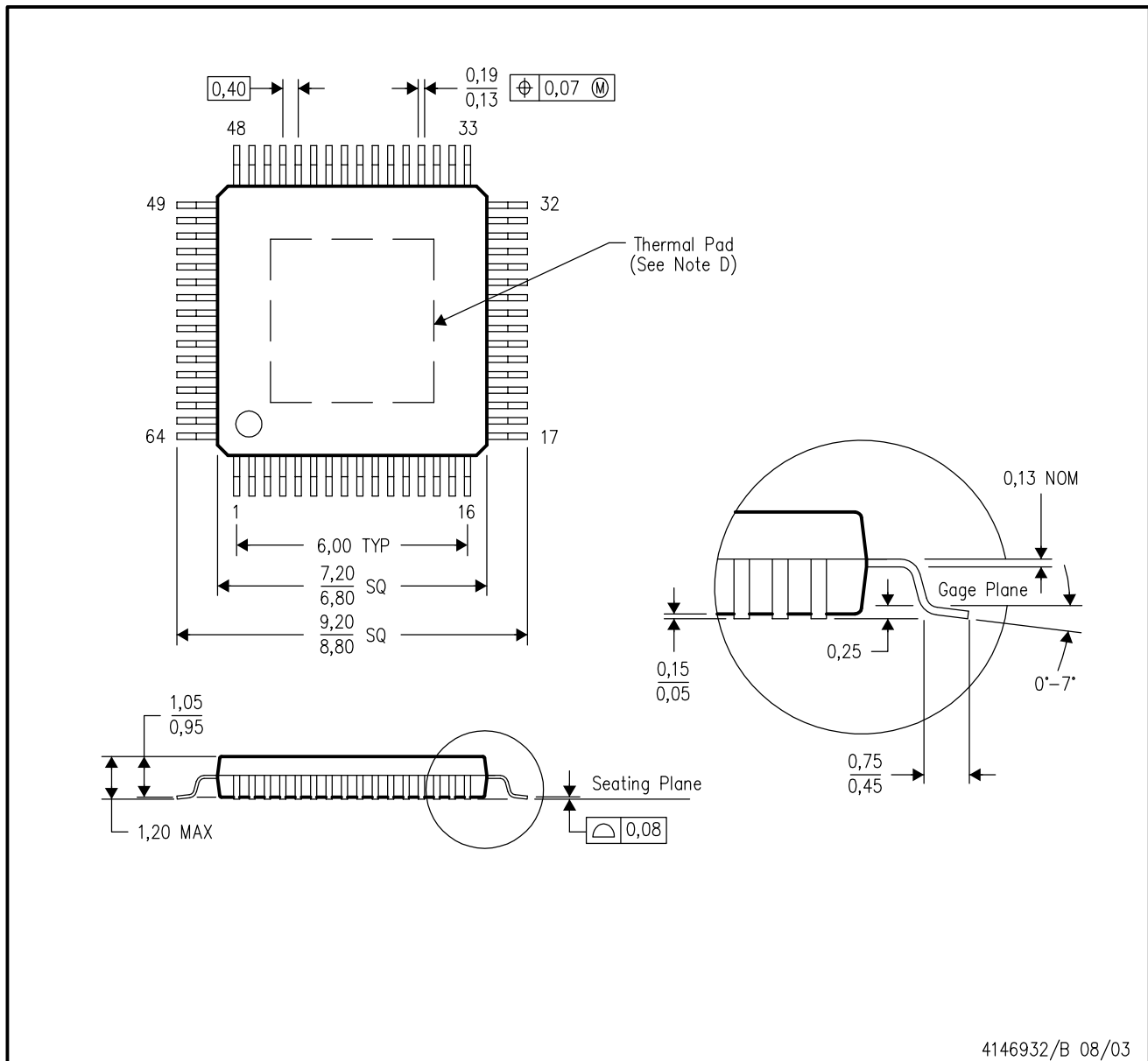
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

PVP (S-PQFP-G64)

PowerPAD™ PLASTIC QUAD FLATPACK



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion.
  - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - Falls within JEDEC MS-026

PowerPAD is a trademark of Texas Instruments.

# THERMAL PAD MECHANICAL DATA

PVP (S-PQFP-G64)

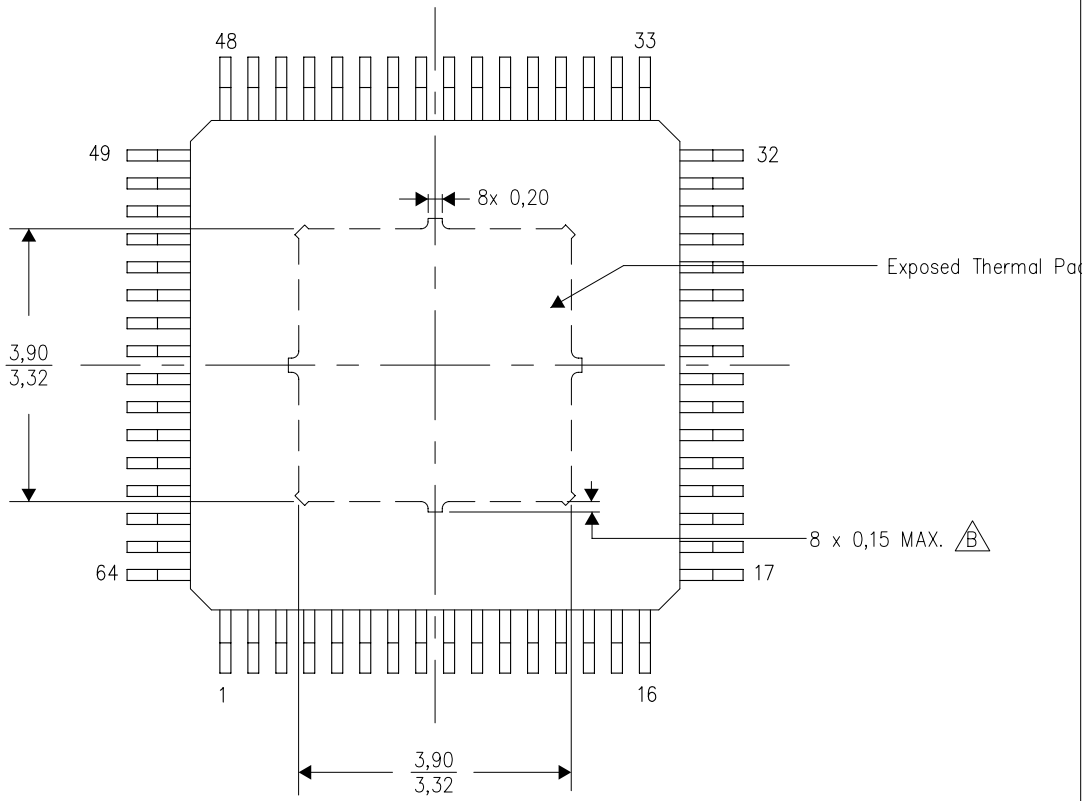
PowerPAD™ PLASTIC QUAD FLATPACK

## THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached to a printed circuit board (PCB). The thermal pad must be soldered directly to the PCB. After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For additional information on the PowerPAD package and how to take advantage of its heat dissipating abilities, refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 and Application Brief, PowerPAD Made Easy, Texas Instruments Literature No. SLMA004. Both documents are available at [www.ti.com](http://www.ti.com).

The exposed thermal pad dimensions for this package are shown in the following illustration.



Top View  
Exposed Thermal Pad Dimensions

4211213/B 09/10

- NOTES: A. All linear dimensions are in millimeters  
B. Exposed tie strap features may not be present.

PowerPAD is a trademark of Texas Instruments.

## 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)