

TWL6041 8-Channel Low-Power Audio Codec for Portable Applications

1 Device Overview

1.1 Features

- Four Audio Digital-to-Analog Converter (DAC) Channels
- Stereo Capless Headphone Drivers
 - Up to 104-dB DR
 - Power Tune for Performance and Power Consumption Tradeoff
- Stereo 8 Ω , 1.5 W per Channel Speaker Drivers also with 4- Ω Support Capability
- Differential Earpiece Driver
- Stereo Line-Out
- Two Audio Analog-to-Digital Converter (ADC) Channels
 - 96-dBA SNR
- Four Audio Inputs:
 - Three Differential Microphone Inputs
 - Stereo Line-In and FM Input
- Two Vibrator and Haptics Feedback Channels
 - Differential H-bridge Drivers
- Two Low-Noise Analog Microphone Bias Outputs
- Two Digital Microphone Bias Outputs
- Analog Low-Power Loop from Line-in to Headphone and Speaker Outputs
- Dual Phase-Locked Loops (PLLs) for Flexible Clock Support:
 - 32-kHz Sleep Clock Input for System Low-Power Playback Mode
 - 12-, 19.2-, 26-, and 38.4-MHz System Clock Input
- Accessory Plug and Unplug Detection, Accessory Button Press Detection
- Integrated Power Supplies:
 - Negative Charge Pump for Capless Headphone Driver
 - Two Low Dropout Voltage Regulators (LDOs) for High Power Supply Rejection Ratio (PSRR)
- I²C Control
- Thermal Protection:
 - Host Interrupt
- Power Supplies:
 - Analog: 2.1 V
 - Digital I/O: 1.8 V
 - Battery: 2.3 V–5.5 V
- Package 3.8-mm x 3.8-mm 81-Pin WCSP

1.2 Applications

- Mobile and Smart Phones
- MP3 Players
- Handheld Devices

1.3 Description

The TWL6041 is an audio codec with a high level of integration providing analog audio codec functions for portable applications, as shown in [Figure 1-1](#). The device contains multiple audio analog inputs and outputs, as well as microphone biases and accessory detection. The device is connected to the OMAP™ 4 host processor through a proprietary PDM interface for audio data communication enabling partitioning with optimized power consumption and performance. Multichannel audio data is multiplexed to a single wire for downlink (PDML) and uplink (PDMUL).

The OMAP4 device provides the TWL6041 device with five PDM audio-input channels (DL0–DL4). Channels DL0–DL3 are connected to four parallel DAC channels multiplexed to stereo headphone (HSL, HSR), stereo speaker (HFL, HFR), and earpiece (EAR) or stereo line outputs (AUXL, AUXR).

The stereo headphone path has a low-power (LP) mode operating from a 32-kHz sleep clock to enable more than 100 hours of MP3 playback time. Very-high dynamic range of 104 dBA is achieved when using the system clock input and DAC path high-performance (HP) mode. Class-AB headphone drivers provide a 1-V_{rms} output and are ground centered for capless connection to a headphone, thus enabling system size and cost reduction. The earpiece driver is a differential class-AB driver with 2-V_{rms} capability to a typical 32- Ω load or 1.4-V_{rms} to a typical 16- Ω load.



Stereo speaker path has filterless class-D outputs with 1.5-W capability per channel. Additionally, the 4-Ω load is supported. For output-power maximization, supply connection to an external boost is supported. Speaker drivers also support hearing aid coil loads.

For vibrator and haptic feedback support, the TWL6041 device has two PWM channels with independent input signals from DL4 or I²C. Vibra drivers are differential H-bridge outputs, enabling fast acceleration and deceleration of vibra motor. An external driver for a hearing aid coil or a piezo speaker requiring high voltage can be connected to line outputs.

The TWL6041 supports three differential microphone inputs (MMIC, HMIC, and SMIC) and a stereo line-input (AFML, AFMR) multiplexed to two parallel ADCs. The PDM output from the ADCs is transmitted to the OMAP4 processor through UL0 and UL1. AFML, AFMR inputs can also be looped to analog outputs (LB0, LB1).

Two LDOs provide a voltage of 2.1 V to bias analog microphones (MBIAS and HBIAS). The maximum output current is 2 mA for each analog bias, allowing up to two microphones on one bias. Two LDOs provide a voltage of 1.8 V to 1.85 V to bias digital microphones (DBIAS1 and DBIAS2). One bias generator can bias several digital microphones at the same time, with a total maximum output current of 10 mA.

The TWL6041 device has an integrated negative charge pump and two LDOs (HS LDO and LS LDO) for high PSRR. The only external supply needed is 2.1 V, which is available from the 2.1-V DC-DC of TWL6030/6032 power-management IC (PMIC) in the OMAP4 system. By powering audio from low-noise 2.1-V DC-DC of low power consumption, high dynamic range and high output swing at the headset output are achieved. All other supply inputs can be directly connected to battery or system 1.8-V I/O.

Two integrated PLLs enable operation from a 12-, 19.2-, 26-, and 38.4-MHz system clock (MCLK) or, in LP playback mode, from a 32-kHz sleep clock (CLK32K). The frequency plan is based on a 48-kS/s audio data rate for all channels, and the host processor uses sample-rate converters to interface with different sample rates (for example, 44.1 kHz). In the specific case of low-power audio playback, the TWL6041 supports the 44.1-kS/s and 48-kS/s rates. Transitions between sample rates or input clocks are seamless.

Accessory plug and unplug detections are supported (PLUGDET). Some headsets have a manual switch for submitting send/end signal to the terminal through the microphone input pin. This feature is supported by a periodic accessory button press detection to minimize current consumption in sleep mode. Detection cycle properties can be programmed according to system requirements.

The TWL6041BSRS, when connected to OMAP4 and OMAP5 platform, includes SRS Audio Effects, SRS pre-processing solutions and SRS TruMedia as standard feature for Android™ ICS.

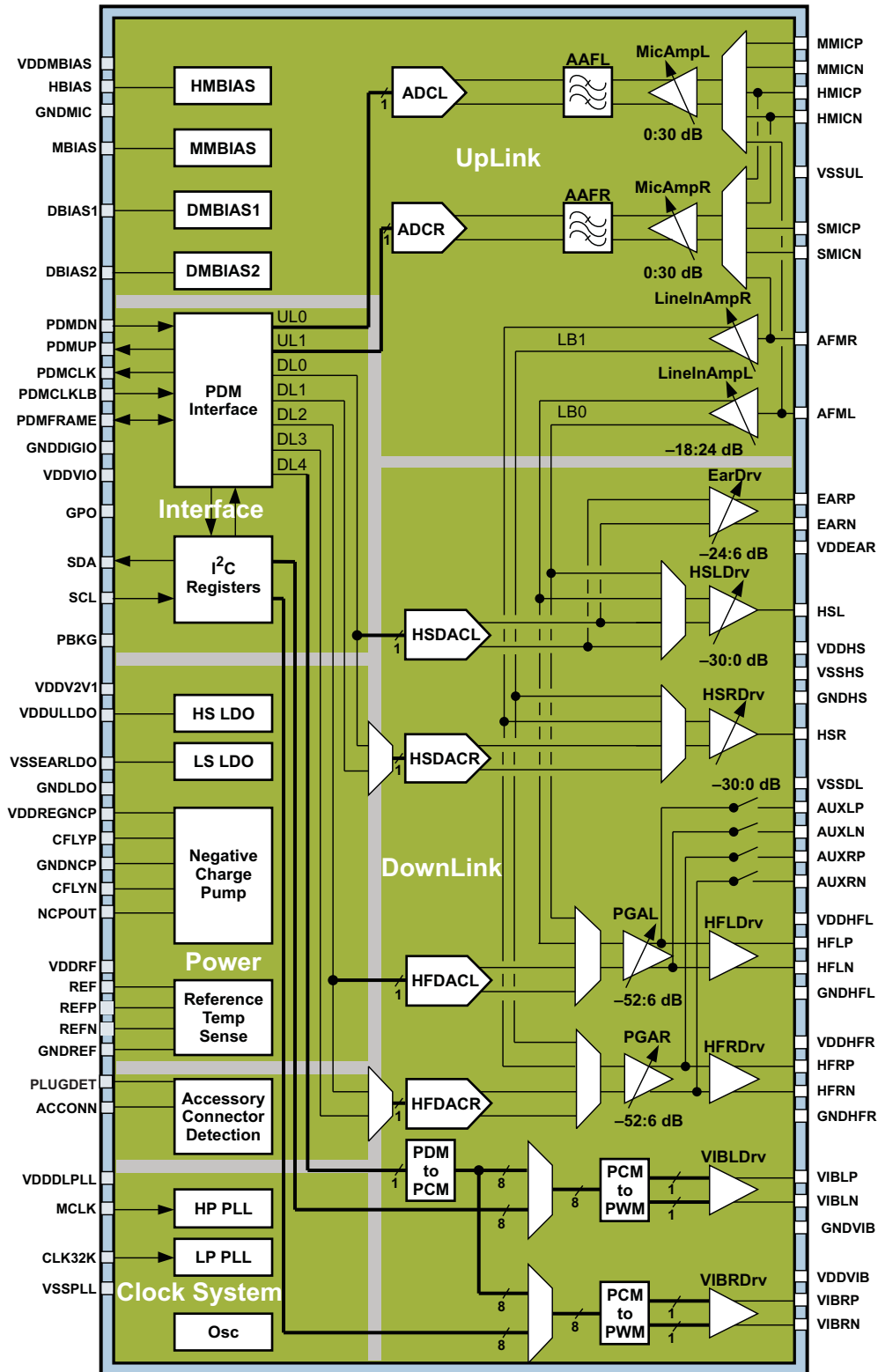
Table 1-1. Device Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TWL6041B	YFF (81)	3.56 mm × 3.56 mm

(1) For more information, see [Section 3, Mechanical Packaging and Orderable Information](#).

1.4 Functional Block Diagram

Figure 1-1 shows a simplified block diagram of the device.



SWCS056-001

Figure 1-1. Simplified Block Diagram

For the complete TWL60xx data sheet (SWCS056), contact your TI sales representative.

2 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision C (June 2012) to Revision D	Page
<ul style="list-style-type: none">• Changed document to standard TI format	<u>1</u>

3 Mechanical Packaging and Orderable Information

3.1 Packaging Information

The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TWL6041BYFFR	ACTIVE	DSBGA	YFF	81	3000	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	-40 to 85	TWL6041B	Samples
TWL6041BYFFT	ACTIVE	DSBGA	YFF	81	250	Green (RoHS & no Sb/Br)	Call TI	Level-1-260C-UNLIM	-40 to 85	TWL6041B	Samples

(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.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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.

TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TWL6041BYFFR	DSBGA	YFF	81	3000	330.0	12.4	3.86	3.86	0.69	8.0	12.0	Q1
TWL6041BYFFT	DSBGA	YFF	81	250	180.0	12.4	3.86	3.86	0.69	8.0	12.0	Q1

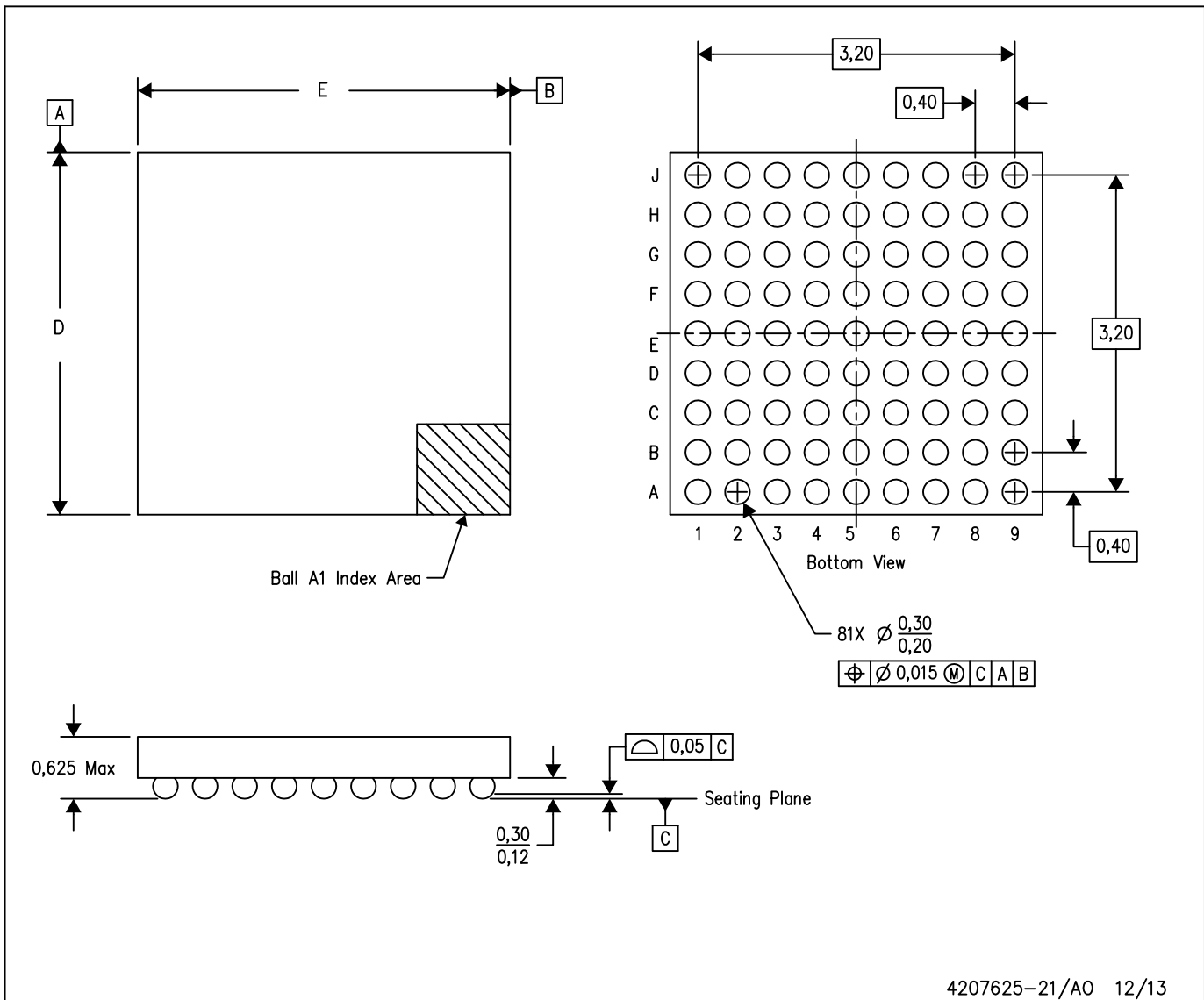
TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TWL6041BYFFR	DSBGA	YFF	81	3000	367.0	367.0	35.0
TWL6041BYFFT	DSBGA	YFF	81	250	210.0	185.0	35.0

YFF (R-XBGA-N81)

DIE-SIZE BALL GRID ARRAY



- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
 - B. This drawing is subject to change without notice.
 - C. NanoFree™ package configuration.

NanoFree 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	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 Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity

Applications

Automotive and Transportation	www.ti.com/automotive
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
Video and Imaging	www.ti.com/video

TI E2E Community

e2e.ti.com