

# USB APPLICATIONS SOLUTIONS GUIDE

Amplifiers, Audio Interfaces, DSPs, Hub Controllers, PC Codecs,  
Peripheral Controllers, Power Switches and Power Management

3Q 2002



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### Safe Harbor Statement

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## USB OVERVIEW

The Universal Serial Bus (USB) standard was established to make connecting PCs, peripherals and consumer electronics flexible and easy. USB allows simplified installation and improved performance for peripheral devices by eliminating the need to repeatedly load new drivers and establish individual settings. USB combines a multitude of existing interfaces into a single easy-to-use connector, greatly reducing system complexity and offering manufacturers the ability to develop highly integrated products.

USB offers three speed nodes of transmission: low speed (LS=1.5 Mbps), full speed (FS=12 Mbps) and high speed (HS=480 Mbps), also referred to as USB 2.0. The USB 2.0 specification, released in early 2000, requires full backward and forward compatibility for devices and cables. All three nodes offer both asynchronous and isochronous (real-time) data transmission over a simple and inexpensive four-wire cable. This meets the requirements of many peripherals, including keyboards, mice, printers, speakers, scanners, external storage devices and digital still cameras.

Defined by a simple three-layer structure, a USB implementation consists of hardware and software that controls the data transmission requirements of peripherals. A typical hardware scheme includes a USB host controller, a USB hub device and a peripheral controller device. The host controller resides in the PC and is the central control element, or the "brains," of the USB system. A hub provides additional USB connectivity. A peripheral controller translates the USB protocol to send and receive digital data for the peripheral device.

Nearly every PC sold today includes at least two USB ports. However, hub devices are important to offer additional ports of connection for an ever-increasing number of peripherals. A single host controller can handle up to 127 devices, allowing for virtually unlimited plug and play functionality.

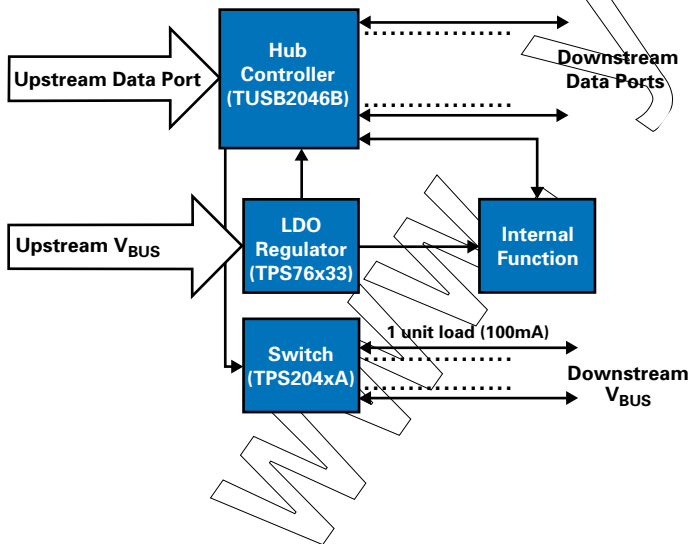
## USB HUB FUNCTIONALITY

The hub manages USB port connect/disconnect activities. These include hub configuration, detection of downstream port devices being connected/disconnected, whether the port is in suspend or resume mode and management of the various states of a port (power-off mode, disconnected, enabled, disabled or suspended). Other basic hub functions include bus fault and reconfiguration, power management and full-speed/low-speed support. In general, an onboard hub can be used to provide this functionality; however, power management is more complex and requires additional circuitry.

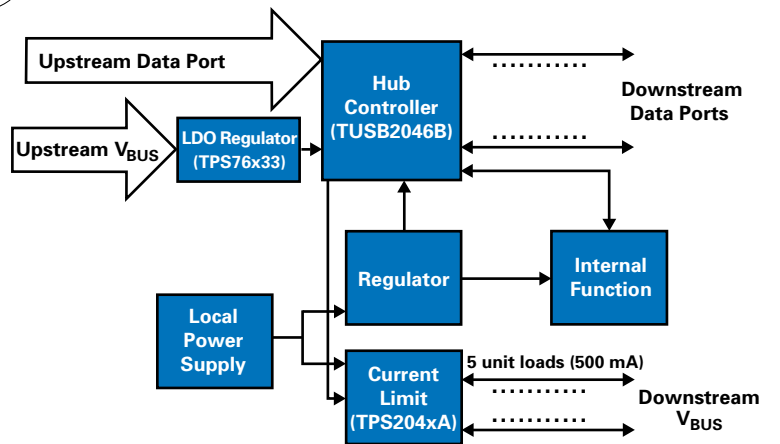
A hub can be self-powered, bus-powered (Figure 1) or a combination of both (Figure 2). A self-powered hub uses a local power supply to power the downstream ports and any local functions. However, the USB interface of the self-powered hub is allowed to draw 100 mA from its upstream port. This source of power can be used to maintain functionality of the USB interface while the remainder of the hub is powered down. The hub controller and any regulators associated with it are two examples of circuitry that can be powered from the upstream port. Self-powered hubs are required to limit and report over-current conditions, and must supply at least 500 mA to each downstream port.

Bus-powered hubs obtain all power from an upstream connection and are required to supply 100 mA to each downstream port. For configuration purposes, the USB specification limits the bus-powered hub current draw from the bus to 100 mA or less on power-up. Once configuration is complete and the system determines the hub controller is connected to a high-powered port, the bus-powered hub is allowed to consume 500 mA. The 500 mA is divided to supply 100 mA to each downstream port, with the remainder used by the hub itself. Because self-powered hubs may experience loss of local power either through disconnecting the power source or depleting the battery, the hub controller can force a re-enumeration of itself as a bus-powered hub. This requires the hub to implement port power switching on all external ports. At this point, the hub must adhere to all the rules of a bus-powered hub, including drawing less than 100 mA from the upstream bus during reset and enumeration.

Bus-Powered Hub (Figure 1)



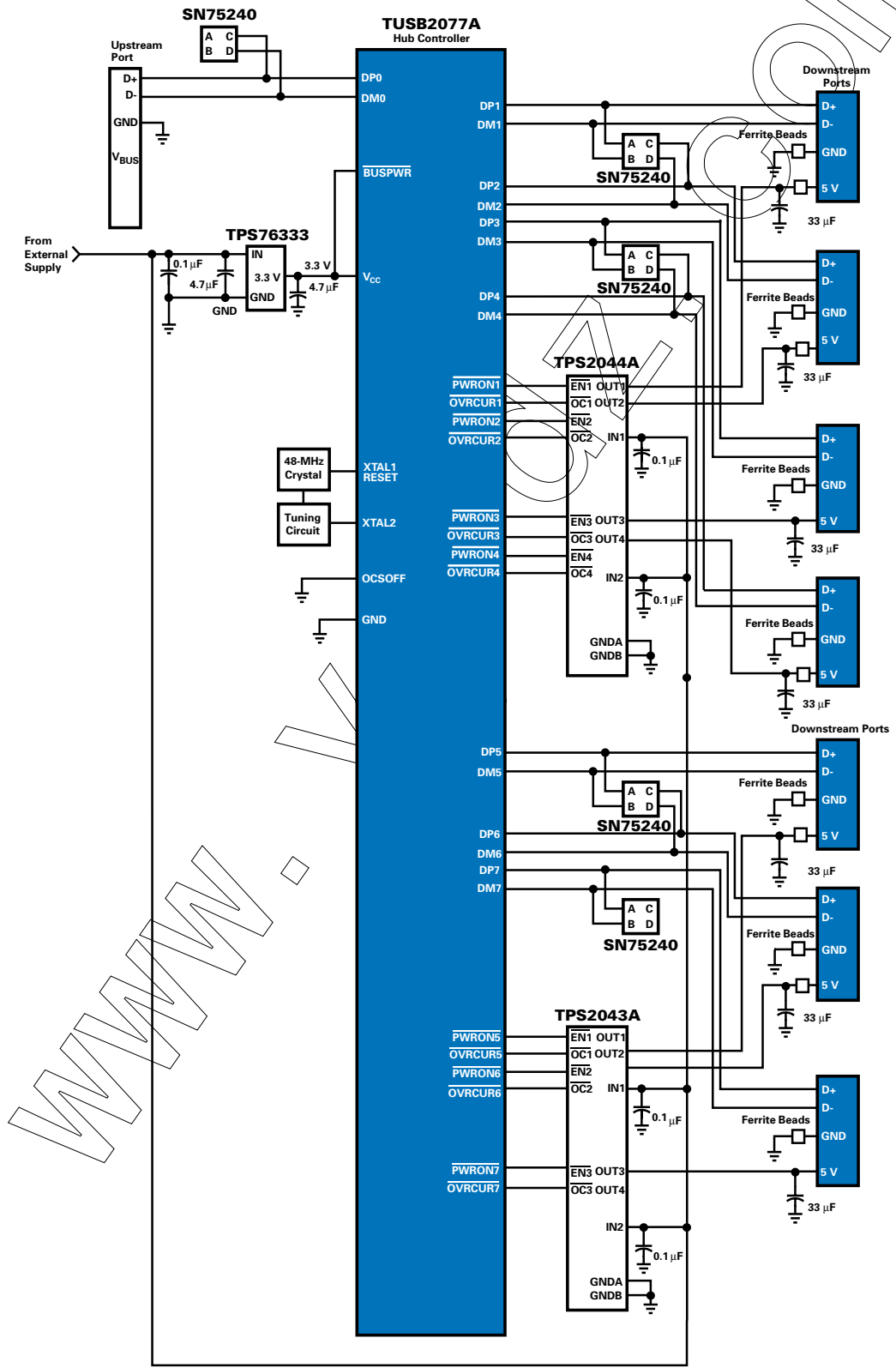
Bus and Self-Powered Hub (Figure 2)



## 7-PORT SELF-POWERED HUB REFERENCE DESIGN

The diagram below demonstrates how a 7-port self-powered hub can be designed entirely with products available from Texas Instruments. Shown are the TUSB2077A hub controller (details on page 8), TPS2044A quad current-limiting power switch and TPS2043A triple current-limiting power switch (pg. 9), TPS76333 3.3-V low dropout regulator (LDO) (pg. 10) and SN75240 transient suppressors (pg. 11). The TPS202x/3x (pg. 10) can be used in place of the TPS2044A and TPS2043A in ganged port configurations.

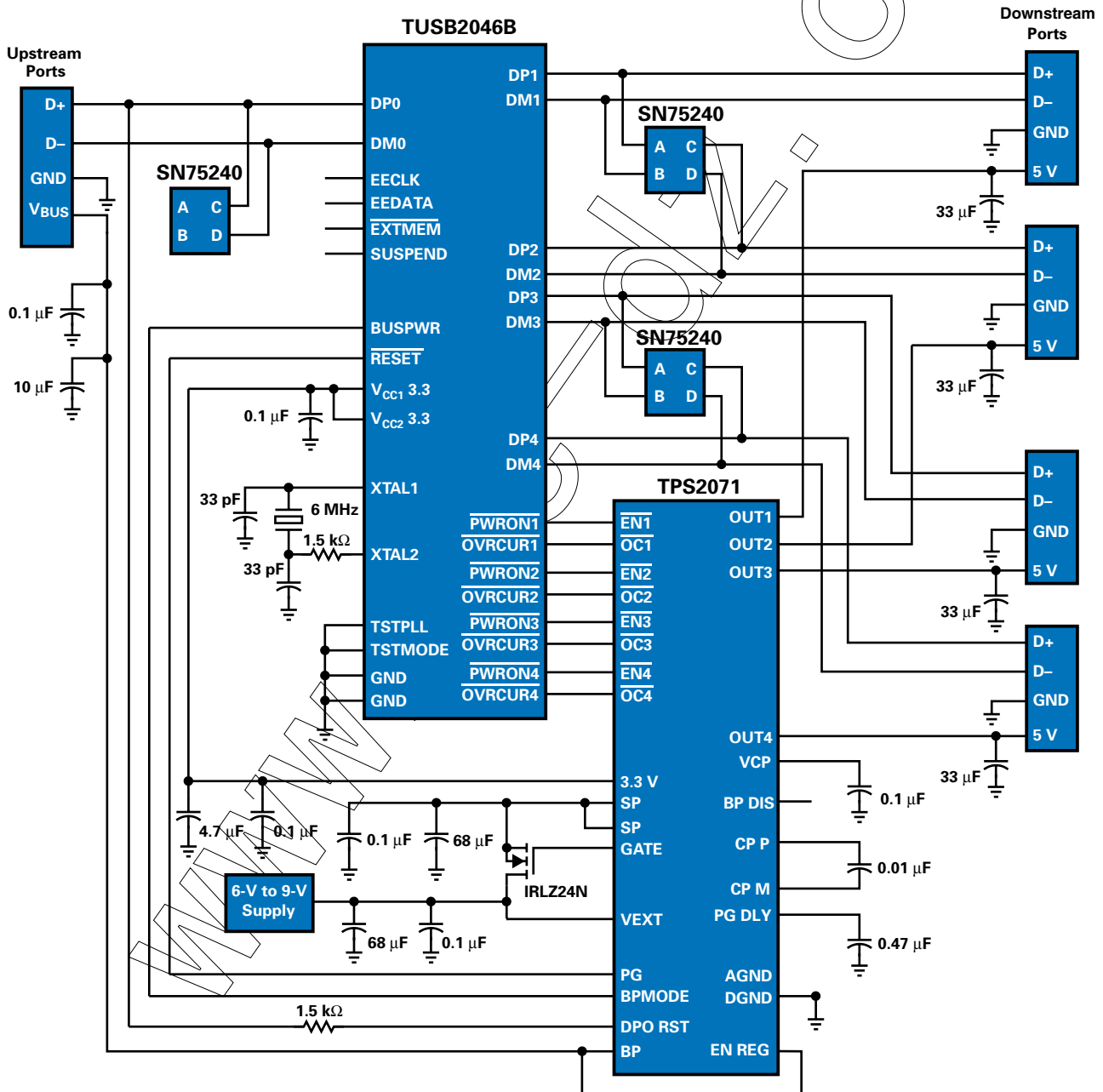
7-PORT SELF-POWERED HUB BLOCK DIAGRAM



## 4-PORT HYBRID HUB REFERENCE DESIGN

The diagram below demonstrates how a 4-port hybrid hub can be designed totally using silicon available from Texas Instruments. Shown are the TUSB2046B hub controller (details on page 8), TPS2071 4-port USB hub power manager (pg. 12) and SN75240 transient suppressors (pg. 11). The TPS2071 meets the need for more advanced integration by reducing the hybrid hub's component count by six and materials cost by dollars. The first of its kind, the TPS2071 provides the complete power solution for self-powered, bus-powered or hybrid USB hubs by incorporating four major functions into a single package: current-limiting switches for four ports, a 3.3-V LDO for local functions, a 5-V LDO controller for a 6-V to 9-V self-power supply and a DPO line control to signal an attach to the host (a USB requirement). A 4-port hub evaluation module/reference design (TPS2071EVM-159), complete with Gerber files, is available to simplify implementation.

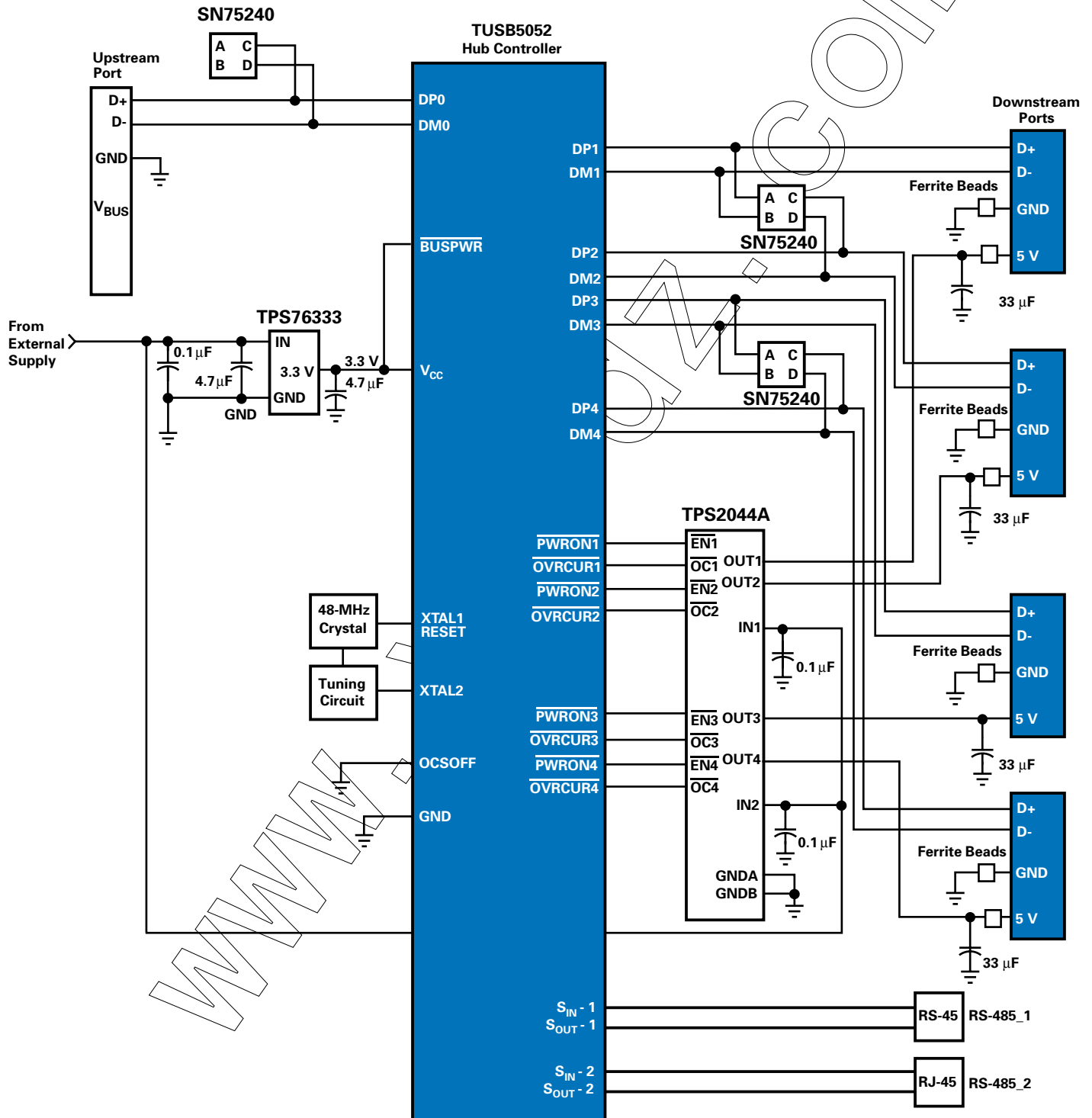
### 4-PORT HYBRID HUB BLOCK DIAGRAM



## EMBEDDED HUB REFERENCE DESIGN

The diagram below demonstrates how a complete hub can be designed totally using silicon available from Texas Instruments. Shown are the TUSB5052 hub controller (details on page 8), TPS2044A quad current-limiting power switch (pg. 9), TPS76333 3.3-V low dropout regulator (pg. 10), and SN75240 transient suppressors (pg. 11). The TPS202x/3x (pg. 10) can be used in place of the TPS2044A in ganged port configurations.

TUSB5052 EMBEDDED HUB BLOCK DIAGRAM





## INDUSTRY-LEADING USB 1.1 HUB CONTROLLER

TUSB2036, TUSB2046B, TUSB2077A

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TUSB2036, TUSB2046B or TUSB2077A

TI offers a variety of USB hub ICs for various applications that are fully compliant to the USB 1.1 specification and are on the USB-IF integrator's list.

### Key Features

- Self- and bus-powered support
- USB suspend/resume operation support
- Custom VID and PID with external serial E<sup>2</sup>PROM
- ESD filtering for babble, overcurrent, Reset, bus-powered inputs
- TUSB2036: Pin-selectable configuration for 2 or 3 ports
- TUSB2046B: 4-port hub
- TUSB2077A: 7-port hub, self-powered for 7 ports and bus-powered for 4 ports

### Applications

- Standalone hub boxes
- Motherboard
- Monitor
- Embedded in peripheral (printer, scanners)
- Set-top box
- Game box

## INTEGRATED DEVICE HAS LEGACY AND USB 1.1 HUB FUNCTIONALITY

TUSB5052, TUSB5152

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TUSB5052 or TUSB5152

The TUSB5x52 product family offers five USB 1.1 ports and two enhanced UARTs. In addition, the TUSB5152 offers parallel port (IEEE 1284) functionality.

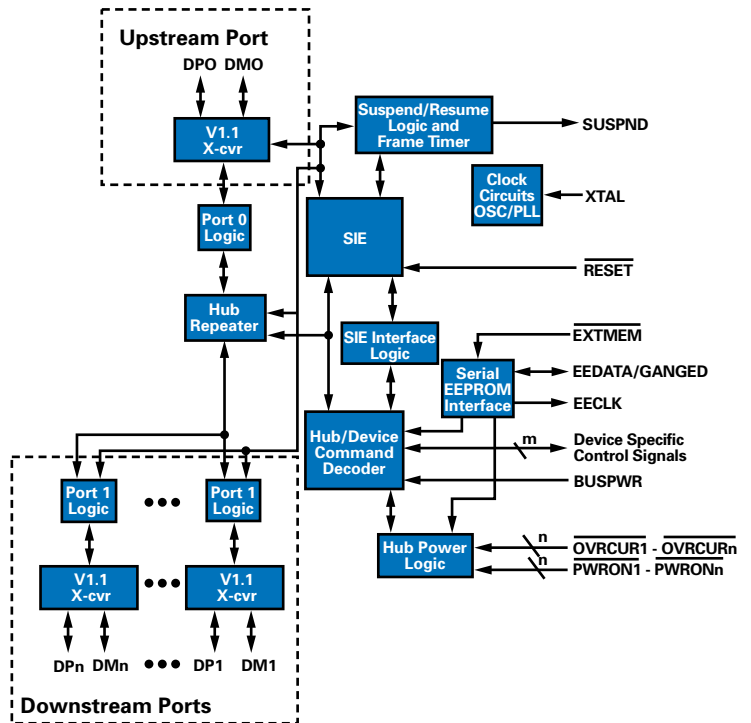
### Key Features

- Embedded 8052 microcontroller
- Five downstream USB ports, and 0 to 5 can be configured as available
- Four of the downstream USB ports can be configured as removable
- Two enhanced UARTs
- One parallel (IEEE 1284) port (TUSB5152 only)
- Built-in, five-channel DMA controller
- Integrated solution results in less cost and reduced board space
- Both devices are available in a 100-pin PZ package

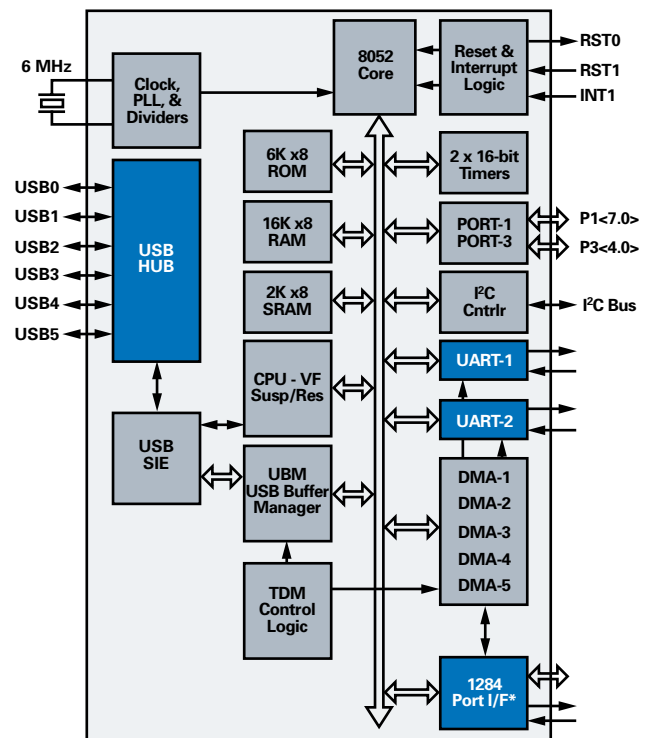
### Applications

- Docking stations
- Hubs with legacy support
- Industrial controllers
- Test equipment

TUSB20xx Block Diagram



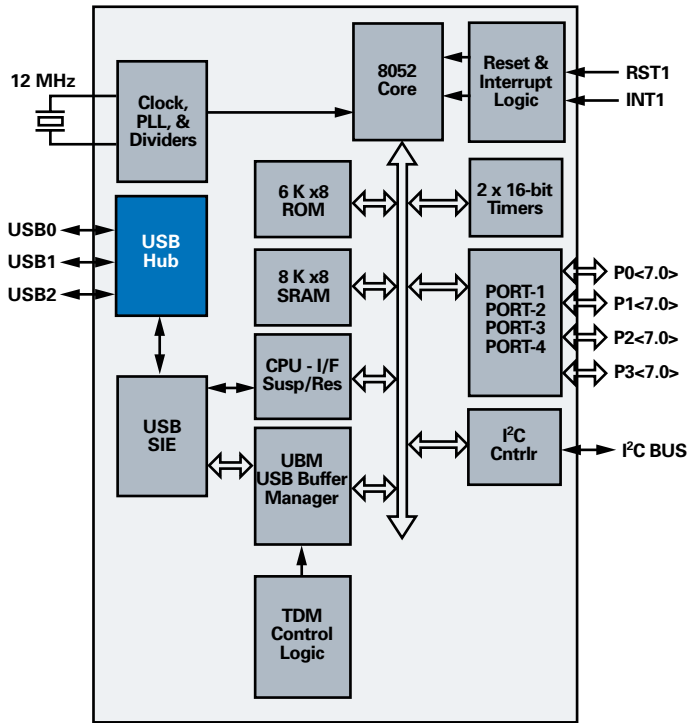
TUSB5052/TUSB5152 Block Diagram



\*TUSB5152 only



TUSB2136 Block Diagram



## INTEGRATED DEVICE OFFERS PERIPHERAL CONTROLLER AND USB HUB

### TUSB2136

Get samples, datasheets, app reports and EVMs at: [www.ti.com/sc/device/TUSB2136](http://www.ti.com/sc/device/TUSB2136)

TI provides a solution to peripheral makers with the TUSB2136's combination of a peripheral controller with a 2-port USB hub.





#### Key Features

- Embedded 8052 microcontroller
- Integrated, configurable 0- to 2-port hub with power management per port
- Supports USB suspend/resume and remote wakeup operations
- Supports a total of 4 input and 4 output endpoints
- Firmware loaded from host PC or via I²C port
- Integrated solution results in less cost and reduced board space
- Customized ROM codes to support special functions
- Packaging: 64-pin TQFP package

#### Applications

- USB keyboards with embedded hub
- Smart Media™/Flash card reader interface
- Peripheral with embedded USB hub

TPS204xA/5xA Portfolio

Configuration	Description	Device
	500-mA switch, -EN	TPS2041A
	500-mA switch, +EN	TPS2051A
	250-mA switch, -EN	TPS2045A
	250-mA switch, +EN	TPS2055A
	500-mA switches, -EN	TPS2042A
	500-mA switches, +EN	TPS2052A
	250-mA switches, -EN	TPS2046A
	250-mA switches, +EN	TPS2056A
	500-mA switches, -EN	TPS2043A
	500-mA switches, +EN	TPS2053A
	250-mA switches, -EN	TPS2047A
	250-mA switches, +EN	TPS2057A
	500-mA switches, -EN	TPS2044A
	500-mA switches, +EN	TPS2054A
	250-mA switches, -EN	TPS2048A
	250-mA switches, +EN	TPS2058A

## USB CURRENT-LIMITING 80-mΩ POWER SWITCHES

### TPS204xA, TPS205xA

Get samples, datasheets, app reports and EVMs at: [www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TPS2041A or TPS2045A

The TPS204xA/TPS205xA are designed to meet all the USB 1.0 and 2.0 requirements for current-limiting and/or power switching to control the power on the voltage bus and includes features to improve the design reliability. For example, when an over-current condition exists, the device intelligently shuts down only the ports that see the fault.

#### Key Features

- Drop-in replacements for TPS204x/5x
- Integrated over-current transient filter (external on TPS204x/5x)
- Independent enable (logic-level) per channel
- Short-circuit protection and over-current logic output
- Operating range: 2.7 V to 5.5 V
- Controlled switch rise time reduces current surges and electromagnetic interference (EMI) concerns
- No drain-to-source back-gate diode, eliminating potential current flow back across device to inputs
- Human-body-model (2 kV) ESD protection
- Single/dual in SOIC-8 package; triple/quad in SOIC-16

#### Applications

- USB hubs, notebooks, desktop PCs and set-top boxes

## USB CURRENT-LIMITING 33-mΩ POWER SWITCHES FOR GANGING MULTIPLE PORTS

TPS202x, TPS203x

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TPS2020 or TPS2030

The TPS202x/3x low on-resistance, current-limiting power distribution switches allow the ganging of multiple ports to a single switch, as described in application note SLVA049. Though a ganged configuration can be cost-effective, all ports will be shut down if one port sees a fault.

### Key Features

- USB 1.1- and 2.0-compliant
- Short-circuit protection with an over-current logic output
- Operating range: 2.7 V to 5.5 V
- Logic-level enable input
- Controlled switch rise time reduces current surges and electromagnetic interference (EMI) concerns
- No drain-to-source back-gate diode
- Human-body-model (2 kV) ESD protection
- Packaging: SOIC-8 package

### Applications

- USB hubs, notebooks, desktop PCs, and set-top boxes

## LOW-POWER 150-mA LOW DROPOUT REGULATORS (LDO)

TPS76333

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/TPS76333](http://www.ti.com/sc/device/TPS76333)

The TPS76333 LDO offers the benefits of low dropout voltage, low-power operation and miniaturized packaging. Offered in a 5-terminal, small-outline, integrated-circuit SOT-23 package, the TPS76333 is ideal for cost-sensitive designs and where board space is at a premium.

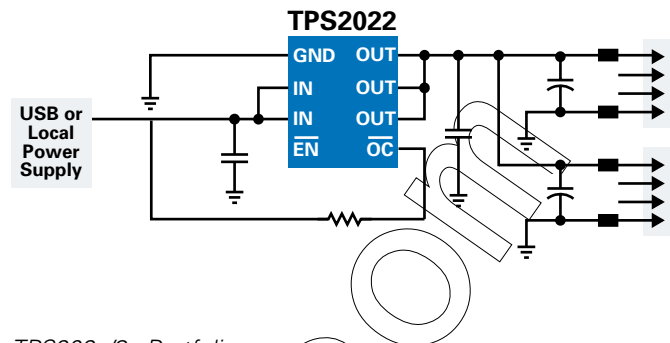
### Key Features

- 150-mA LDO
- 3.3 output voltage; other outputs in TPS763xx series include 5 V, 3.8 V, 3.3 V, 3.0 V, 2.8 V, 2.7 V, 2.5 V, 1.8 V, 1.6 V and variable
- Dropout voltage, typically 300 mV at 150 mA
- Thermal protection
- Over-current limitation
- Less than 2-μA quiescent current in shutdown mode
- -40°C to 125°C operating junction temperature range
- Packaging: 5-pin SOT-23 (DBV)

### Application

- USB hubs

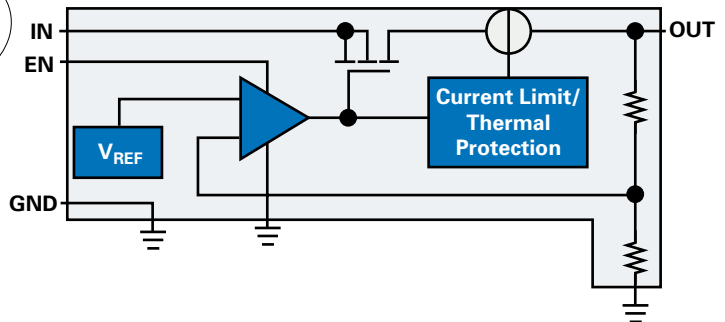
TPS202x Application Diagram



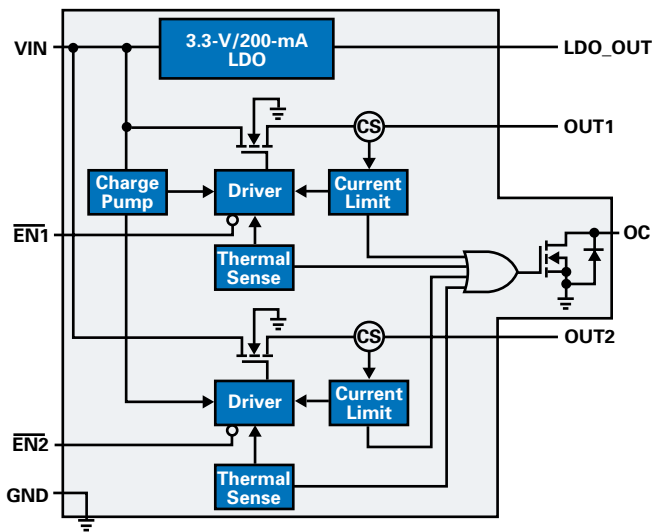
TPS202x/3x Portfolio

Active Low Enable	Active High Enable	Continuous Current (A)	Current Limit (A) (min)
TPS2020	TPS2030	0.2	0.22
TPS2021	TPS2031	0.6	0.66
TPS2022	TPS2032	1.0	1.1
TPS2023	TPS2033	1.5	1.65
TPS2024	TPS2034	2.0	2.2

TPS76333 Block Diagram



TPS2149 Block Diagram



### 3.3-V LDO AND DUAL SWITCH FOR USB HUBS WITH LOW-POWER PORTS

TPS2149

Get samples, datasheets, app reports and EVMs at: [www.ti.com/sc/device/TPS2149](http://www.ti.com/sc/device/TPS2149)

The TPS2149 integrates two power distribution switches and an LDO in an MSOP-8 package, providing a complete power management solution for bus-powered USB hubs with low-power ports, which saves up to 60% in board space over typical two-chip implementations.

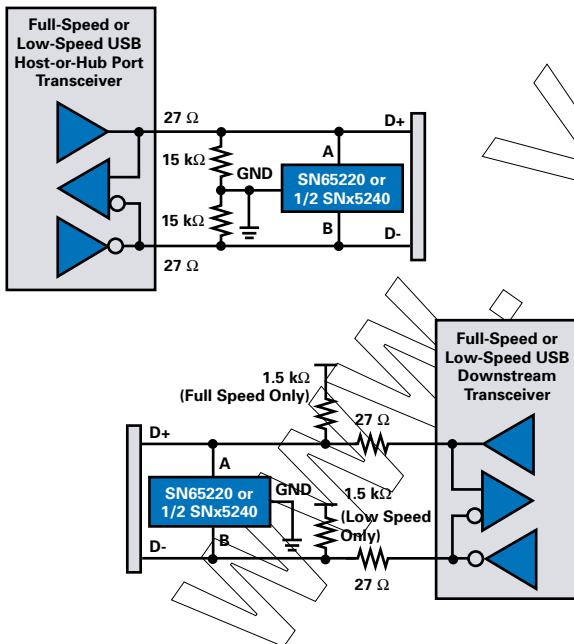
#### Key Features

- Complete power management solution for bus-powered USB hubs with low-power ports
- 3.3-V, 200-mA low-dropout voltage regulator with inrush control
- Two 5-V 340-mΩ (typ) high-side MOSFETs
- Independent thermal- and short-circuit protection for LDO and each switch
- 2.9-V to 5.5-V operating range
- CMOS- and TTL-compatible enable inputs
- 75-μA (typ) supply current
- -40°C to 85°C ambient temperature range

#### Applications

- Keyboard hubs and set-top-boxes

SN65220 and SNx5240 Application Diagrams



### PROTECT ASICS AGAINST NOISE TRANSIENTS ON USB PORTS

SN65220, SN65240, SN75240

Get samples, datasheets and app reports at: [www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with SN65220, SN65240 or SN75240

The SN65220, SN65240 and SN75240 single and dual transient voltage suppressors can significantly increase the ESD protection level and thus reduce the risk of damage to the ASIC circuits behind USB ports due to noise transients.

#### Key Features

- Protects submicron 3-V or 5-V silicon from noise transients
- Applicable to two high- or low-speed USB host, hub or peripheral ports
- Port ESD protection capability exceeds:
  - 15-kV human body model
  - 2-kV machine model
- Low current leakage: 1 μA max
- Stand-off voltage: 6.0 V min
- Low capacitance: 35 pF (typ)

#### Applications

- PDAs
- Smartphones
- MP3 players

## COMPLETE POWER MANAGERS FOR 4-PORT HUBS

### TPS207x

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TPS2070 or TPS2074

The TPS207x provides the complete power solution for 4-port, self-powered, bus-powered, or hybrid USB hubs by incorporating four major functions on one IC: current-limiting switches for four ports, a 3.3-V low dropout regulator (LDO) for local functions, a 5-V LDO controller for self power (TPS2070, TPS2071), and a DP0 line control to signal an attach to the host (a USB requirement). This level of single-chip integration offers a fast, proven solution while significantly reducing the bill of materials cost.

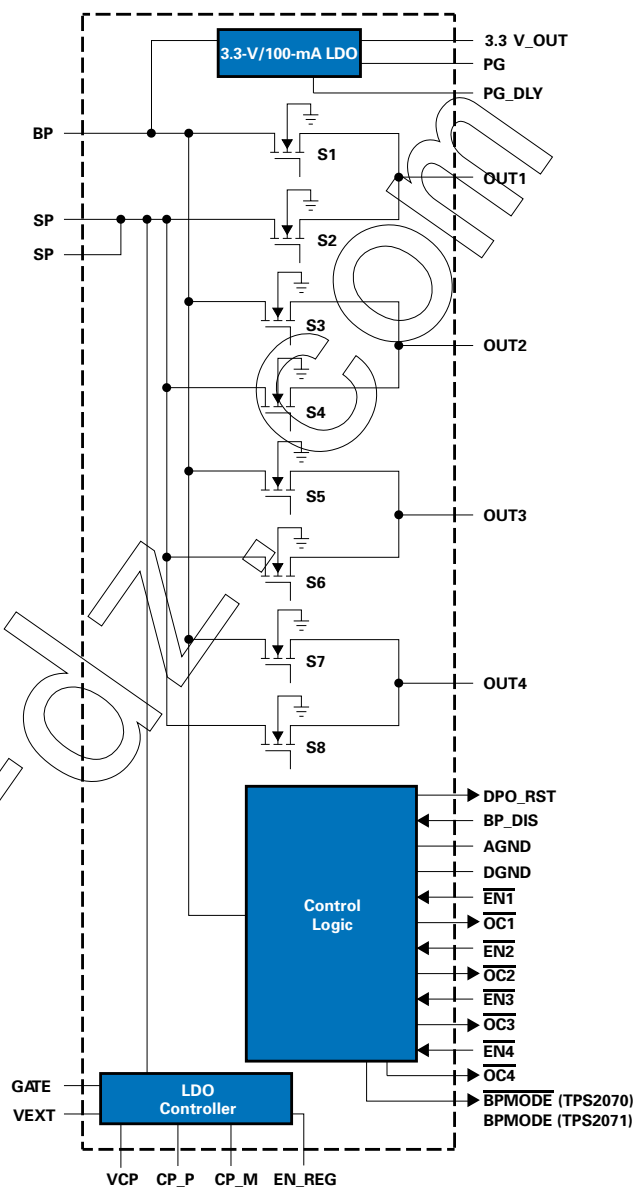
#### Key Features

- USB 1.1- and 2.0-compliant
- Low  $r_{DS(on)}$  protection switches for four ports
- Dual current limits: 120 mA in bus-powered mode; 600 mA in self-powered mode
- 3.3-V, 100-mA LDO for device controller and local functions
- 5-V, 3-A LDO controller for a 6-V to 9-V self-power supply (TPS2070/1)
- Operating range: 4.5 V to 5.5 V
- Auto-switching between bus/self power

#### Applications

- USB hub in monitor, hub boxes, and desktop PCs

TPS2070/1 Block Diagram



TPS207x Portfolio

Device	5-V LDO Controller	Bus-Power Mode Indicator	Pins	Package
TPS2070	Yes	Active low	32	HTSSOP
TPS2071	Yes	Active high	32	HTSSOP
TPS2074	No	Active low	24	SSOP
TPS2075	No	Active high	24	SSOP

**TO KNOW MORE ►**

For detailed information about peripherals featured in this issue:

TPA610XA2 low-voltage amp	15
TAS1020 USB audio interface	15
PCM2900 stereo audio codec	16
TPS78833 and TPS78825 LDO	16
Digital still and PC cameras	17
TMS320DSC25 still image capture	18
TPS2148 LDO and dual switch	18
TPS208x switch ICs	19
TPS21xx power mux ICs	19

**USB PERIPHERAL FUNCTIONALITY**

A USB peripheral controller enables USB connectivity of a peripheral device to either a host or hub. Examples of USB peripheral devices include headsets, printers and keyboards. Unlike a hub or host, the USB peripheral does not support downstream functions. It does, however, have an upstream facing port that must meet the requirements identified in the USB specification (see Universal Serial Bus Specification Revisions 1.1 and 2.0 and also USB Implementers Forum Web page: [www.usb.org](http://www.usb.org)).

A USB peripheral can be classified as either a low-power bus-powered function, a high-power bus-powered function or a self-powered function. A low-power bus-powered function obtains all power from the upstream bus and is limited to 100 mA maximum. A high-power bus-powered function also obtains all power from the upstream bus and is limited to 100 mA maximum, but only on power-up during configuration. Once configuration is complete, a high-power bus-powered function may draw up to 500 mA of current from the upstream bus. A self-powered function obtains power from a source other than the upstream bus. It is allowed to draw up to 100 mA from the upstream bus, but it is not required to do so.

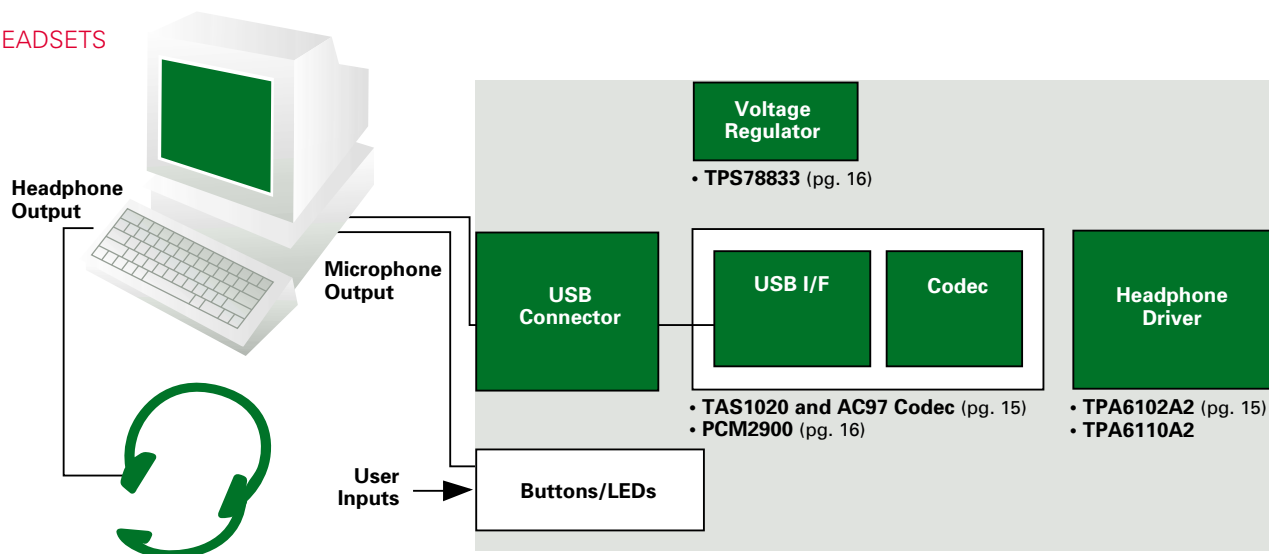
The USB specification also requires peripherals obtaining power from the upstream facing port to support a mode known as "suspend." A device must transition into suspend mode if it is in a constant idle state for more than 3.0 milliseconds. During suspend, any device operating in a low-power mode must limit its current consumption to 500  $\mu$ A maximum. If a device is configured for high-power and a remote wake-up feature is enabled, its maximum current consumption during suspend is limited to 2.5 mA.

Regardless of the classification of the USB peripheral, the upstream facing port must meet the inrush current requirements of the USB specification. The amount of inrush current on any function is defined by the amount of input capacitance. For this reason, the USB specification limits the amount of input capacitance seen at the upstream facing port to 10  $\mu$ F maximum across  $V_{BUS}$  and Ground. If the device requires more bypass capacitance, then some form of surge current limiting must be implemented.

**USB Peripheral Solutions From Texas Instruments**

TI is a total solution provider for USB. Devices available for USB peripherals include USB peripheral controllers for managing communications, LDOs for regulating the USB bus voltage of 5 V down to levels employed by digital functions, transient suppressors and power managers such as the TPS214x. Devices in the TPS214x family integrate an LDO with one or more power switches to help meet the USB requirements. On a high-power bus-powered function, a power switch may be needed to isolate circuitry during configuration, while the LDO provides the 3.3 V needed by the peripheral controller. For peripherals requiring a large input capacitor, the TPS214x family of parts can be used to isolate this capacitor during power up. The TPS214x family is available in various switch configurations to allow the designer to meet the USB peripheral requirements.

## USB HEADSETS



USB headset architectures can vary depending on the target application; however, in general, most will have the same basic design blocks. The most basic feature of any headset is to transmit and receive audio data from a PC. Many headsets also include features such as buttons and LEDs. TI offers several solutions to help meet the needs of a wide range of USB headsets from basic to full featured.

## USB HEADSET PRODUCTS

TI provides a complete and compelling solution that addresses the entire signal chain in a USB headset.

TI provides several options for USB headset designers from a highly integrated option with a great price to the most flexible solution available on the market. The PCM2900 (page 16) offers a high degree of integration and requires no programming, which enables quick designs, while the TAS1020 (page 15) offers the world's best versatility for USB headsets. The TAS1020 is specially designed for audio applications and has many features that are unique in the industry. One such feature is a configurable Codec port that allows almost any audio Codec to be used in the system. This enables the USB headset to have the perfect price-to-performance ratio. The TAS1020 also is completely programmable, which allows for a tailored solution that can be upgraded in the field. Whether you are looking to do a design with the lowest cost or the highest performance, TI has the right USB headset solution for you.

### Power Supply Voltage Regulator

TI has developed a special voltage regulator targeted for USB bus-powered applications, the TPS78833 (page 16). This voltage regulator not only provides up to 150 mA of regulated 3.3-V power, but also controls USB inrush current. This feature eliminates the need for external circuitry to control inrush and reduces cost, board space and design complexity.

### USB Firmware & Host Software Drivers

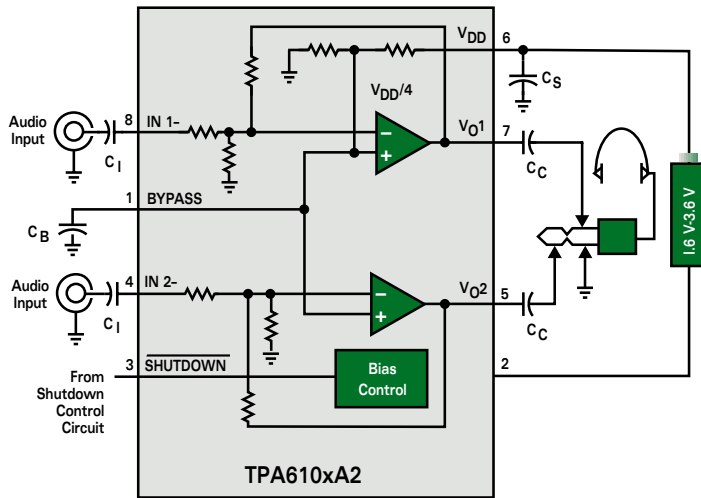
In addition to providing a complete silicon solution, TI also provides a comprehensive solution for software needs. TI solutions are completely programmable to meet almost any application requirements. Example application firmware is provided under a no-cost software license agreement, which provides a jumpstart on product development. The USB headset reference design does not require any special host drivers to operate and demonstrates a wide range of features without custom drivers.

### Driving the Headphones

TI has an extensive headphone driver portfolio, which is sure to meet any needs. For a USB headset, designers should choose a driver that supports a low-power shutdown state to allow for USB bus-powered applications. The TPA6102A2 (page 15) is a perfect fit with up to 50 mW of driving power and excellent audio performance.

USB headset architectures can vary depending on the target application; however, in general, most will have the same basic design blocks. The audio signals to and from the PC need to be transmitted by a device with a USB interface. This device performs many tasks beyond just buffering and reformatting the data. It is also the system controller and interfaces to LEDs and buttons as well as controlling the power sequencing for the entire board. The playback audio data also needs to be synchronized.

TPA610xA2 Block Diagram



## LOW-VOLTAGE HEADPHONE AMPLIFIER

### TPA610xA2

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TPA6100A2, TPA6101A2 or TPA6102A2

The TPA610xA2 family of stereo audio power amplifiers operates from a 1.6-V to 3.6-V supply and delivers 50 mW of continuous RMS power per channel into 16-Ω loads.

The new TPA6101A2 and TPA6102A2 devices save board space by internally setting the amplifier gain, which eliminates six external resistors. The TPA6100A2 gain is set externally for designs that require maximum flexibility.

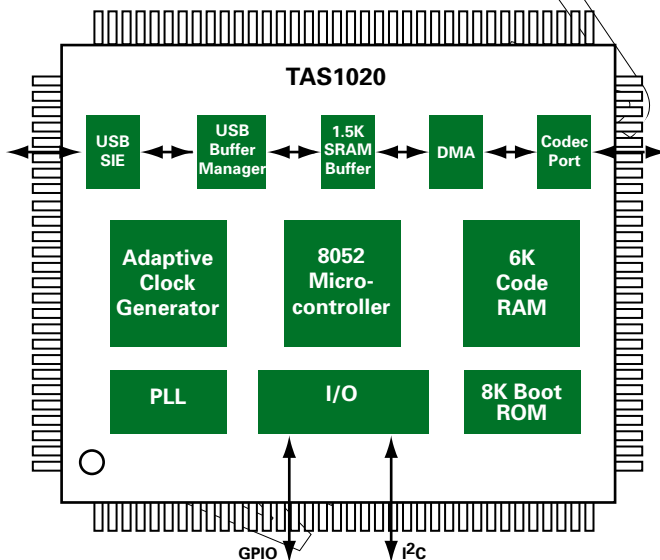
#### Key Features

- 50-mW stereo output drive
- 1.6-V to 3.6-V operating supply voltage
- 0.75-mA low supply current
- 50-nA low shutdown current
- Internal gain setting
- Internal mid-rail generation

#### Applications

- USB headsets
- Internet-ready:
  - Wireless phones
  - PDAs
  - Internet appliances

TAS1020 Block Diagram



## PROGRAMMABLE USB AUDIO INTERFACE

### TAS1020

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/TAS1020A](http://www.ti.com/sc/device/TAS1020A)

The TAS1020 IC is a USB peripheral interface device designed specifically for applications that require isochronous data streaming.

#### Key Features

- Complements the TUSB3200 and provides a low-cost alternative for full-duplex stereo solutions
- On-chip clock generation and adaptive clock generator (ACG)
- Customizable audio performance level; supports most standard AC97 or I<sup>2</sup>S Codecs
- General-purpose mode allows interfacing with devices like TI's TMS320C54x™ DSP generation
- Integrated DMA controller moves isochronous audio data from the PC to the Codec without intervention, eliminating the need to code tight assembly routines with critical timing
- Field upgrades enabled via USB DFU class
- USB headset reference design available

#### Applications

- USB headsets
- USB headphones
- USB speakers

## SINGLE-CHIP, STEREO AUDIO CODEC

### PCM2900

Get samples, datasheets and app reports at:

[www.ti.com/sc/device/PCM2900](http://www.ti.com/sc/device/PCM2900)

The PCM2900 is a single-chip stereo audio codec with an integrated USB 1.1-compliant interface controller. The PCM2900 employs the same SpAct™ technology used in the popular PCM2702 device for outstanding audio quality.

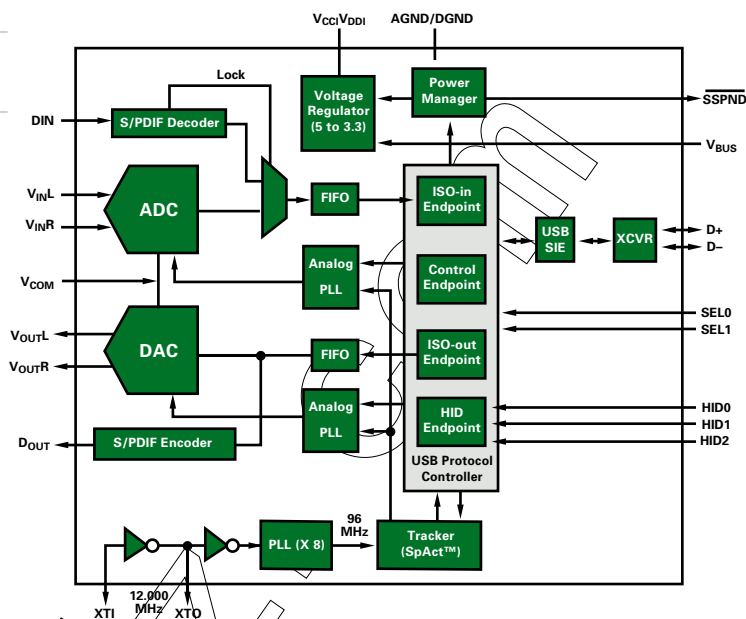
#### Key Features

- Supports a wide range of sampling frequencies from 8 kHz up to 48 kHz for both playback and record; this allows the host to select any frequency without requiring sample rate conversion
- Integrated clock generator requires only a single external 12-MHz crystal to generate all necessary clocks
- Requires no programming, which shortens new product development cycles
- Supports HID volume and mute controls through dedicated input pins
- Packaging: 28-pin SSOP

#### Applications

- USB headsets
- USB speakers
- USB audio interface box

PCM2900 Block Diagram



## 150-mA LOW-NOISE LDO WITH IN-RUSH CURRENT CONTROL FOR USB APPLICATIONS

### TPS78833, TPS78825

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TPS78833 or TPS78825

The TPS78825 and TPS78833 are very small (SOT-23) package, low-noise LDOs that regulate the output voltage to 2.5 V and 3.3 V, with input voltage ranging from 2.7 V to an absolute maximum of 13.5 V. The devices use the SR pin to program the output voltage slew rate to control the in-rush current. This is specifically used in USB applications where a large load capacitance is present at start-up.

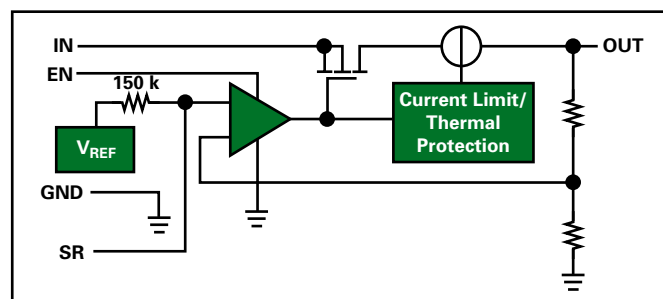
#### Key Features

- Available in 2.5 V (TPS78825) and 3.3 V (TPS78833)
- Programmable slew rate control
- Output noise typically 56  $\mu$ V<sub>RMS</sub>
- Only 17- $\mu$ A quiescent current at 150 mA
- 1- $\mu$ A quiescent current in standby mode
- Dropout voltage typically 150 mV at 150 mA (TPS78833)
- Over-current limitation
- -40°C to 125°C operating junction temperature range
- Packaging: 5-pin SOT-23 (DBV) package

#### Application

- USB peripherals such as headsets

TPS78833 Block Diagram

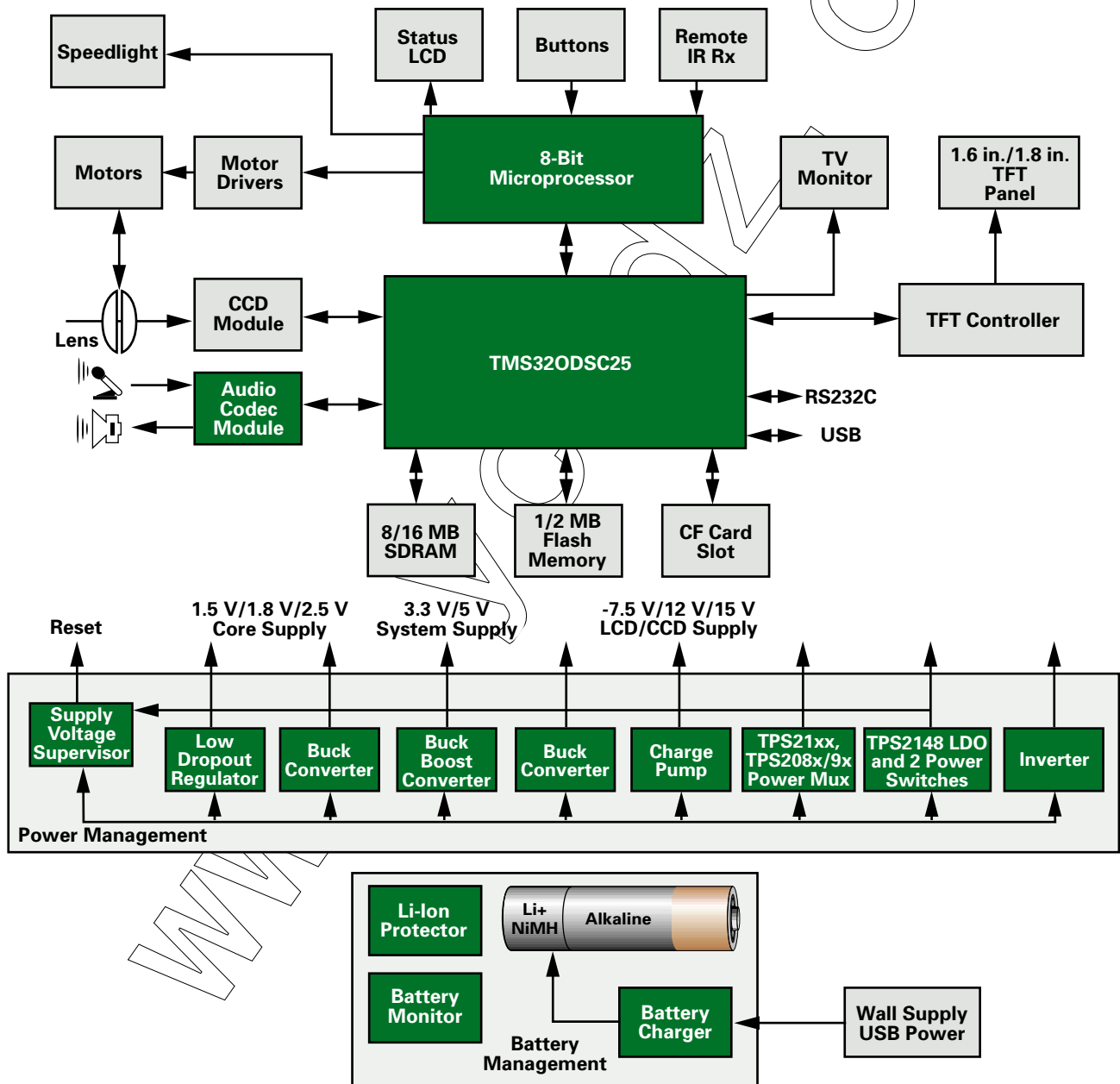




## DIGITAL STILL AND PC CAMERAS

TI has a comprehensive power management portfolio including supervisors, LDOS, buck converters, boost converters, charge pumps, battery protectors/monitors/chargers, devices that combine an LDO with power switches, and power muxes that allow a peripheral to select between different power sources. TPS2148 (page 18) integrates a 3.3-V LDO to provide power to functions with two power switches. The switches can be used for power segmentation to allow the camera to meet the USB current requirements during standby (500  $\mu$ A), start-up (100 mA) and operation (500 mA). TPS21xx (pg. 19) and TPS208x/9x (pg. 19) are devices that allow the peripheral to select between using a battery when mobile or USB-bus power when connected to a PC during picture downloading, to save battery life. The TMS320DSC25 (pg. 18) DSP-based processor is a system-on-a-chip integrating USB function, an ARM7™ processor, TI's TMS320C54X™ DSP core, a real-time preview engine, video encoder and a host of imaging peripherals to provide 500 MIPS of processing power for portable video and imaging applications.

TYPICAL DIGITAL CAMERA BLOCK DIAGRAM



## MPEG-4 I+P ≥ 20 FPS (CIF), STILL IMAGE CAPTURE & PLAYBACK

### TMS320DSC25

Get white papers, development tools, and more product information at: [www.ti.com/sc/digitalcamera](http://www.ti.com/sc/digitalcamera)

The TMS320DSC25 is a highly-integrated image processing system-on-a-chip. Providing 500 MIPs processing power and consuming less than 400 mW power, the TMS320DSC25 is ideal for a variety of portable imaging applications.

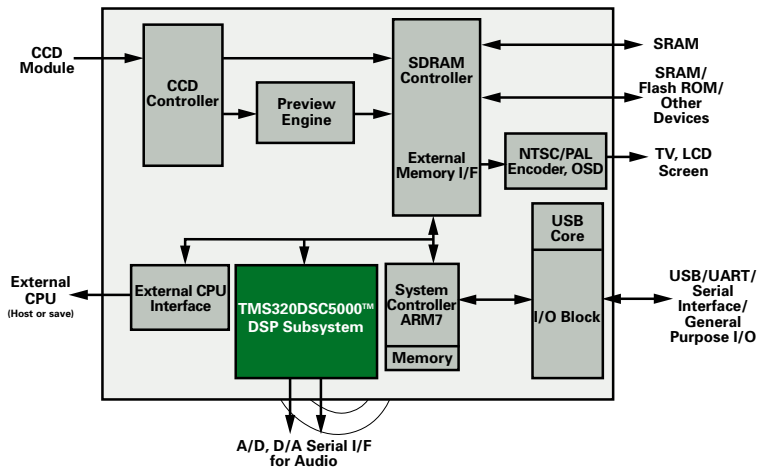
#### Key Features

- Combined TMS320C54x™ DSP core and ARM7™ core for fully programmable image processing and system control
- Seamless interface to Compact Flash, Smart Media, Multi-Media Card, Secured Digital, and Memory Stick
- Integrated peripherals:
  - Real-time preview engine
  - NTSC/PAL video encoder
  - USB controller
  - 2 SPI and 2 UART
- Packaging: 288-pin MicroStar™ BGA

#### Applications

- PC cameras
- Digital still cameras
- Snapshot photo printers

TMS320DSC25 Block Diagram



## 3.3-V LDO AND DUAL SWITCH FOR USB PERIPHERAL POWER MANAGEMENT

### TPS2148

Get samples, datasheets, app reports and EVMs at: [www.ti.com/sc/device/TPS2148](http://www.ti.com/sc/device/TPS2148)

The TPS2148 integrates two power distribution switches and an LDO in an MSOP-8 package. The switches allow power segmentation to meet the current USB requirements.

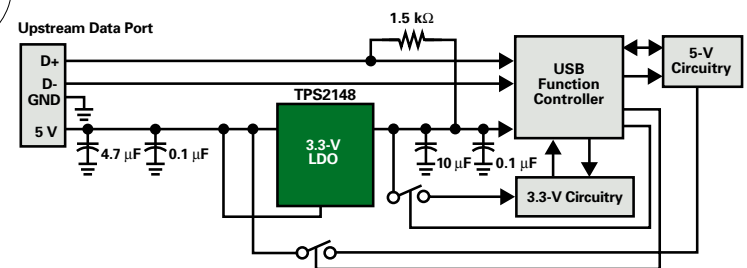
#### Key Features

- Complete power management solution for USB bus-powered peripherals
- 3.3-V 200-mA low-dropout voltage regulator with enable
- 3.3-V 340-mΩ (typ) MOSFET for power segmentation
- 5-V 340-mΩ (typ) MOSFET for power segmentation
- Independent thermal and short-circuit protection for LDO and each switch
- 2.9-V to 5.5-V operating range
- CMOS- and TTL-compatible enable inputs
- 75-μA (typ) supply current
- -40°C to 85°C ambient temperature range

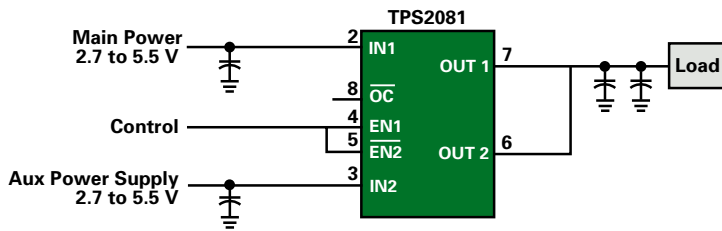
#### Applications

- USB peripherals such as digital cameras, Zip® drives and speakers

TPS2148 Application Diagram



TPS208x Application Diagram



## INDUSTRY'S FIRST TRUE QUAD 80-m $\Omega$ SWITCH ICs ALLOW POWER MUXING

### TPS208x/TPS209x

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TPS2086 or TPS2096

Power mux ICs allow switching between multiple power rails. TPS208x and TPS209x are current-limiting power switches that can be configured as power mux ICs for up to four rails by tying the outputs together.

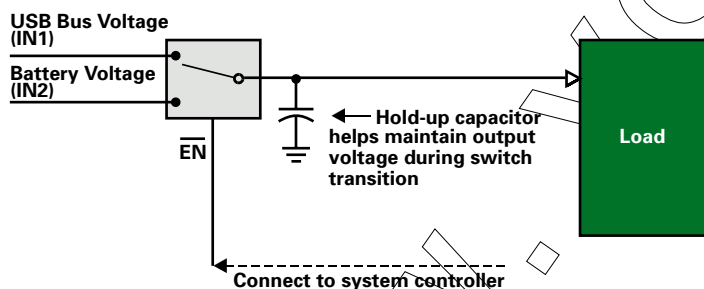
#### Key Features

- Design flexibility
- Duals, two inputs/outputs
- Quads, four inputs/outputs
- Short-circuit and thermal protection
- Operating range: 2.7 V to 5.5 V
- Current limits:
  - 700 mA (min) (TPS208x)
  - 300 mA (min) (TPS209x)
- No drain-to-source back-gate diode, eliminating potential current flow back across device to inputs
- Packaging: 8- and 16-pin SOIC

#### Applications

- Switch between power rails (power muxing)
- Memory card sockets

TPS2100 Application Diagram



## POWER MUX ICs ALLOW SEAMLESS TRANSITIONS FROM USB POWER TO BATTERY

### TPS21xx

Get samples, datasheets, app reports and EVMs at:

[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TPS2100, TPS2101, TPS2102, TPS2103, TPS2104 or TPS2105

The TPS21xx devices are dual-input, single-output power switches designed to provide uninterrupted output voltage when transitioning between two independent power supplies.

#### Key Features

- Seamless 4- $\mu$ s transition from IN1 to IN2
- IN1: 500-mA rating 250-m $\Omega$   $r_{DS(on)}$
- IN2: 100-mA rating 1.3-m $\Omega$   $r_{DS(on)}$  (TPS2102/3/4/5)  
10-mA rating 1.3-m $\Omega$   $r_{DS(on)}$  (TPS2100/1)
- Input voltage range: 2.7 V to 4 V (TPS2100/1/2/3)  
2.7 V to 5.5 V (TPS2104/5)
- No drain-to-source back-gate diode, eliminating potential current flow back across device to inputs
- Packaging: Space-saving SOT-23

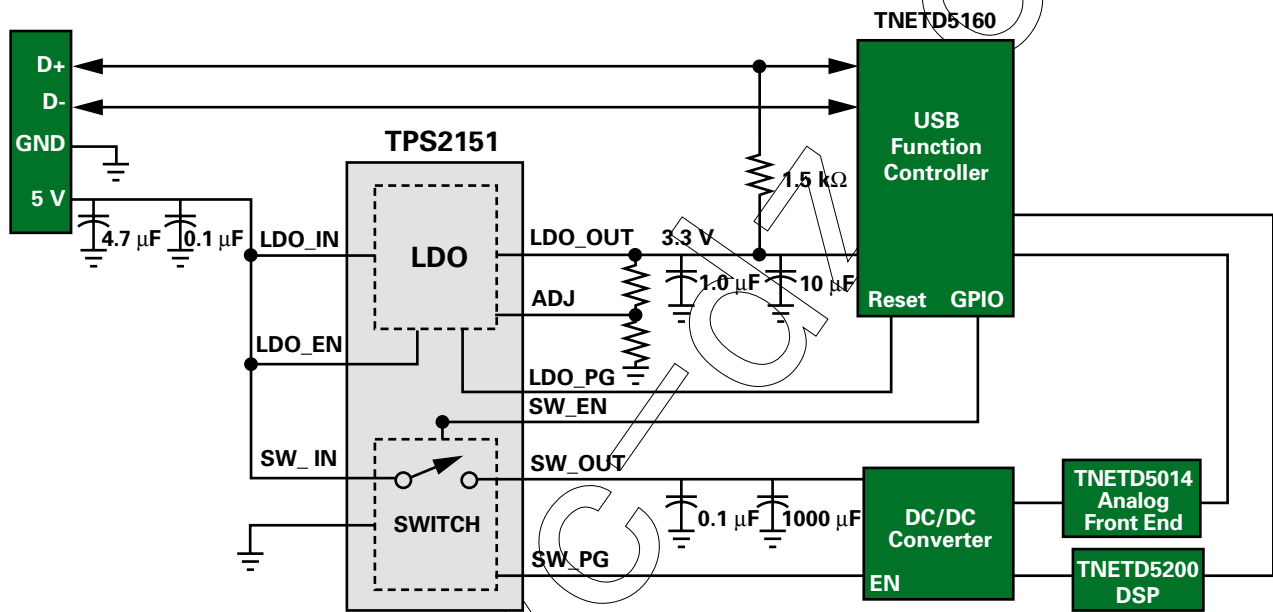
#### Applications

- Wireless phones
- PDAs
- Calculators

## COMPLETE BROADBAND ACCESS SOLUTIONS

Texas Instruments provides the underlying silicon and software for cable, DSL, wireless home networking and VoIP access technologies. TI solutions are available for all aspects of broadband delivery, from infrastructure technology for service providers to last-mile access for consumers and businesses. The use of the TPS2151 (page 23) allows the ADSL modem to meet USB requirements. During enumeration, the TPS2151 keeps the large capacitor at the input to the DC-to-DC converter isolated from the USB 5-V source. Once enumeration is complete, the dual-current limit feature of the TPS2151 controls the inrush to the large capacitor by limiting the charging current to 100 mA. After the switch output voltage reaches approximately 93% of the input voltage, the switch PG enables the DC-to-DC converter and the current limit increases to 800 mA. TI also offers solutions for cable modems (pg. 22).

USB BUS-POWERED ADSL MODEM BLOCK DIAGRAM



www.ti.com

AU5

## USB-BASED FULL-RATE ADSL MODEM

AU5

Get samples, datasheets, app reports and EVMs at:  
[www.ti.com/rd/AU5](http://www.ti.com/rd/AU5)

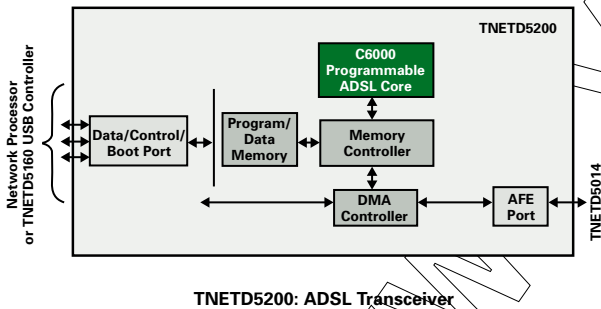
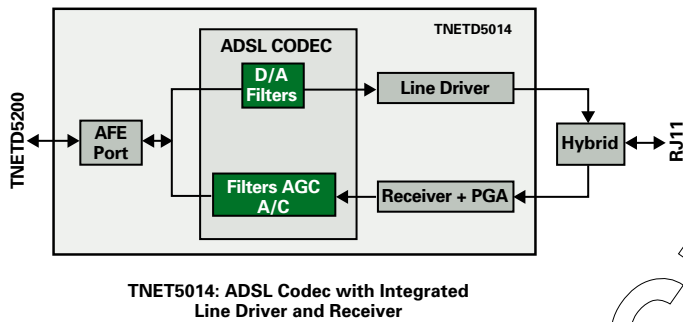
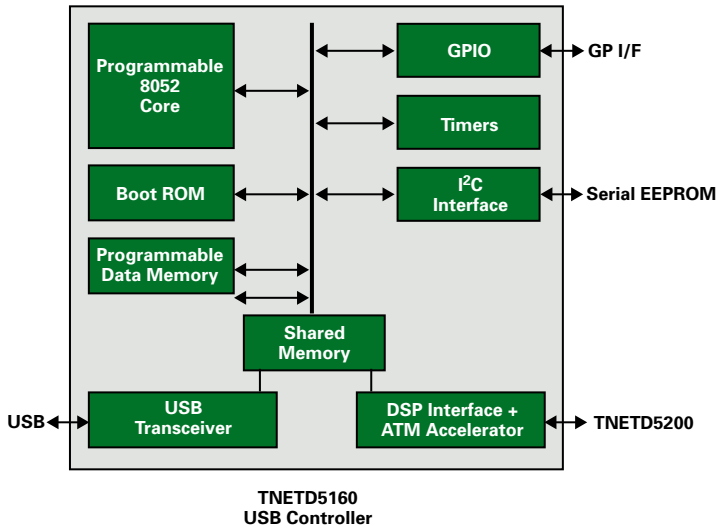
TI's highly integrated ADSL AU5 chipset gives USB-based ADSL modem designers a cost-effective and simple way to quickly get advanced products to market. Built on TI's industry-leading DSP platform and five proven generations of ADSL technology, the AU5 helps manufacturers meet consumer demand for powerful and programmable products that offer their customers simple plug-and-play operation.

### Key Features

- Industry's highest performing ADSL modem — supports bus- or line-powered designs
- Compact design with integrated single-chip AFE that includes Codec, line driver/receiver
- Hardware-based SAR for high throughput and low latency operation
- Meets and exceeds DSL Forum WT-062 interoperability specification

### Application

- External ADSL modems



## DOCSIS™ 1.1-CERTIFIED CABLE MODEM SOLUTION

### TNETC405

Get samples, datasheets, app reports and EVMs at:  
[www.ti.com/rd/docsis11](http://www.ti.com/rd/docsis11)

TI's TNETC405 is the industry's first DOCSIS 1.1-certified cable modem solution, becoming the foundation for expanding the list of offerings by cable providers, packet telephony, multimedia and USB.

This DOCSIS 1.1-certified reference design solution is a complete system with highly optimized silicon hardware and software, enabling cable operators to accelerate the rate of broadband adoption. The open software architecture allows customers the ability to customize and personalize their own value-added services, such as QoS and voice applications.

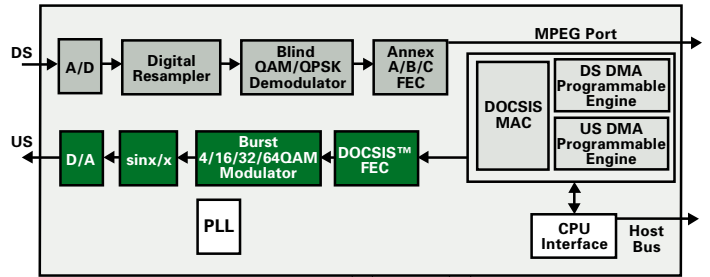
#### Key Features

- TNETC405 is a complete reference design solution
- Enables delivery of high-speed Internet service tiers
- Foundation for home networking applications, packet telephony and multimedia services
- Open software architecture enables customization and personalization of features such as QoS and voice applications
- Supports DOCSIS/EuroDOCSIS 1.1 and DOCSIS 2.0 A-TDMA
- Designed for lowest overall system cost
- Integrated in reference design platforms for quick time-to-market

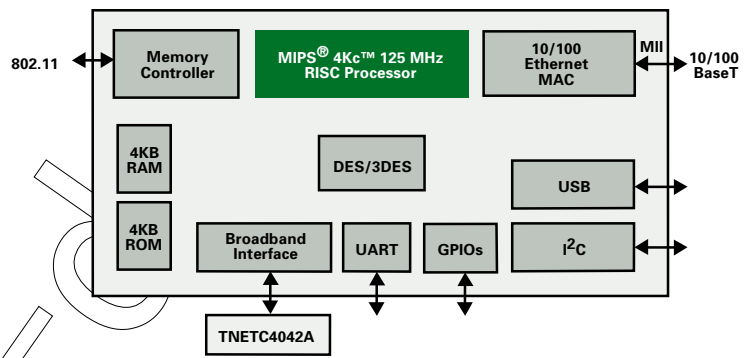
#### Applications

- Home networking
- Packet telephony

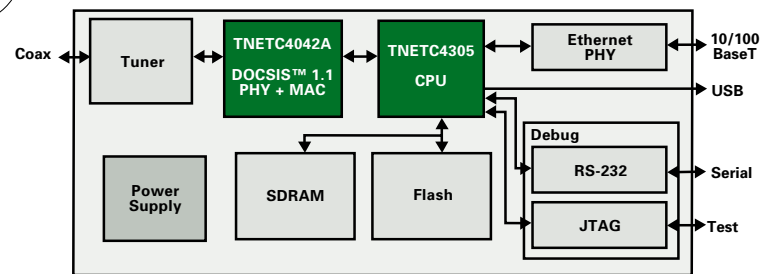
TNETC4042 Block Diagram



TNETC4305 Block Diagram



TNETC405 Block Diagram



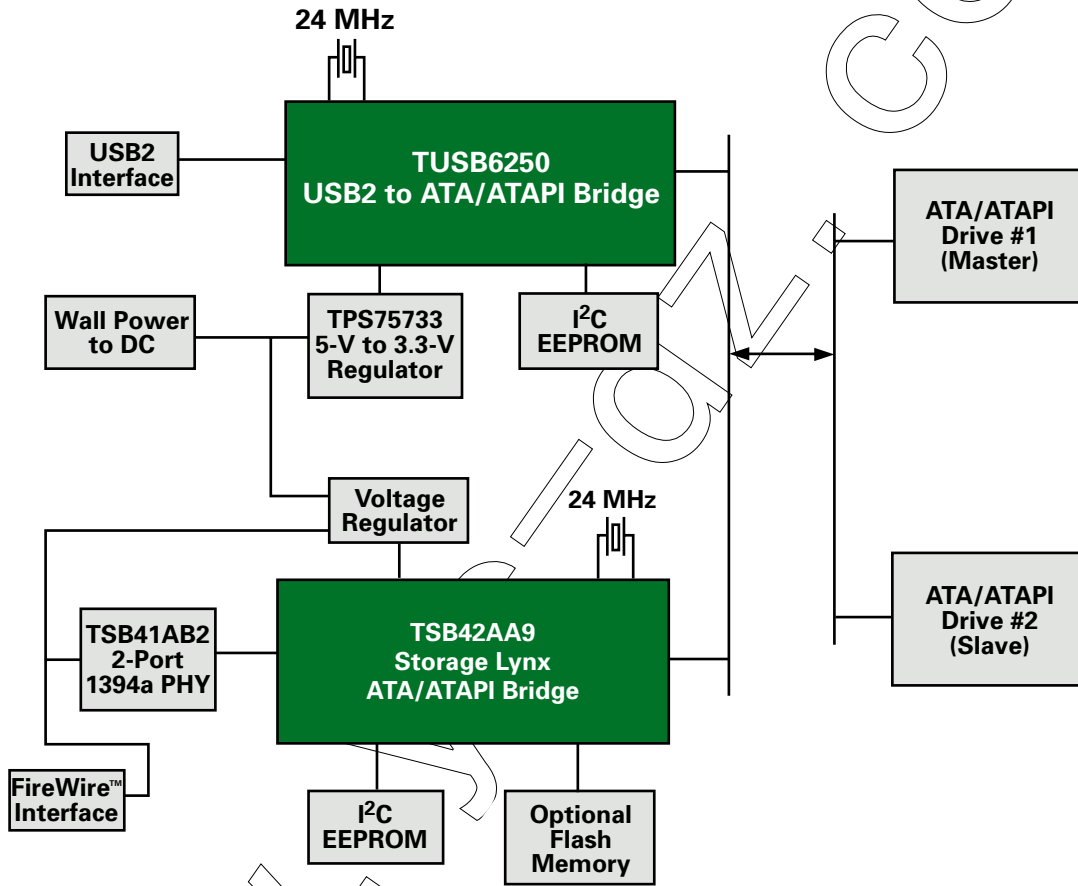
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## EXTERNAL STORAGE

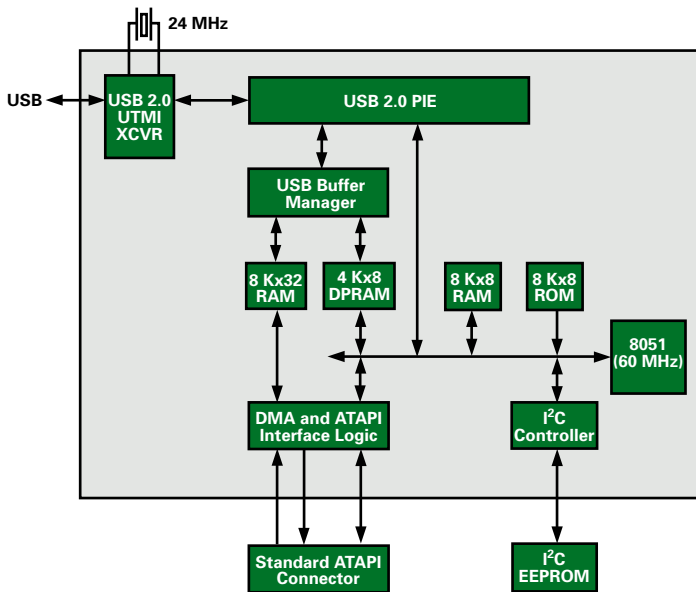
Texas Instruments offers the TUSB6250 USB 2.0 ATA/ATAPI bridge solution (page 25) to enable the development of high capacity, USB 2.0-based storage peripherals for PCs and Macs. Examples of such products include MP3 players, portable hard disk drives (HDDs), Zip® drives, and removable CD and DVD burners. In addition to the TUSB6250, TI solutions include voltage regulators, such as the TPS75733 (page 25), optimized for use with ATA and ATAPI drives. The TSB42AA9, a 1394 (FireWire™) high-performance link layer controller for ATA and ATAPI storage devices, acts as a bridge between the 1394 and ATA/ATAPI buses. For more information about the TSB42AA9 and TI's 1394 products, please go to [www.ti.com/rd/1394](http://www.ti.com/rd/1394).

COMBINATION HDD BLOCK DIAGRAM





TUSB6250 Application Diagram



## USB 2.0-TO-ATA/ATAPI BRIDGE

### TUSB6250

Get samples, datasheets, app reports and EVMs at:  
[www.ti.com/sc/device/TUSB6250](http://www.ti.com/sc/device/TUSB6250)

The TUSB6250 is a flexible, firmware-driven USB 2.0-to-ATA/ATAPI bridge solution. Adding the TUSB6250 to a standard, off-the-shelf ATA or ATAPI device, such as an HDD or CD-RW drive, will transform that drive into a fully functional, USB 2.0-compliant peripheral storage product.

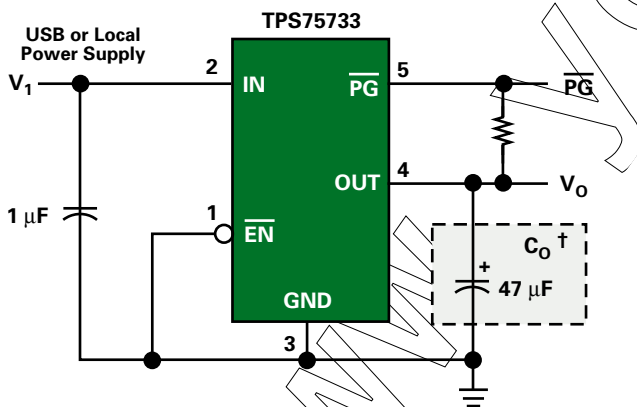
#### Key Features

- Integrated USB 2.0 transceiver
- Supports USB high speed (480 Mbps) and full speed (12 Mbps)
- Highly programmable architecture allows customer differentiation of drive products
- Integrated 30-MIPs WARP processor with 8051 instruction set
- 32 Kbytes of SRAM allocatable between processor program code and data buffering requirements
- Extremely low power consumption makes it ideally suited for bus-powered applications
- 12 general-purpose I/O pins for user customization
- 5-V failsafe ATA/ATAPI I/F ensures operation in adapter applications

#### Applications

- PC/MAC USB2-compliant mass storage peripherals
- High-capacity USB 2.0 digital audio players

TPS75733 Application Diagram



## FAST-TRANSIENT RESPONSE 3-A LOW-DROPOUT VOLTAGE REGULATORS

### TPS75733, TPS757xx

Get samples, datasheets, app reports and EVMs at:  
[www.ti.com/sc/device/partnumber](http://www.ti.com/sc/device/partnumber)

Replace partnumber in URL with TPS75701, TPS75718, TPS75715, TPS75725 or TPS75733.

The TPS757xx family of 3-A LDO contains four fixed-voltage option regulators with integrated power-good (PG) and an adjustable voltage option regulator. These devices are capable of supplying 3 A of output current with a dropout of 150 mV (TPS75733).

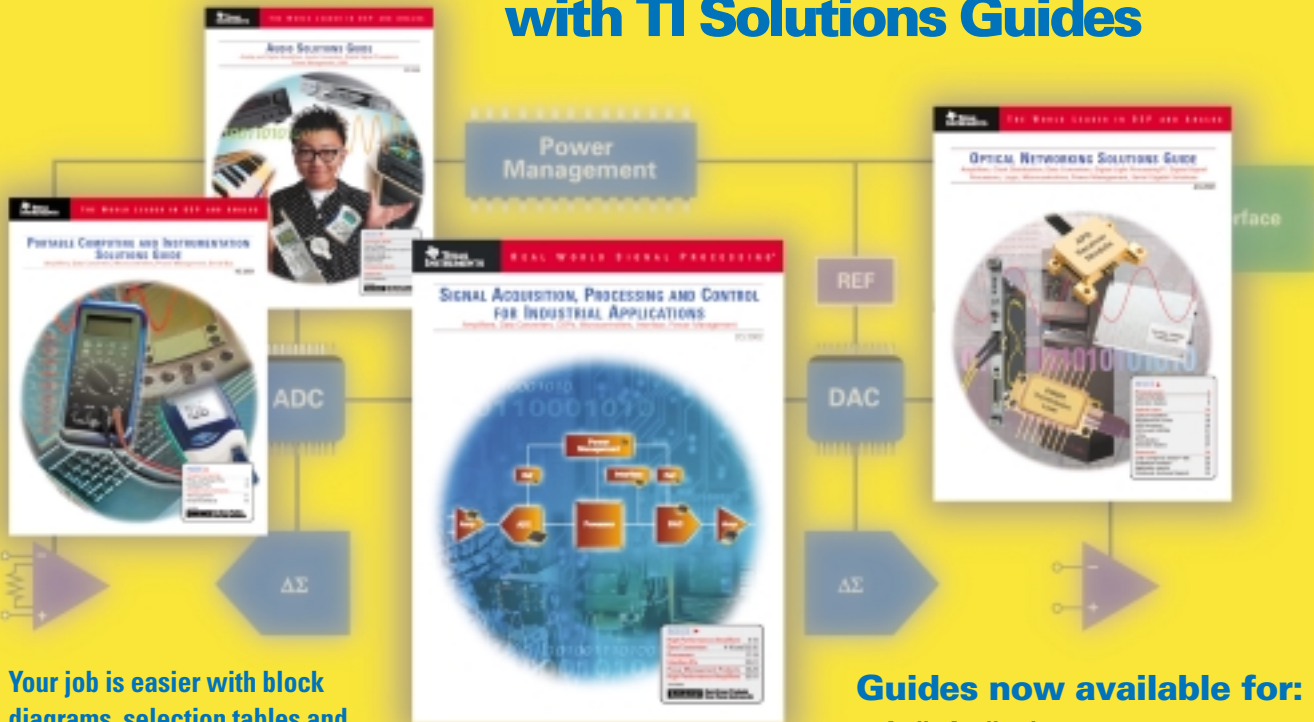
#### Key Features

- 3-A LDO
- Available in 1.5-V, 1.8-V, 2.5-V, and 3.3-V fixed-output and adjustable versions
- Open drain Power-Good (PG) status output (fixed options only)
- Dropout voltage typically 150 mV at 3 A (TPS75733)
- Low 125-µA typical quiescent current
- Fast transient response
- Packaging: 5-pin TO-220 and TO-263 surface-mount

#### Application

- USB external storage

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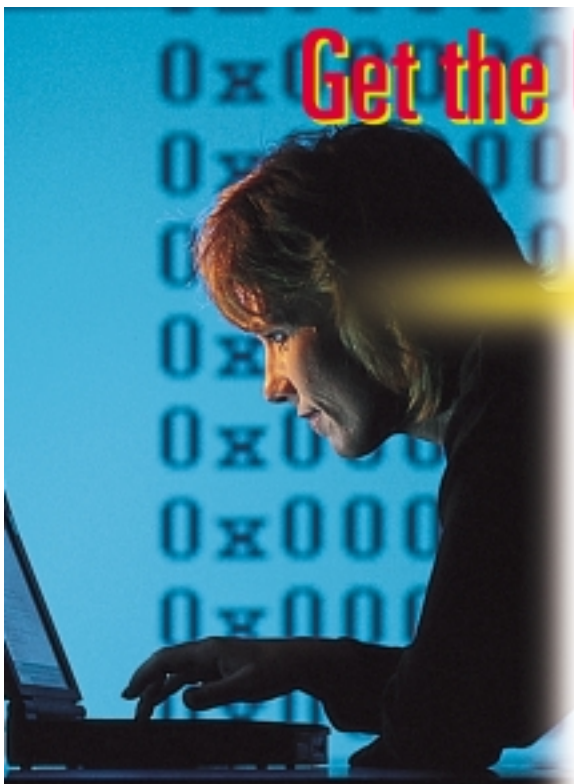
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