

TUSB6250
Demonstration Board

User's Guide

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Read This First

About This Manual

This manual describes the hardware and use of the TUSB6250 demonstration board.

How to Use This Manual

This document contains the following chapters:

Chapter 1—Introduction

Chapter 2—TUSB6250 Demonstration Board Hardware

Chapter 3—TUSB6250 Demonstration Board Functions

Chapter 4—TUSB6250 Firmware Programmer User's Guide

Appendix A—Bill of Materials

Appendix B—Power Regulator Suggestions

Appendix C—Schematics

Appendix D—Demonstration Board Revisions

Appendix E—Suspend Current Measurement Procedure

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This book may contain cautions and warnings.

This is an example of a caution statement.

A caution statement describes a situation that could potentially damage your software or equipment.

This is an example of a warning statement.
A warning statement describes a situation that could potentially cause harm to you.

The information in a caution or a warning is provided for your protection. Please read each caution and warning carefully.

Related Documentation From Texas Instruments

TUSB6250 USB 2.0 to ATA/ATAPI Bridge Controller data manual (SLLS535)

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Introduction

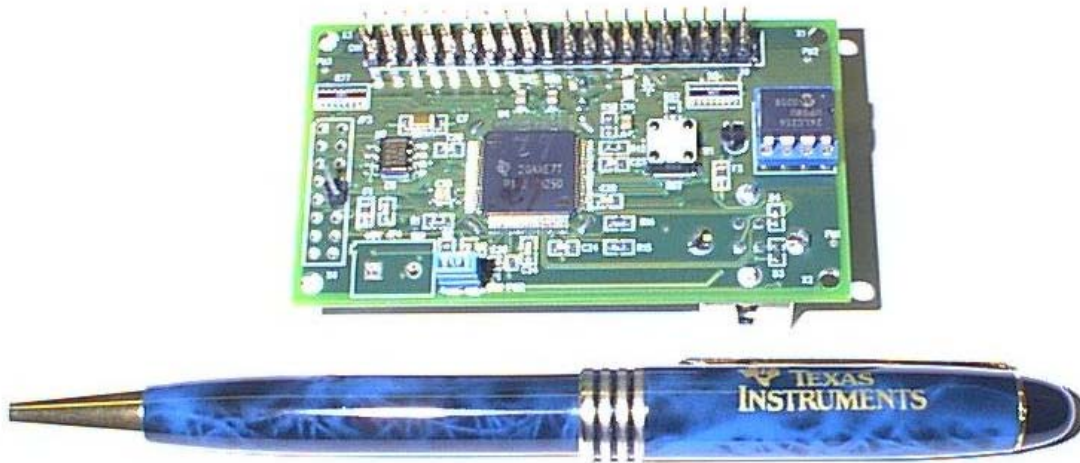
This chapter gives a brief introduction to the TSUB6250 demonstration board.

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1.1 Introduction

The TUSB6250 demonstration board is a free standing reference design that acts as a bridge between a (PC or Mac™) hi-speed USB and an ATA/ATAPI device. It is used to evaluate system compatibility and to develop firmware that resides in external I²C memory, which is executed by the TUSB6250 embedded microcontroller. It also provides a TUSB6250 hardware reference design for connection to an ATA/ATAPI device such as a hard disk drive (HDD), ZIP drive, magneto-optical drive (MO), ORB, CD-ROM, CD-R/W, DVD-ROM, or DVD-RAM.

Figure 1–1. TUSB6250 Demonstration Board



1.2 TUSB6250 Demonstration Board Feature Set

The demonstration board provides the following features:

- One type-B hi-speed USB port connector
- 40-pin ATA/ATAPI header connector
- Serial I²C EEPROM (32K × 8)
- Supports hi-speed USB (HS, 480 Mb/s) and USB (full speed, FS, 12 Mb/s)
- Access to 16 GPIOs for optional uses

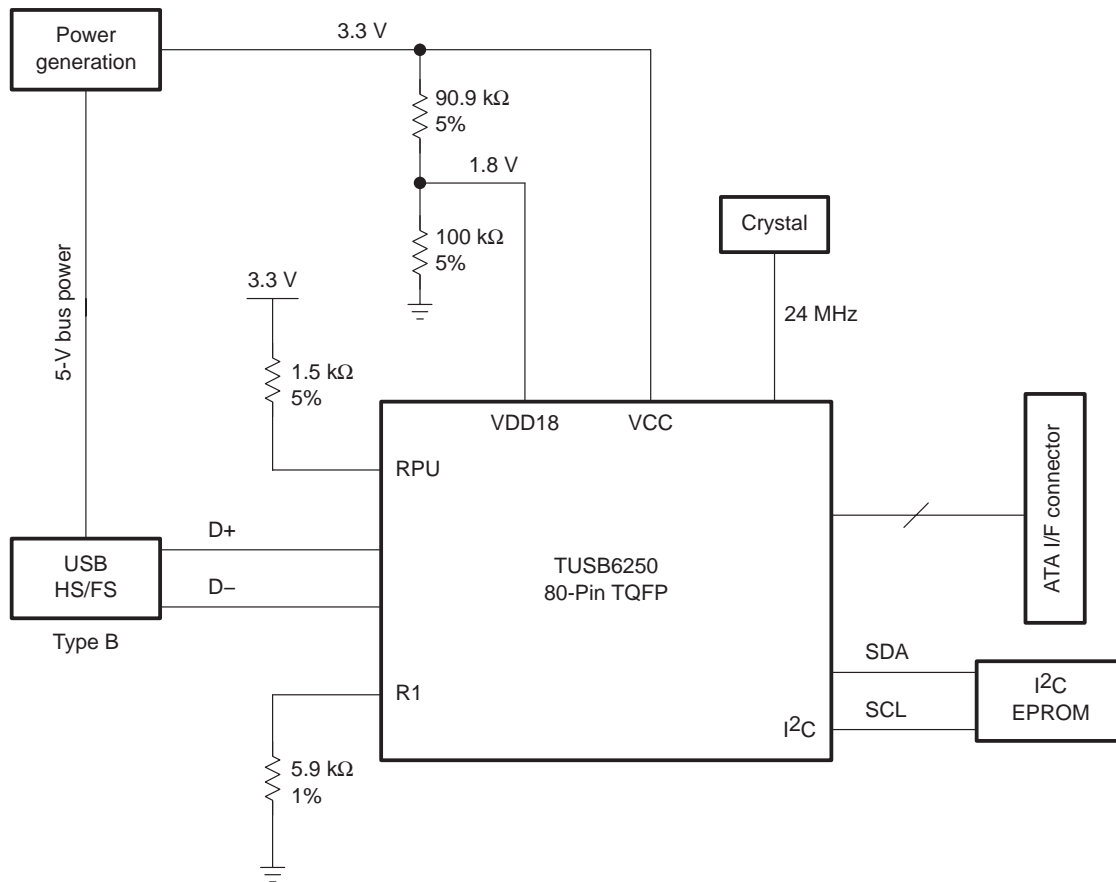
TUSB6250 Demonstration Board Hardware

This chapter gives an overview of the TUSB6250 hardware and installation.

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2.1 Hardware Overview

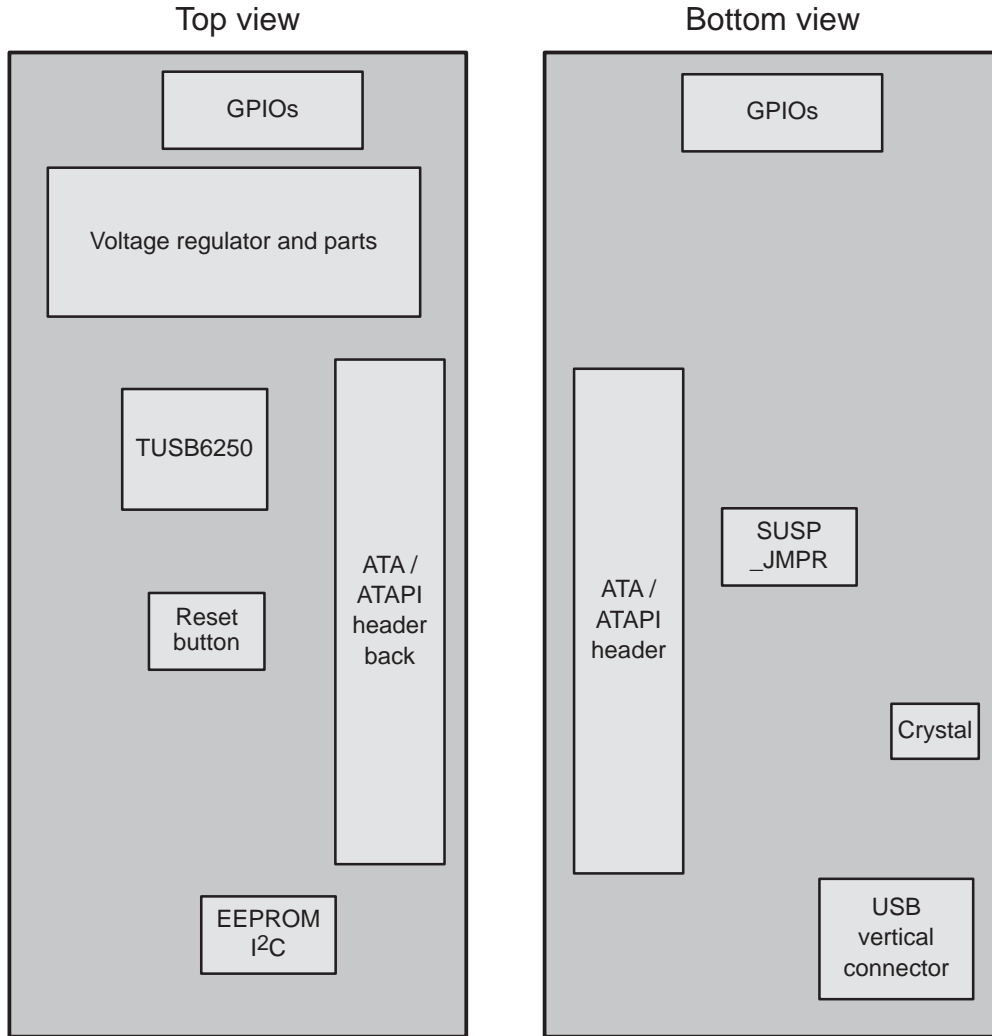
Figure 2–1. Basic Block Diagram of the TUSB6250 Demonstration Board



TUSB6250 demonstration board hardware can be divided into four functional areas. See Figure 2–1 for a block diagram, Figure 2–2 for a component layout, and Figure 2–3 and Figure 2–4 for specific location information.

- Hi-speed USB interface. The demonstration board connects to a PC or Mac via a hi-speed USB port. This is controlled by an integrated HS/FS PHY device.
- The TUSB6250 functions as a bridge between the ATA/ATAPI drive and the PC or Mac.
- ATA/ATAPI 40-pin header connector. Adapters can be used for 44-pin connection.
- Serial I2C serial EEPROM (32K byte)

Figure 2-2. Component Layout Diagram of the TUSB6250 Demonstration Board



2.2 Hardware Installation

The following parts/devices are needed to set up the demonstration board:

- Hi-speed USB cable
- ATA/ATAPI device (HDD, CDROM, DVD, etc.)
- ATA/66 ribbon cable, 40-pin, 80-conductor cable
- Power source for ATA/ATAPI device
- PC or Mac with USB host controller or PC/Mac with USB onboard host controller card. A high-speed host controller is required for high-speed operation.

To set up the demonstration board, perform the following steps:

- 1) Ensure the ATA/ATAPI device power source is off.
- 2) Connect the ribbon cable (pin 1 is identified on the board) between the demonstration board and the ATA/ATAPI device.
- 3) Connect the ATA/ATAPI device to its power source.
- 4) Configure the demonstration board optional jumper (as shown Table 2–1) if the suspend LED is desired to be operational. Turn on the ATA/ATAPI device power supply.

Note:

Use of the suspend LED consumes 2 mA of current, and it is recommended that the LED jumper be removed for board current measurements.

- 5) Connect the hi-speed USB cable between the demonstration board and the PC or Mac. The PC or Mac may be running.

Table 2–1. Jumper/Switch Settings for the TUSB6250 Demonstration Board

Jumper	Setting	
Jumper 1 (suspend LED)	On = suspend LED	Off = no LED
Switch 1 (reset switch)	Depressed = reset	—



TUSB6250 Demonstration Board Functions

The demonstration board circuitry encompasses the following functions:

- Power generation
- Reset circuitry
- Required supporting circuitry
- GPIO access
- I²C serial EEPROM for firmware code and VID/PID storage
- EMI/ESD protection (optional)

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3.1 Power Generation

The demonstration board power generation uses a TPS77633D (U7), which converts 5 V to 3.3 V.

Cost versus application need determines the type of LDO or switching regulator used; see Appendix B for more information.

3.2 Reset Circuitry

The power-on-reset (POR) time is recommended to be at least 1 ms. With the demonstration board reset circuitry (R57: 15 k Ω and C14: 1 μ F), the time constant is 15 ms and the POR is more than 1.5 ms.

3.3 Required Supporting Circuitry

Bandgap reference: R74 on terminal 11 (of the TUSB6250 device) must be 5.9 k Ω at 1% tolerance.

3.4 I²C CMOS Serial EEPROM

The I²C serial EEPROM, U5, is a Microchip Technology Inc. 24LC256 32K \times 8 (256K bits). The I²C interface of the TUSB6250 device (terminals 21, SCL, and 22, SDA) have been pulled high through R87 and R88.

Note:

The TUSB6250 I²C implementation does not support master/slave bus arbitration.

3.5 GPIO Access

Sixteen general-purpose input/output signals are available for optional functional use at location AP1 as described in Table 3–1.

Table 3–1. GPIO Access-Point Header

Terminal	Signal	Comment
1	3.3 V	
2	P2_0	
3	P2_1/ $\overline{\text{PWR100}}$	This terminal is asserted by bootcode.
4	GND	
5	P2_2/ $\overline{\text{PWR500}}$	
6	P2_3	
7	P2_4	
8	P2_5	
9	P2_6	
10	P2_7	
11	P3_0/SIN	This dual-function terminal can be used as either GPIO or as the serial data input of the integrated 8051 microcontroller serial port.
12	P3_1/SOUT	This dual-function terminal can be used as either GPIO or as the serial data output of the integrated 8051 microcontroller serial port.
13	P3_2/ $\overline{\text{CD1}}$	These terminals can be used as either GPIOs or compact flash card insertion/removal detection function implemented by the end-product developer's custom firmware.
14	P3_3/ $\overline{\text{CD2}}$	
15	P3_4	
16	P3_5	
17	P3_6	
18	P3_7	

Note:

See the TUSB6250 data manual (SLLS535) for further details on the signals and their uses.

3.6 EMI/ESD Protection (Optional)

EMI protection can be accomplished, if needed, by using the TDK ACM2012-900-2P or the Murata DLW21SN900SQ2, (common mode choke, i.e., CMC). At this time, neither the TDK nor the Murata CMC devices are designed on the TUSB6250 demonstration board, but have been used on previous TUSB6250 board designs at Texas Instruments.

ESD protection can be accomplished, if needed, with Pulse-Guard™ discharging diodes; at this time Pulse-Guard diodes are not used but have been used on previous designs. Pulse-Guard ESD suppressors help protect sensitive electronic equipment against electrostatic discharge (ESD). They supplement the on-chip protection of the TUSB6250 device.

Note:

ESD testing by the Texas Instruments ESD testing center has determined that no extra ESD protection is required for the TUSB6250 demonstration board design. The TUSB6250 demonstration board is compliant with CE mark 8-kV ESD testing as well as industrial 16-kV levels.

TUSB6250 Firmware Programmer User's Guide

The TUSB6250 device requires an EEPROM for firmware storage. This EEPROM is read at device power up, and the code is executed from internal RAM. The TUSB6250-based storage device can have firmware upgraded via the USB bus. This feature allows for end-user field upgradeability. This function requires firmware version 00.00.01.10.x or later. A driver is also required to execute this function. When the update is initiated, the TUSB6250 firmware is put in a firmware update mode. The firmware disconnects from USB, and then reconnects with a different VID and PID. This causes the FWUpdate driver to load. At this point, the application can send data to the device through this driver. This chapter describes how to use the application.

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4.1 Firmware Programmer Utility	4-2

4.1 Firmware Programmer Utility

This functionality is supported with Windows™ 98SE (with TI-provided USB mass storage driver), Windows 2000, Windows ME, and Windows XP.

Step 1: Run the install executable. This installs the application and driver necessary for the firmware update functionality.

Step 2: Plug in the device to the host PC. When the application is first opened, a warning message appears (see Figure 4–1).

Figure 4–1. Warning Message



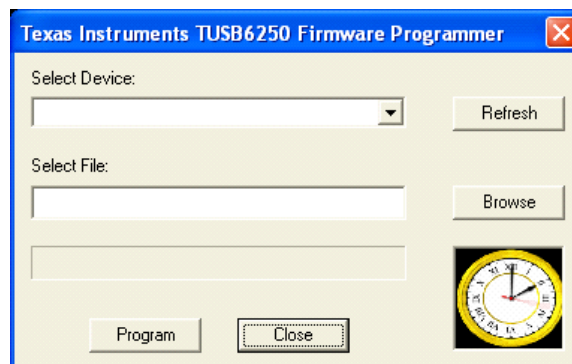
This message warns the user of the potential for data loss. If the device attached is a removable media device (CD, DVD, Zip, etc.), then it is recommended that the user eject the disk before proceeding. If the device is a fixed media type (HDD), then it is recommended that the user first stop the device using the Safely Remove Hardware application by double-clicking the plug-and-play icon in the system tray (see Figure 4–2), selecting the USB Mass Storage Device, and clicking on the Stop button. After the device is stopped, it must be unplugged from the USB, then plugged into the USB. Make sure no data is being written to the drive and click OK on the warning message to continue.

Figure 4–2. Windows Plug-and-Play Icon



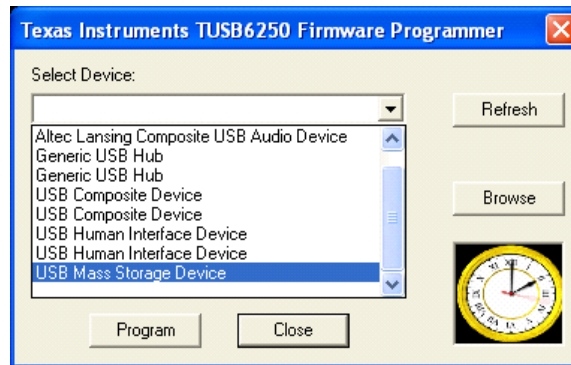
Step 3: Figure 4–3 shows the application when it first appears.

Figure 4–3. Initial View of Application



Select the device from the drop-down list. It should be listed as USB Mass Storage Device, as in Figure 4–4.

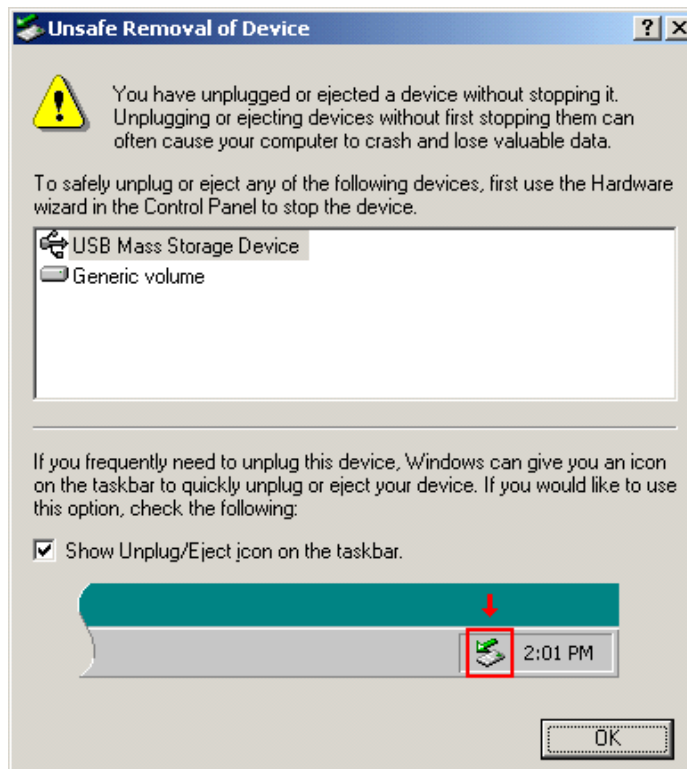
Figure 4–4. Select Device From List



Then select the proper hex file and press Program.

Step 4: After a few seconds, the device disconnects itself from the USB bus and reconnects as a different device. This causes a special driver to be loaded so the application can send the proper data (firmware) to the device. When this occurs, the Unsafe Removal notice may appear, depending on the OS (see Figure 4–5). This is normal. No user action is required in this step.

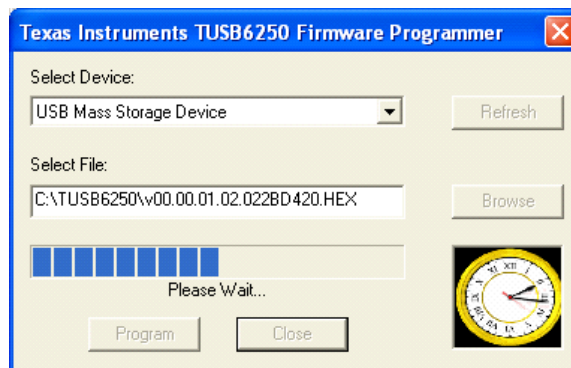
Figure 4–5. Unsafe Removal Notice



Step 5: Once the special driver is loaded, the application starts sending the data (firmware) to the device. As this is happening, the progress bar displays the progress, as seen in Figure 4–6. No user action is required in this step.

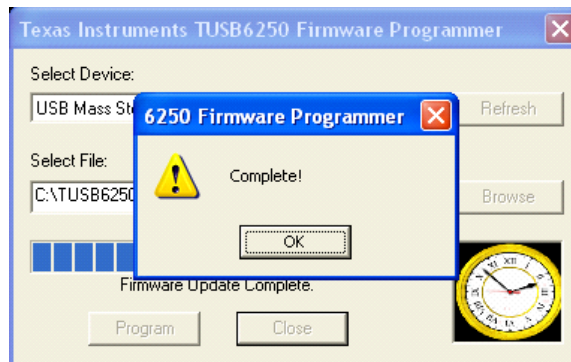


Figure 4–6. In the Progress of Updating



Step 6: When complete, a message box appears (see Figure 4–7). The whole process may take as much as two minutes to complete. When the process has completed, the firmware again disconnects from the USB bus. After closing the application, the user must unplug power to the device for the changes to take effect.

Figure 4–7. Firmware Update Completed



Bill of Materials

This appendix contains the bill of materials for the TUSB6250 demonstration board.

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A.1 Bill of Materials	A-2

A.1 Bill of Materials

Table A-1. Bill of Materials

Item	Qty	Reference	Part	Footprint	Mfr Part Number	Mfr
1	1	AP1	CON18	HDR18	1043511	AMP/Tyco
2	3	C2, C19, C26	4.7- μ F capacitor	SMT_0805	C0805C475K8PACTU	Kemet
3	8	C3, C14, C18, C27, C32, C33, C35, C38	1- μ F capacitor	SMT_0805	C0805C105K4RACTU	Kemet
4	7	C4, C6, C10, C23, C34, C42, C43	0.1- μ F capacitor	SMT_0603	C0603C104K4RACTU	Kemet
5	1	C7	10- μ F capacitor	SMT_0805	GRM21BR61A106KE19L	Murata
6	2	C11, C12	33-pF capacitor	SMT_0603	C0603C330J5GACTU	Kemet
7	7	C16, C17, C20, C21, C30, C31, C40	0.01- μ F capacitor	SMT_0603	C0603C103K5RACTU	Kemet
8	6	C24, C25, C28, C29, C36, C37	0.001- μ F capacitor	SMT_0603	C0603C102K5RACTU	Kemet
9	1	CN1	Header 20X2-100 MIL	HDR40	10-89-1401	Molex
10	1	D1	LED	SMT_0805	LTST-C171CKT	Lite-On
11	2	F1, F2	MPZ2012S331A ferrite	SMT2012	MPZ2012S331AT	TDK
12	4	GND1, +5VIN, +5V, +3V3	Test point	HDR1	87720-1	AMP/Tyco
13	1	JP1	Jumper	HDR2	104351-1	AMP/Tyco
14	2	R3, R81	0- Ω resistor	SMT_0603	9C06031A0R00JLHFT	Yageo America
15	1	R12	1.5-k Ω resistor	SMT_0603	9C06031A1501JLHFT	Yageo America
16	4	R14, R15, R24, R76	10-k Ω resistor	SMT_0603	9C06031A1002JLHFT	Yageo America
17	3	R42, R46, R49	82- Ω resistor	SMT_0603	9C06031A82R0JLHFT	Yageo America
18	3	R43, R44, R48	22- Ω resistor	SMT_0603	9C06031A22R0JLHFT	Yageo America
19	1	R57	15-k Ω resistor	SMT_0603	9C06031A1502JLHFT	Yageo America
20	9	R58, R87-R93, R95	1-k Ω resistor	SMT_0603	9C06031A1001JLHFT	Yageo America
21	1	R74	5.9-k Ω 1% resistor	SMT_0603	9C06031A5901FKHFT	Yageo America
22	1	R75	5.6-k Ω resistor	SMT_0603	9C06031A5601JLHFT	Yageo America

Item	Qty	Reference	Part	Footprint	Mfr Part Number	Mfr
23	2	R78, R79	33-Ω resistor pack	SMT_ ctszip8	742C163330J	CTS Corporation
24	6	R80, R82–R86	33-Ω resistor	SMT_0603	9C06031A33R0JLHFT	Yageo America
25	1	R94	4.7-kΩ resistor	SMT_0603	9C06031A4701JLHFT	Yageo America
26	1	SW1	Switch	TH	EVQ-PAD04M	Panasonic- ECG
27	1	U3	Type B USB-shield	TH- connector	67265-0000	Molex
28	1	U4	TUSB6250	80-TQFP	TUSB6250	Texas Instruments
29		U5	24LC256 EEPROM	8-DIP	24LC256-I/P	Microchip
30	1		EEPROM socket for U5	8-DIP	2-641260-1	AMP/Tyco
31	1	U7	TPS77633D regulator	8-SOIC	TPS77633D	Texas Instruments
32	1	Y1	24-MHz crystal	SMD	CYSD6F51B-24	Crystek



Power Regulator Suggestions

This appendix provides the leading particulars on the suggested three power regulators.

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B.2 TPS77633 Linear LDO	B-2
B.3 TPS62007 Switching Regulator	B-2

B.1 TPS76633 Linear LDO

Device Part Number	Output Current	Quiescent Current	Package	Suitable Application
TPS76633	250 mA	35 μ A	8 pin	Self-powered

- Linear LDO** Good for bus-powered captive cable with self-powered drive
Also good for 5-V drive, regardless if it is bus- or self-powered.
- Pros** Low cost at high volume
- Cons** Not enough output current for bus-powered applications
- Comment** Recommend this one for self-powered or bus-powered captive cable with self-powered drive application

B.2 TPS77633 Linear LDO

Device Part Number	Output Current	Quiescent Current	Package	Suitable Application
TPS77633	500 mA	85 μ A	8 pin	Bus-powered

- Linear LDO** Used on demonstration board
- Pros** 500-mA output current
Low cost savings compared to switching regulator
- Cons** Only good for bus-powered drive when drive itself meets the following requirements:
 – The drive must consume less than 380 mA to 400 mA (depending on ATA modes) during worst-case normal operation
 – Need to pay attention to higher quiescent current (85 μ A)

B.3 TPS62007 Switching Regulator

Device Part Number	Output Current	Quiescent Current	Package	Suitable Application
TPS62007	600 mA	50 μ A	10 pin	Bus powered

Switching Regulator

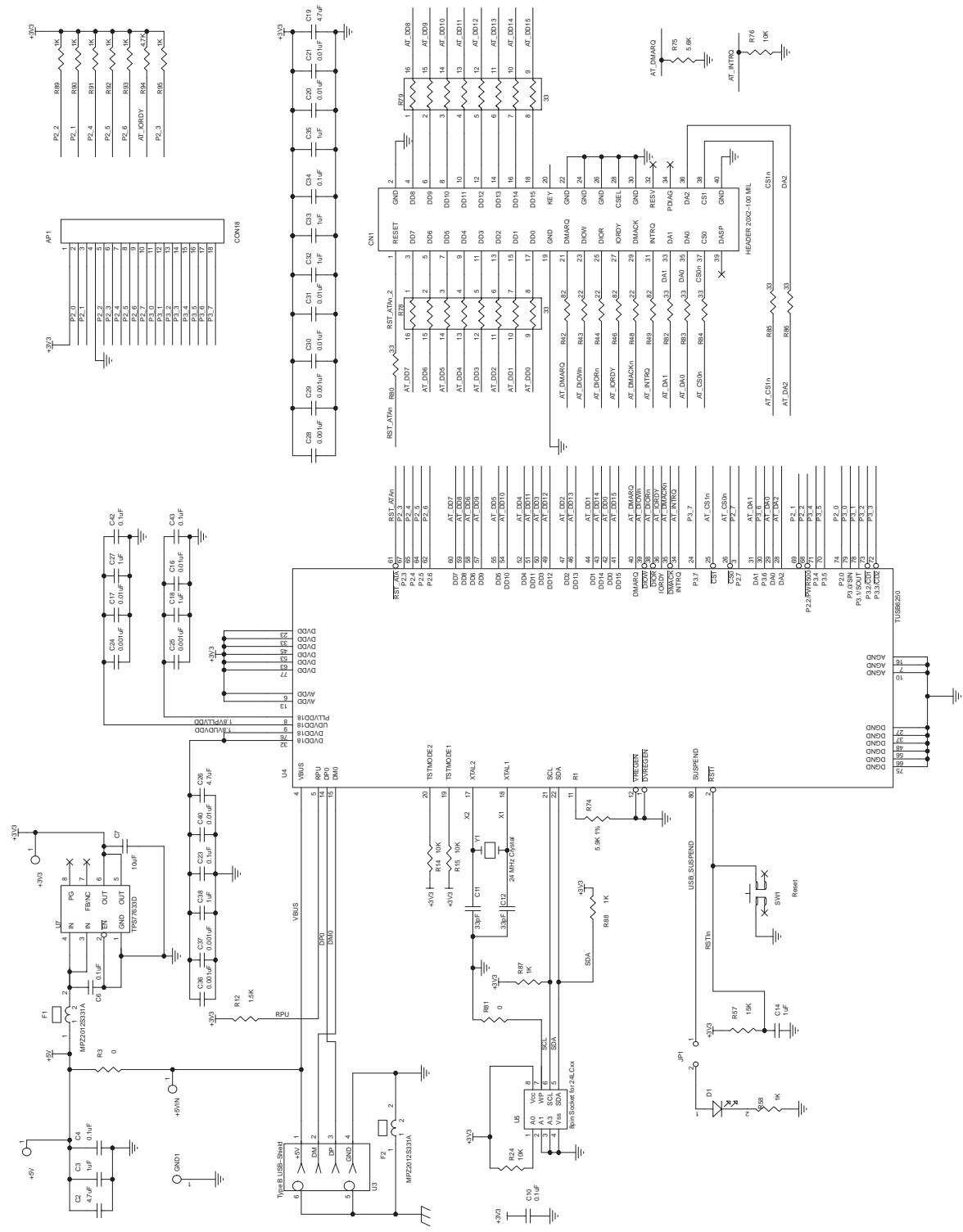
- Pros** 600-mA output current
Much higher efficiency: about 90%
Lower quiescent current (50 μ A)
Only one regulator is needed for bridge and drive with one additional power MOSFET
Perfect for a true bus-powered 3.3-V 1.8-in. HDD solution

- Cons** Major drawback is expense:
- Cost is nearly double that of an LDO
 - Needs more external components like one inductor and a couple of capacitors
 - Needs one power MOSFET as the power switch to control the power of hard-drive
- Comment** Only good for bus-powered drive when the drive itself meets the following:
- The drive must be 3.3 V and consume less than 517 mA (an estimate)
 - Operating at UDMA-66 Read/Write/Startup during worst case of normal operation



Schematic

This chapter contains the schematic for the TUSB6250 demonstration board.



C-2

Demonstration Board Revisions

This appendix provides information on the differences between the multiple versions of the TUSB6250 demonstration boards supplied by Texas Instruments.

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D.1 Green Board Version (First Board Created)	D-2
D.2 Blue Board Version (First Revision)	D-2
D.3 Red Board Version (Second Revision)	D-3
D.4 Yellow Board Version (Third Revision)	D-3
D.5 Lime Board Version (Fourth Revision)	D-3

D.1 Green Board Version (First Board Created)

- The TUSB6250 terminal grounds are isolated from the demonstration board ground. Terminal grounds were attached to the board ground after production.
- Contains buried capacitor effect between board layers two and three power/ground (2 mil dielectric) to improve EMI.
- DP/DM USB differential signal impedance is approximately 80 Ω
- Contains optional ESD component footprints for protection: D3, D4 (Not populated)
- Includes a jumper for USB bus-power or self-power selection. Jumper installed indicates bus power.
- Built with 16 access points for user access to GPIOs.
- UDVDD18 and PLLVDD18 are connected with DVDD18 through two ferrites: F6 and F7 on the board.
- The VREGEN and DVREGEN terminals are connected to the SUSPEND terminal.
- The PDIAG and DASP signals from the ATA/ATAPI interface are connected to the TUSB6250 terminals P3.6 and P3.7, respectively.

D.2 Blue Board Version (First Revision)

- The TUSB6250 terminal grounds are attached to the demonstration board ground (true of all later revisions).
- Buried capacitor effect between board layers two and three removed (true of all later revisions).
- DP/DM USB differential signal impedance is about 90 Ω
- Contains optional ESD component footprints for protection: D3, D4 (Not populated)
- A jumper for USB bus-power or self-power selection. Jumper installed indicates bus power.
- 16 access points for user access to GPIOs.
- UDVDD18 and PLLVDD18 are connected with DVDD18 through two ferrites: F6 and F7 on the board.
- The VREGEN and DVREGEN terminals are connected to the SUSPEND terminal.
- The PDIAG and DASP signals from the ATA/ATAPI interface are connected to the TUSB6250 terminals P3.6 and P3.7, respectively.

D.3 Red Board Version (Second Revision)

- Removed optional ESD component footprints (true of all later revisions).
- Removed jumper for power selection. This demonstration board revision is always configured for USB bus power.
- Built with 18 access points for user access to GPIOs
- UDVDD18 and PLLVDD18 are separated from DVDD18 via capacitors to ground.
- The VREGEN and DVREGEN terminals are connected to the SUSPEND terminal.
- The PDIAG and DASP signals from the ATA/ATAPI interface are connected to the TUSB6250 terminals P3.6 and P3.7, respectively.

D.4 Yellow Board Version (Third Revision)

- Ground test point near I²C is removed to ease EEPROM installation/removal.
- Resistor size is decreased to reduce board congestion.
- Added resistor R3 to act as a power-selection device. When R3 is installed, the demonstration board is configured for USB bus power. When R3 is not installed, the demonstration board is configured to be self-powered.
- The DVREGEN terminal is connected to the SUSPEND terminal. The VREGEN terminal is connected to ground.
- The PDIAG and DASP signals from the ATA/ATAPI interface are no longer connected to the TUSB6250; the TUSB6250 does not use them during normal operations.

D.5 Lime Board Version (Fourth Revision)

- Voltage divider resistors R1 and R2 removed
- DVREGEN terminal is connected to ground.



Suspend Current Measurement Procedure

This appendix details the procedure for measuring the USB suspend current for a system with a bus-powered TUSB6250 demonstration board and a self-powered ATA/ATAPI device.

Topic	Page
E.1 Suspend Current Measurement	E-2

E.1 Suspend Current Measurement

The ATA/ATAPI specification states that a pullup resistor is required on the IORDY signal of the ATA/ATAPI interface. On the most recent revision of demonstration board (yellow), the AT_IORDY signal is pulled high to 3.3 V through a 4.7-k Ω resistor.

During USB suspend, the ATA/ATAPI device is powered down. If the AT_IORDY signal remains pulled high during the USB suspend, then current flows back to the ATA/ATAPI device increasing power consumption. To prevent increased power consumption in a bus-powered design, the AT_IORDY should be pulled high through a resistor to 3.3 V via a FET controlled by the PWR500 (P2.2) terminal and the TUSB6250 firmware should be set to enable the internal pulldown resistors on the ATA/ATAPI signals during USB suspend. A reference design is available.

In order to obtain a valid suspend current measurement of the TUSB6250 for each version of the demonstration boards, the following modifications must be completed:

E.1.1 Green Board Version

- The IORDY terminal is pulled high through the R77 chip resistor. The AT_IORDY trace needs to be cut and left open.
- The AT_PDIAGn and AT_DASPN signals are multiplexed with the GPIO signals P3.6 and P3.7. During the USB suspend, TUSB6250 terminals P3.6 and P3.7 are pulled high internally by the firmware. From the ATA/ATAPI interface side, the AT_PDIAGn and AT_DASPN are pulled low. The AT_PDIAGn and AT_DASPN traces should be cut and left open.

E.1.2 Blue Board Version

- The IORDY terminal is pulled high through the R77 chip resistor. The AT_IORDY trace needs to be cut and left open.
- The AT_PDIAGn and AT_DASPN signals are multiplexed with the GPIO signals P3.6 and P3.7. During the USB suspend, TUSB6250 terminals P3.6 and P3.7 are pulled high internally by the firmware. From the ATA/ATAPI interface side, the AT_PDIAGn and AT_DASPN are pulled low. The AT_PDIAGn and AT_DASPN traces should be cut and left open.

E.1.3 Red Board Version

- AT_IORDY is pulled high through a resistor, R94. R94 should be removed.
- The PDIAG and DASP signals from the ATA/ATAPI are not connected and therefore no modification is required.

E.1.4 Yellow Board Version

- AT_IORDY is pulled high through a resistor, R94. R94 should be removed.
- The PDIAG and DASP signals from the ATA/ATAPI are not connected and therefore no modification is required.