TEXAS INSTRUMENTS

TLV320AIC23EVM

Evaluation Module for the TLV320AIC23 Codec and the TLV320DAC23 Audio DAC

User's Guide

June 2001

Digital Audio Products

SLEU003

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Preface

Read This First

About This Manual

How to Use This Manual

This document contains the following chapters:

- Chapter 1—Introduction to the TLV320AIC23EVM Control Software
- Chapter 2—EVM Board Overview
- Chapter 3—Software Functional Overview
- Chapter 4—Host GUI Application
- Chapter 5—DSP Application
- Chapter 6—Host Software Development Support

Related Documentation From Texas Instruments

A number of reference sources were used in the development of this document. The documents used are listed below:

- TI document: TLV320AIC23, Stereo Audio CODEC, 8 to 96-kHz, With Integrated Headphone Amplifier, June 2001, literature number SLWS106.
- TI document: TLV320DAC23, Stereo Audio D/A Converter, 8 to 96-kHz, With Integrated Headphone Amplifier, June 2001, literature number SLES001.

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Chapter 1

Introduction to the TLV320AIC23EVM Control Software

This document covers the user software provided with the TLV320AIC23EVM board based on the TI TLV320AIC23 (hereafter referred to as AIC23) or the TLV320DAC23 (hereafter referred to as DAC23). Except where noted the AIC23 applies to both the TLV320AIC23 and the TLV320DAC23. This software is composed of host software for an Intel-based PC running Windows 9X™, NT 4.0™, or 2000[1]™ and target software for the C54x DSP. The function, operation, and implementation of the software are described. A description of the TLV320AIC23 EVM board's connectors and jumpers is also provided, along with instructions on how to configure the board for use with the TLV320AIC23 EVM user software or as a stand-alone USB audio device.

The TLV320AIC23 EVM platform is useful for the TLV320AIC23 and the TLV320DAC23 device evaluations. The provided software allows users to exercise the various modes and features of the AIC23 codec and DAC23 audio DAC. The provided software is not intended to be used as the starting point for production applications.

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[1] The TLV320AIC23EVM user software was developed on Windows 2000 and tested on Windows 2000 Windows Me.

1.1 Acronyms

- ADC Analog-to-digital converter
- AIC Analog interface circuit
- API Application programming interface
- DAC Digital-to-analog converter
- DDK Driver development kit
- DLL Dynamic link library
- DSK DSP starter kit
- DSP Digital signal processor
- EVM Evaluation module
- GUI Graphical user interface
- HPI Host port interface
- JTAG Joint test action group
- OS Operating system
- PCI Peripheral component interconnect
- PPC Parallel port controller
- TBC Test bus controller
- TI Texas Instruments
- VxD Virtual device driver

Chapter 2

EVM Board Overview

The TLV320AIC23 EVM is designed to facilitate evaluation of the performance and functionality of the TLV320AIC23 codec and the TLV320DAC23 audio DAC.

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2.1 Digital Interfaces

The TLV320AIC23 EVM has three digital interfaces:

- DSP interface: This interface is compatible with the daughter-card connector of TI DSP DSKs. The supplied user software supports C54x DSPs on DSK/EVM boards with a parallel port interface.
- USB interface: The TLV320AIC23 EVM features a TUSB3200 USB controller. The firmware implements the USB audio device class, which makes it possible to play back sound files (MP3, WAV) from a Windows™ PC. The supplied user software does not utilize the USB interface.
- SPDIF interface: An onboard SPDIF transceiver can be used to connect the AIC23 or DAC23 to a coaxial SDIF source or preamplifier. The firmware for this part is still in development. The supplied user software does not utilize the SPDIF interface.

2.2 Analog Interfaces

The TLV320AIC23 EVM has the following analog interfaces:

- Microphone in (AIC23 only)
- Line in
- Headphone out
- Line out

2.3 Power Supply

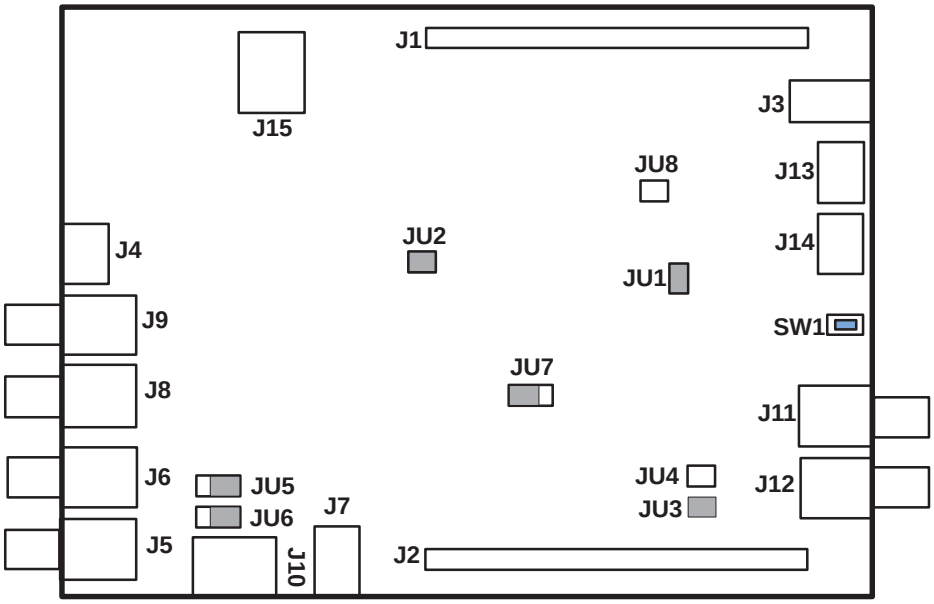
There are three ways to power up the TLV320AIC23 EVM:

- Separate supplies: For highest performance, separate supplies for analog and digital can be connected to the TLV320AIC23 EVM.
- 7-V dc input. The TLV320AIC23 EVM has one connector for a 7-V to 9-V power supply such as a wall-plug adapter.
- DSP daughter-card connector. This option is convenient to evaluate the functionality of the data converter if (small) signal degradation due to the power supply from the DSP board is acceptable.

2.4 Connectors and Jumpers

Figure 2–1 shows the location of the TLV320AIC23 EVM connectors, jumpers, LEDs, and reset button.

Figure 2–1. TLV320AIC23 EVM Board Diagram



Connectors:

J1, J2:	DSP interface (McBSPs, power supply)
J3:	3.3-V digital power supply
J4:	3.3-V analog power supply
J5:	Left line in
J6:	Right line in
J7:	Microphone in (AIC23 only)
J8:	Left line out
J9:	Right line out
J10:	Headphone out
J11:	SPDIF in
J12:	SPDIF out
J13:	7-V to 9-V dc power supply
J14:	5-V power supply
J15:	USB connector

LEDs:

D2:	3.3-V indicator
D3:	5-V indicator
D4:	USB active

Switch:

SW:	Reset button

Jumpers:

JU1: Voltage regulators enable. Remove if external supplies on J4, J13, and J14 are used.

JU2: Connects digital and analog ground planes. Always keep the jumper inserted.

JU3: DSP interface select. Insert jumper for DSP interface.

JU4: SPDIF interface select. Insert jumper for SPDIF interface.

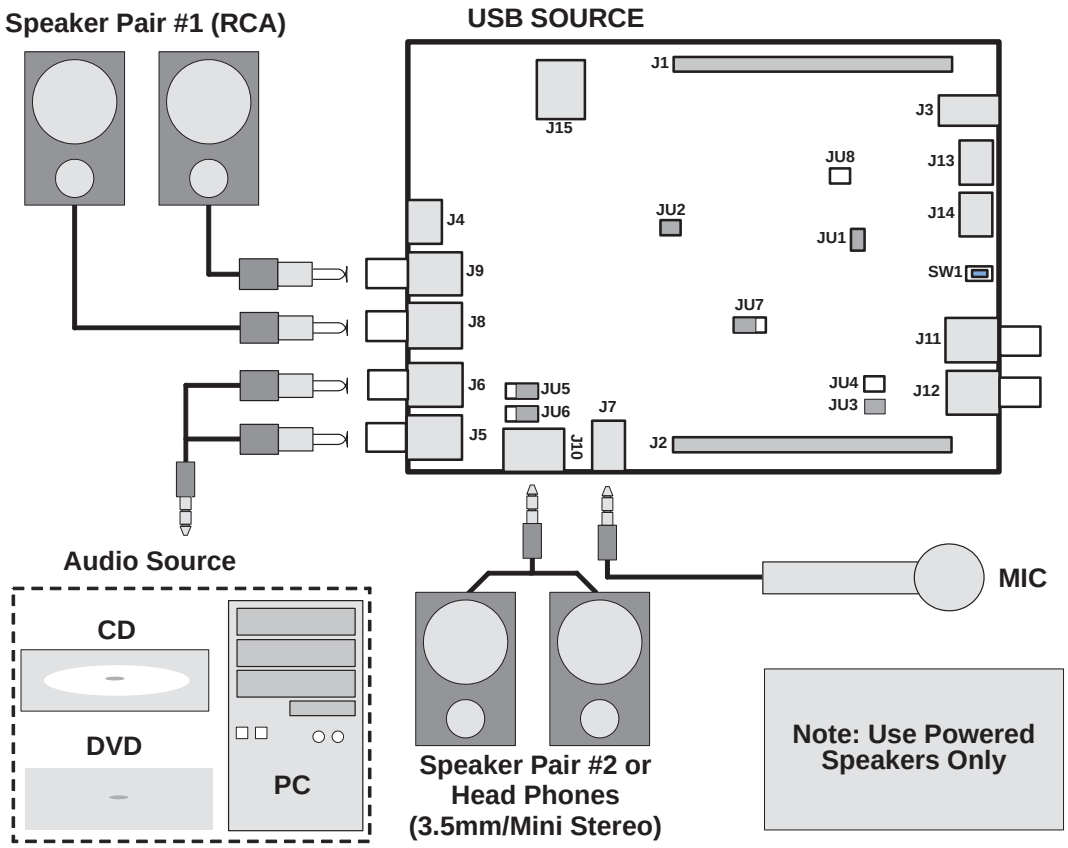
JU5: Left channel internal/external headphone amplifier select. Left position: external amplifier; right position: internal amplifier.

JU6: Right channel internal/external headphone amplifier select. Left position: external amplifier; right position: internal amplifier.

JU7: I^2C/SPI select. Left position: SPI, use SPI for DSP interface; right position.: use I2C for USB and SPDIF.

JU8: Flash write protection. Insert jumper to write-protect the flash (holds USB firmware).

Figure 2–2. TLV320AIC23 EVM Board Audio Connection Example



2.5 Configuration for DSP Connection With Supplied Software

The TLV320AIC23 EVM is compatible with the daughter-card connectors on many TI DSP EVMs and DSKs. The following example is based on a TMS320VC5402 DSK from Texas Instruments.

The supplied user software supports C54x DSPs on DSK/EVM boards with a parallel-port interface.

For jumper connections regarding left and right positions, it is assumed users are holding the TLV320AIC23 EVM so they can read the TI logo.

In order to use the TLV320AIC23 EVM with the DSP DSK, the DSP interface must be selected:

- ❑ JU1: In, enable voltage regulators
- ❑ JU2: In, connect analog and digital ground planes
- ❑ JU3: In, select DSP interface
- ❑ JU4: Out, do not select SPDIF interface
- ❑ JU5: Right position, select internal headphone amplifier
- ❑ JU6: Right position, select internal headphone amplifier

- ❑ JU7: Left position, select SPI control interface
- ❑ JU8: In, write-protect flash memory

Connect an analog audio signal source to the line inputs (J5 and J6) and a headphone or speakers to the headphone connector (J10).

The DSP interface uses McBSP0 for the digital audio data and McBSP1 for the control interface. The supplied user software uses the DSP format of the AIC23/DAC23—FS + 32 bit data (16 bit left and 16 bit right channel) in master mode for the digital audio interface. All the clock signals (BCLK, LRCIN, LRCOUT) are generated by the data converter. McBSP1 is used in SPI mode.

2.6 Configuration for USB Connection With USB Audio Support

The TLV320AIC23 EVM is compatible with the daughter-card connectors on many TI DSP EVMs and DSKs. The following example is based on a TMS320VC5402 DSK from Texas Instruments.

The supplied AIC23 codec tester software does not use the USB interface. The USB interface is used with the built-in USB audio class driver in Windows 98, Windows 98 SE, and Windows 2000.

For jumper connections regarding left and right positions, it is assumed that users are holding the TLV320AIC23 EVM so they can read the TI logo.

In order to use the TLV320AIC23 EVM with the DSP DSK, the DSP interface must be selected:

- ❑ JU1: In, enables voltage regulators
- ❑ JU2: In, connects analog and digital ground planes
- ❑ JU3: Remove this jumper for USB mode.
- ❑ JU4: Out, do not select SPDIF interface.
- ❑ JU5: Right position, selects internal headphone amplifier
- ❑ JU6: Right position, selects internal headphone amplifier
- ❑ JU7: Right position, selects I^2C control interface
- ❑ JU8: In, write-protects flash memory

After selecting the DSP interface, follow these steps:

1) Connect the USB cable to a PC and to the TLV320AIC23 EVM USB connector. Connect a headphone or speakers to the headphone connector (J10). No external power is needed, power is supplied via the USB connection.

2) If the PC is running Windows 98, Windows 98 SE, or Windows 2000, it recognizes the USB connection immediately after it is made. When clicking on the speaker icon, the volume control menu comes up. In the lower left hand of the volume menu the words USB device appear. This assures users that the PC recognizes the TLV320AIC23 EVM as a USB audio device.

3) Load an audio player. The media player included with Windows may be used. Another player is Winamp, which may be downloaded from http://www.winamp.com/

4) Load a music source file (MP3 or WAV). A source for music from the internet can be found at http://shoutcast.com/. Play the selected music source.

5) The music is heard from the attached headphones or speakers.

Chapter 3

Software Functional Overview

This chapter describes the user software for the TLV320AIC23 EVM.

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3.1 Software Component Summary

The user software developed for the TLV320AIC23 EVM can be divided into three main areas:

- Host GUI application
- DSP application
- Host software development support

The following paragraphs describe the components of each of these areas.

3.2 Host GUI Application

The host GUI application (aic23.exe) provides the user interface to control the TLV320AIC23 EVM via the DSP application running on the C54x DSK/EVM. When aic23.exe is executed, the menu bar will read *AIC23 Codec Tester*. The host GUI application communicates with the DSP over the parallel port interface.

The host GUI application supports both high-level user-friendly control of the AIC23 and low-level register control of the AIC23. The main dialog controls sample rate selection, playback (i.e., tone generation), playback and record (i.e. loopback), and volume. Secondary dialogs are used to control the digital and analog audio paths and to provide direct register access.

The host GUI application sends commands to the DSP application over the C54x DSK/EVM parallel port interface. The DSP application modifies the AIC23 state in response to the commands it receives.

3.3 DSP Application

The DSP application (aic23.out) runs on a C54x DSK/EVM. It initializes the DSP and the DSK/EVM peripherals (McBSPs), it configures the AIC23, and then it enters a command loop where it receives commands from the host GUI application over the C54x DSK/EVM parallel port interface. Each command is processed to completion and then it polls for the next command.

The supported commands are: RESET, TEST (host communication), REG_WRITE, WRITE_ALL (e.g. registers), PLAY (a tone of specified frequency), RECORD (AIC23 only) (e.g., playback and record), and STOP (the current PLAY or RECORD (AIC23 only) command).

The PLAY and RECORD (AIC23 only) commands are DMA-driven via callback routines that run continuously until a STOP command is received.

3.4 Host Software Development Support

The host software development support enables the host GUI application to communicate with the DSP application running on the C54x DSK/EVM. This support consists of an application-programming interface (API) DLL that provides user-callable functions, and a set of drivers supporting access to the hardware under Windows 9X, NT 4.0, or 2000.

The user-mode API is implemented in evmdsk54x.dll. This DLL provides a common user-mode interface across all Win32 operating systems. The ring-3 DLL communicates with the driver that handles all the OS-specific details and direct board accesses.

The hardware drivers are implemented in ppc54x.dll, dlportio.dll, and dlportio.sys. These drivers handle the OS-specific details and provide a consistent interface to the user-mode DLL. This arrangement allows host applications to be executed on any Win32 platform without recompilation.

Chapter 4

Host GUI Application

The host GUI application (aic23.exe) provides the user interface to control the TLV320AIC23 EVM via the DSP application running on the C54x DSK/EVM.

The AIC23.exe executable file resides in the Bin directory of the AIC23 software distribution CD or in the Software directory of the TLV320AIC23EVM CD.

There is no need to install the AIC23.exe application, as all needed files reside in the Bin or in the Software directory and the application can be run directly from that location.

If you are running on Windows NT 4.0 or Windows 2000 and you have not installed the C54x DSK/EVM support software, then you must install the dlportio driver prior to running AIC23.exe. The dlportio driver provides low-level access to the DSK/EVM parallel port interface. To install the dlportio driver, run the dlportio.exe installation program located in the Bin directory.

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4.1 Operation

The host GUI application supports both high-level *user-friendly* control of the AIC23 and low-level register control of the AIC23. The main dialog controls sample rate selection, playback (i.e., tone generation), record (AIC23 only) and playback (i.e., loopback), and volume. Secondary dialogs are used to control the digital and analog audio paths and provide direct register access.

You may exit the application in any of the following ways:

- ❑ Hit the Esc key while the main dialog has focus.
- ❑ Click the X button in the upper right corner of the main dialog.
- ❑ Hit the Alt+F4 keys while the main dialog has focus.
- ❑ Select the Close item from the main dialog's system menu.

4.1.1 Main Dialog

The main dialog is shown in Figures 4–1 and 4–2.

Figure 4–1. Main Dialog, Phones Volume Selected

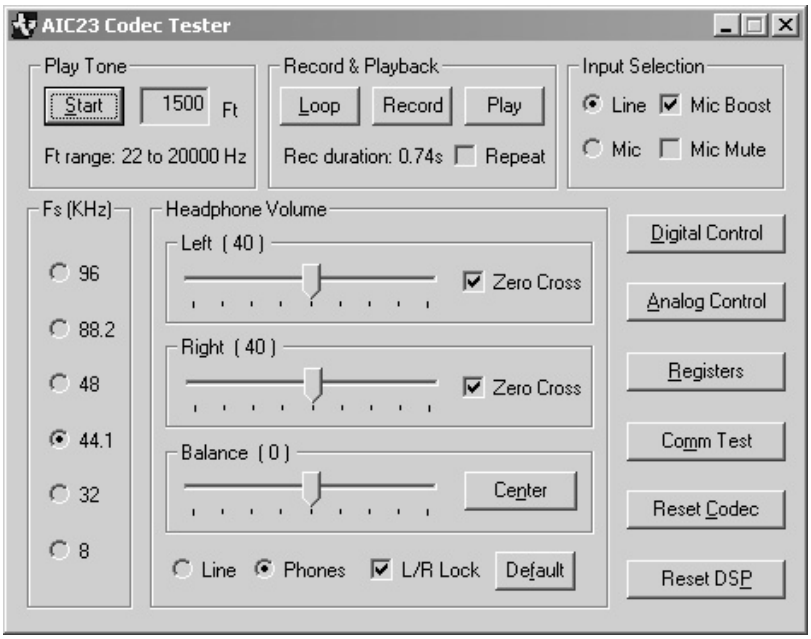
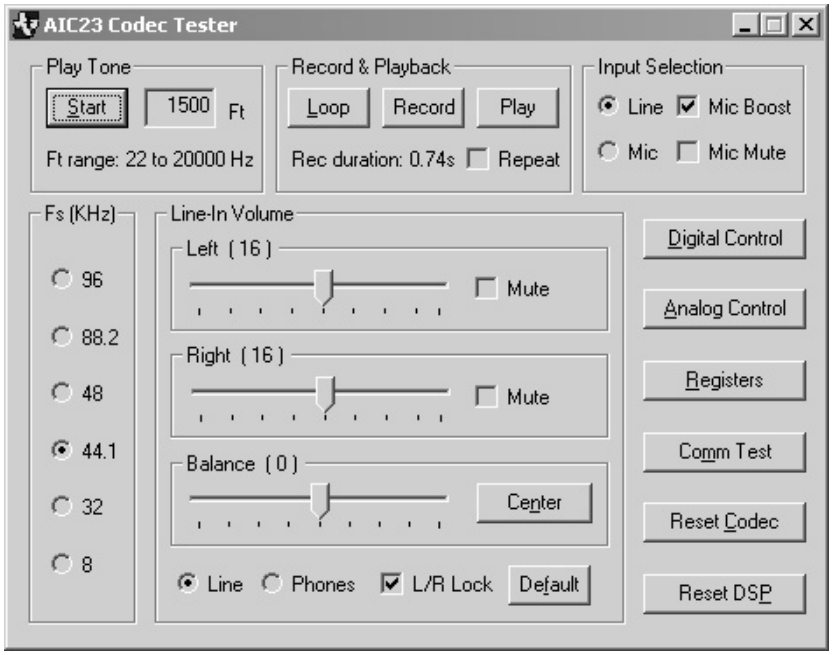


Figure 4–2. Main Dialog, Line Volume Selected



The main dialog allows control of the AIC23 functions described in the following subsections.

4.1.1.1 Sampling Rate

The sampling rate is selected with the Fs group of radio buttons. Selecting a new sampling rate puts the new rate into effect immediately. Sampling rates of 8, 32, 44.1, 48, 88.2, and 96 kHz are supported. If a tone is playing or Record & Playback (i.e., loopback) is running when the sampling rate is changed, the tone or loopback is stopped prior to the change and restarted after the change.

4.1.1.2 Volume

Volumes for the Line-In inputs and headphone outputs are controlled with the Volume group of controls. The appearance of the Volume group of controls varies depending on whether the Phones or Line radio button is selected.

When Phones is selected, the headphones output volume is controlled, and Zero Cross check boxes appear next to the Left and Right volume sliders to control the AIC23's zero-cross detect feature on the headphone outputs.

When Line is selected, the line-In input volume is controlled, and Mute check boxes appear next to the Left and Right volume sliders to control the AIC23's mute feature on the line-in inputs.

You can switch back and forth between controlling the line or phones volume, as their settings are preserved as you switch between them.

The Left and Right volume sliders operate in linear AIC23 register units. For phones, the range is 0 to 80, and 47 is added to the values before they are written to the AIC23's registers. For line, the range is 0 to 31.

The Left and Right volume sliders can be locked by selecting the L/R Lock check box. When locked, the sliders move in unison, i.e., when you move one of the sliders the other slider moves the same distance in the same direction, until it hits the end of the range.

The Balance slider allows you to selectively decrease the volume of one channel at a time. Moving the slider left of center decreases the right channel volume. Moving it right of center decreases the left channel volume. Clicking the Center button centers the slider.

When L/R Lock is selected and the Balance slider is centered, the AIC23's feature that simultaneously loads the left and right channel volume registers with a single register write is enabled.

The Default button resets all the volume controls to their default state (for the current line or phones selection only).

4.1.1.3 Play Tone

The Play Tone controls allow you to play a tone of specified frequency. Enter the desired frequency in the Ft edit control and click on the Start button. Once the Start button has been clicked it changes to a Stop button. Clicking the Stop button without changing the Ft value stops the tone playback. For convenience, if you change the Ft value and click Stop, the new frequency is put into effect.

The valid range of tone frequencies that can be played is sampling-rate dependent. If you select a value that is out of range, a message box is displayed indicating the valid range. The range in Hz is (SRate / 2048) + 1 to (SRate / 2) – 1, with an upper limit of 20,000. The 2048 value is the size of the PCM data buffer used to hold the waveform data for the tone in the DSP application.

If a tone is playing when the sampling rate is changed, the tone is stopped prior to the change and restarted after the change with a new waveform appropriate for the new sampling rate.

The Play Tone and Record & Playback functions are mutually exclusive, i.e. only one may be running at a time. If you start one while the other is running, then the first one is stopped.

4.1.1.4 Record and Playback

The Record & Playback controls allow you to perform a loopback record(AIC23 only)/playback operation, or separate record and play operations.

For loopback analog input is accepted from the Line-In or Mic (AIC23 only) inputs, converted to digital format with the TLV320AIC23's ADC, and immediately converted back to analog output with the TLV320AIC23 or TLV320DAC23's DAC on the Line-Out and Headphones outputs. The digital data stays within a 2048 byte DSP internal memory data buffer; it is not transferred to the host.

The Loop button starts loopback running. Once the Loop button has been clicked, it changes to a Stop button. Clicking the Stop button stops the loopback operation.

For recording (AIC23 only), analog input is accepted from the Line-In or Mic inputs, converted to digital format with the TLV320AIC23's ADC, and the digital data is stored within a 64-Kbyte DSK/EVM external memory data buffer; it is not transferred to the host.

The Record (AIC23 only) button starts record running. Once the Record (AIC23 only) button has been clicked, it changes to a Stop button. Clicking the Stop button stops the record operation.

For playback, the digital data is read from the 64-Kbyte DSK/EVM external memory data buffer and converted back to analog output with the AIC23's DAC on the Line-Out and Headphones outputs.

The Play button starts playback running. Once the Play button has been clicked, it changes to a Stop button. Clicking the Stop button stops the playback operation.

The Play button is initially disabled when the application is started. It is enabled once you have recorded some audio.

Select the Repeat checkbox to automatically repeat playback each time it finishes.

The amount of time that can be recorded and played back is limited by the size of the 64-Kbyte data buffer used to hold the PCM data and the current sampling rate. The available time is shown in seconds to the right of the Rec duration: text.

If you change the sampling rate between recording and playback, the audio will not sound correct when played back. No sampling rate conversion is performed on the recorded data when the sampling rate is changed.

The Record and Playback and the Play Tone functions are mutually exclusive, i.e., only one may be running at a time. If you start one while the other is running, the first one is stopped.

4.1.1.5 Input Selection

Select the input source by selecting either the Line or Mic (AIC23 only) radio button. The input source may be changed while loopback or record is running, in which case the change takes immediate effect.

The TLV320AIC23's Mic Boost feature is enabled with the Mic Boost check box.

The TLV320AIC23's Mic Mute feature is enabled with the Mic Mute check box.

4.1.1.6 Comm Test

The Comm Test button initiates a simple communication test that verifies that the host GUI application is properly communicating with the DSP application.

If communication is operating, correctly then clicking the Comm Test button should result in the three LEDs on the C54x DSK/EVM board blinking in succession ten times. Finally the read and write bandwidth of the parallel port connection to the DSK/EVM (in bytes per second) is measured and reported in a message box.

4.1.1.7 Reset Codec

The Reset Codec button resets and reconfigures the AIC23.

4.1.1.8 Reset DSP

The Reset DSP button resets the DSP, downloads the DSP application, and resets and reconfigures the AIC23.

4.1.1.9 Secondary Dialog Access

The Digital Control, Analog Control, and Registers secondary dialogs are accessed by clicking their respective buttons.

The secondary dialogs are modal dialogs, e.g., the main dialog does not respond to an input while a secondary dialog is open.

Changes made to the AIC23 register set affecting the controls on the main dialog are reflected in the main dialog control state when the secondary dialog is closed. That is, the main dialog control state is updated to match the register state when the secondary dialog is closed.

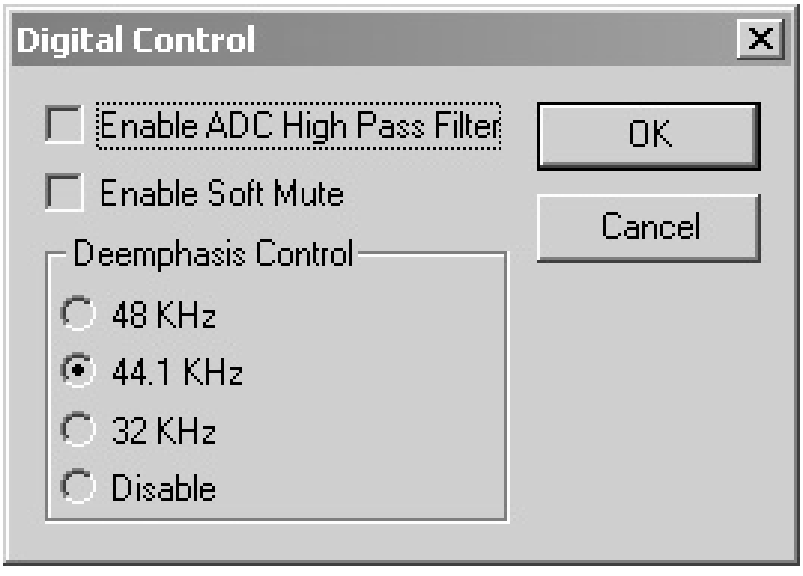
The secondary dialogs are covered in the following sections.

4.1.2 Digital Control Dialog

The Digital Control dialog provides the interface to control the functionality covered by the AIC23's digital audio path control register.

The Digital Control dialog is shown in Figure 4–3.

Figure 4–3. Digital Control Dialog



Select the Enable ADC High Pass Filter (AIC23 only) checkbox to enable the TLV320AIC23's ADC high-pass filter.

Select the Enable Soft Mute checkbox to enable the AIC23's DAC soft mute control.

Select the appropriate Deemphasis Control radio button to control the AIC23's DAC digital filter deemphasis.

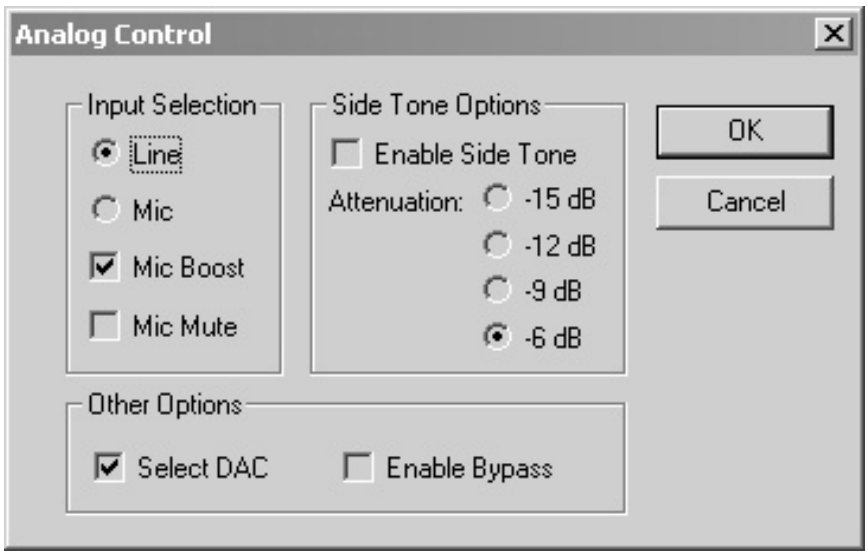
Changes made on this dialog take immediate effect. You may accept the changes with the OK button, or cancel them with the Cancel button. Canceling the changes restores the AIC23 register state to what it was when the dialog was first opened.

4.1.3 Analog Control Dialog

The Analog Control dialog provides the interface to control the functionality covered by the AIC23's analog audio path control register.

The Analog Control dialog is shown in Figure 4–4.

Figure 4–4. Analog Control Dialog



The Input Selection controls duplicate some of the functionality that appears on the main dialog. Select the input source by selecting either the Line or Mic (AIC23 only) radio button. The input source may be changed while loopback is running, in which case the change takes immediate effect. The TLV320AIC23's Mic Boost feature is enabled with the Mic Boost check box. The TLV320AIC23's Mic Mute feature is enabled with the Mic Mute check box.

Select the Enable Side Tone checkbox to enable the AIC23's sidetone feature that sums the Mic (AIC23 only) input into the Line Out and Headphone outputs. Select the appropriate Attenuation radio button to control the degree of attenuation applied to the sidetone signal.

Select the Enable Bypass checkbox to enable the AIC23's bypass feature that sums the Line Input into the Line Out and Headphone outputs.

Select the Select DAC checkbox to enable the AIC23's DAC Select feature that sums the DAC output into the Line Out and Headphone outputs.

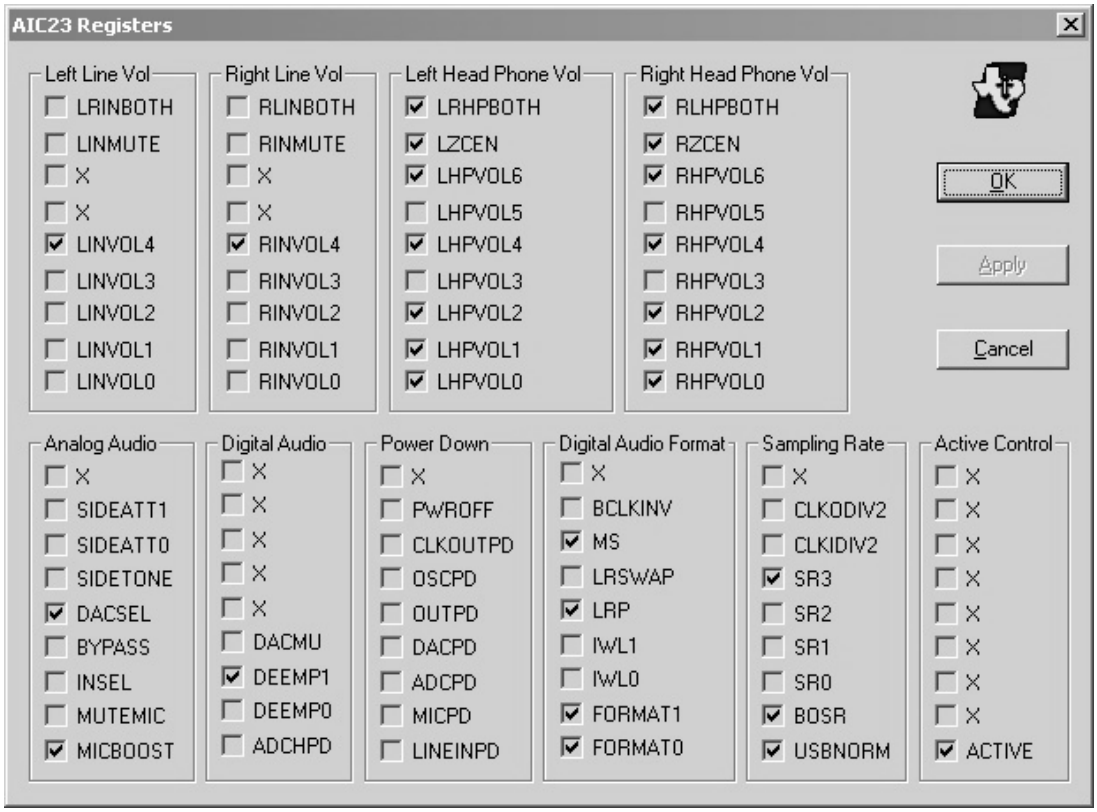
Changes made on this dialog take immediate effect. You may accept the changes with the OK button, or cancel them with the Cancel button. Canceling the changes restores the AIC23 register state to what it was when the dialog was first opened.

4.1.4 Registers Dialog

The Registers dialog provides direct access to the AIC23's registers.

The Registers dialog is shown in Figure 4–5.

Figure 4–5. Registers Dialog



Changes made on this dialog take effect only on OK or Apply. You may accept the changes with the OK button, or cancel them with the Cancel button. Canceling the changes restores the AIC23 register state to what it was when the dialog was first opened. You may cancel your changes even after applying them.

Changes made to the AIC23 register set affecting the controls on the main dialog are reflected in the main dialog control state when the Registers dialog is closed. That is, the main dialog control state is updated to match the register state when the Registers dialog is closed.

Note that you do not have complete control over the LR/RLINBOTH and the LR/RLHPBOTH values, or over the L/RHPVOL values, once the Registers dialog has been closed. In order to function correctly, the main dialog must keep the BOTH values consistent with the current state of the main dialog controls; it cannot preserve the values established by the Registers dialog. Also, any L/RHPVOL values less than 47 are forced to 47 by the main dialog. This should have no perceptible effect since the AIC23 defines all values of 47 or less as mute values.

4.2 Implementation

The host GUI application resides in the Software\AIC23GUI subdirectory in the TLV320AIC23 EVM software distribution.

The host GUI application is a Win32 C++ MFC-based application.

The host GUI application is built using the Microsoft Visual Studio 6.0 (with Service Pack 4) IDE development environment. Load the workspace into the IDE, select the Win32 Release or Win32 Debug configuration, and select the Rebuild All item from the Build menu. This builds all host application executables, including AIC23.exe, evmdsk54x.dll, and ppc54x.dll. The DSP application must be built and its binary application file (AIC23.out) must be available prior to building the host application. The DSP application binary is bound into AIC23.exe as a resource to assure that it is available when AIC23.exe is run.

The application is implemented in the following source files:

- Aic23.h/cpp — The application class, CAic23App
- Aic23dlg.h/cpp — The main dialog class, CAic23Dlg
- Analog.h/cpp — The analog control dialog class, CAnalogCtrl
- Digital.h/cpp — The digital control dialog class, CDigitalCtrl
- Register.h/cpp — The registers dialog class, CControlRegisters
- Aic23reg.h/cpp — The AIC23 register access class, Aic23Reg
- Msngr.h/cpp — The host/DSP message communication class,
- MsngrStdafx.h — MSVC precompiled header configuration file
- Resource.h — Resource control id definitions
- Aic23.rc — Resource definitions

The CAic23App application class is a standard AppWizard generated template class with nothing of interest to note in its implementation.

The CAic23Dlg main dialog class consists of initialization methods, a set of message map driven message handler routines to respond to the controls on the dialog, and a set of support methods. Dialog initialization starts with the OnInitDialog method. OnInitDialog calls the SetupDSP method to initialize the C54x DSK/EVM and download the DSP application, then it calls the DialogInit method to initialize the state of the dialog and the AIC23. The SetupDSP method calls the C54x DSK/EVM Win32 user mode API routines (evmdsk54x_open, evmdsk54x_hpi_open, evmdsk54x_reset_board, and evmdsk54x_coff_load) to initialize the DSP. The Aic23Reg::updateReg and updateAll methods are used to write to the AIC23 registers. The

Msngr::sendMsg method is used to send a message (i.e. command) to the DSP application. The message handlers respond to their particular control and modify the state of the application and AIC23 registers, and/or send DSP commands as appropriate for that control and the present context.

The CAnalogCtrl, CDigitalCtrl, and CControlRegisters classes are implemented in the usual manner, with initialization occurring in their OnInitDialog method, and a set of message-map-driven message handler routines to respond to the controls on the dialog. The message handlers respond to their particular control and modify the state of the application and AIC23 registers as appropriate. The OnInitDialog method saves a copy of the AIC23 registers on entry to the dialog so that they may be restored if the user selects the Cancel button to exit the dialog.

The Aic23Reg class writes to the AIC23 registers by sending REG_WRITE and WRITE_ALL commands to the DSP using the Msngr::sendMsg method. A local in-memory copy of the register set is maintained to support modifying a subset of the bits in a given register.

The Msngr class sends commands to the DSP by writing commands and their parameters into a command buffer in DSP memory with the evmdsk54x_write and evmdsk54x_write_single C54x DSK/EVM Win32 user mode API routines. Prior to writing a command, the command field in the command buffer is polled with the evmdsk54x_hpi_read_single routine to see if the buffer is available, i.e., the DSP is not busy processing a command. A value of zero in the command field means that the DSP is ready to accept a new command. The Msngr class writes the parameters first and the command field last. The DSP is in a loop polling the command field. When it sees the command field become nonzero, it begins processing the command; it sets the command field to zero when it completes the command, which allows the host to write the next command to the buffer.

Chapter 5

DSP Application

This chapter describes the operation and implementation of the aic23.out DSP application.

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5.1 Operation

The DSP application (aic23.out) runs on a C54x DSK/EVM. It initializes the DSP and the DSK/EVM peripherals (McBSPs), configures the AIC23, and then enters a command loop where it receives commands from the host GUI application over the C54x DSK/EVM parallel port interface. Each command is processed to completion and then the application polls for the next command.

The supported commands are: RESET, TEST (host communication), REG_WRITE, WRITE_ALL (e.g. registers), TONE (play a tone of specified frequency), LOOP (e.g., record and playback), RECORD (to a memory buffer), PLAY (from a memory buffer), and STOP (the current TONE, LOOP, PLAY, or RECORD command). The command parameters are presented in Table 5–1.

Table 5–1. DSP Application Command Parameters

Command	Parameters
RESET	None
TEST	None
REG_WRITE	UINT16 AIC23 register index and register value
WRITE_ALL	UINT16 [10] AIC23 register value array
TONE	UINT32 sampling rate in Hz UINT16 frequency in Hz
LOOP	UINT32 sampling rate in Hz
RECORD	UINT32 sampling rate in Hz
PLAY	UINT32 sampling rate in Hz UINT16 repeat flag (1 = repeat)
STOP	UINT16 Full reset flag (1 = full reset)

The RESET command performs a full reset and reconfiguration of the McBSPs and the AIC23.

The TEST command blinks the three LEDs on the DSK/EVM on/off ten times in succession.

The REG_WRITE command writes a specified value to a single AIC23 register.

The WRITE_ALL command writes the entire AIC23 register set.

The TONE command generates a buffer of PCM data for a tone of specified frequency and then plays the data through the AIC23 DAC until the STOP command is received.

The LOOP command reads a buffer of PCM data via the AIC23 ADC and then plays the data through the AIC23 DAC repeatedly until the STOP command is received.

The RECORD command reads buffers of PCM data via the AIC23 ADC and stores the data in a 64K external memory buffer until either the STOP command is received or the 64K buffer is full.

The PLAY command reads buffers of PCM data from a 64K external memory buffer and then plays the data through the AIC23 DAC until either the STOP command is received or the 64K of data is exhausted.

Once started, the TONE, LOOP, PLAY, and RECORD commands are DMA-driven via callback routines that run continuously until the STOP command is received.

The STOP command reconfigures the McBSPs and breaks the continuous callback process to stop the playback of PCM data through the AIC23 DAC. Also, it can optionally perform a full reset and reconfiguration of the AIC23.

5.2 Implementation

The DSP application resides in the Software\AIC23DSP subdirectory in the TLV320AIC23 EVM software distribution.

The DSP application is built using the TI Code Composer Studio for the C5000 version 1.20 IDE. Load the project into the IDE and select the Rebuild All item from the Project menu to build the application.

The DSP application is a C BIOS II-based application implemented in the following source files:

- Main.c — The application entry point, command loop and handlers
- Msg.h — Command buffer, AIC23 registers and sample rate definitions
- Type.h — Basic type definitions used by Main.c
- Tidc_api.c — Data converter wizard generated API code
- Tidc_api.h — Data converter wizard generated interface to Tidc_api.c
- Taic23_ob.c — Data converter TAIC23 object initialization and access routines
- Taic23_fn.h — Data converter wizard-generated interface to Taic23_ob.c
- Dc_conf.h — Data converter wizard-generated configuration file
- Aic23cfg.s54 — Code Composer generated configuration file

The DSP interface uses McBSP0 for the digital audio data and McBSP1 for the control interface. The DSP application uses the DSP format of the AIC23/DAC23 (FS + 32-bit data (16 bit left and 16 bit right channel) in master mode for the digital audio interface. All the clock signals (BCLK, LRCIN, LRCOUT) are generated by the data converter. McBSP1 is used in SPI mode.

The application entry point is the main routine in Main.c. The main routine first initializes the DSK/EVM and application variables, and then initializes the McBSPs and blinks the LEDs to provide visual feedback that the application is running. Finally, it enters the command loop, calling the getCmd routine to

poll for a command from the host; then a command is received calling the processCommand routine to process it. The getCmd routine is a simple routine that polls the command field of the command buffer in a tight loop until it is nonzero. The processCommand routine is a simple dispatch routine consisting of a switch statement that calls the appropriate command handler routine, depending on which command was received.

The RESET command is implemented by calling dc_configure to perform a full reset and reconfigure the McBSPs and the AIC23.

The TEST command is implemented by calling the blink routine to blink the DSK/EVM LEDs.

The REG_WRITE and WRITE_ALL commands are implemented by calling the aic23_write_reg data converter routine to write the register values.

The TONE command is implemented by calling the signal routine to generate PCM waveform data for the specified tone frequency, then calling the data converter dc_wblock routine to initiate an interrupt-driven DMA transfer from the PCM data buffer to the AIC23 DAC. When the data transfer is complete, the wcallback routine is called, which initiates another transfer from the same data buffer if the STOP command has not been received.

The LOOP command is implemented by calling the data converter dc_rblock routine to read PCM data from the input source into a data buffer via the AIC23 ADC, and then calling the data converter dc_wblock routine to initiate an interrupt-driven DMA transfer from the PCM data buffer to the AIC23 DAC. When the read data transfer is complete, the rcallback routine is called; this routine initiates another transfer to the same data buffer if the STOP command has not been received. When the write data transfer is complete, the wcallback routine is called, which initiates another transfer from the same data buffer if the STOP command has not been received.

The RECORD (AIC23 only) command is implemented by calling the data converter dc_rblock routine to read PCM data from the input source into a small internal memory data buffer via the AIC23 ADC. When the read data transfer is complete, the rcallback routine is called; this routine copies the data from the internal memory buffer to a 64K external memory buffer and then initiates another transfer to the same internal data buffer if the STOP command has not been received.

The PLAY command is implemented by calling the data converter dc_wblock routine to write PCM data from the small internal memory data buffer to the AIC23 DAC. When the write data transfer is complete, the wcallback routine is called, this routine copies data from the 64K external memory buffer to the internal memory buffer and then initiates another transfer from the same internal data buffer if the STOP command has not been received.

The STOP command is implemented by setting a global flag variable that indicates to the PLAY and RECORD (AIC23 only) callback routines that their activity has been stopped. The STOP command also performs either a full or partial reset, depending on the value of its parameter. The full reset is the same as that performed by the RESET command. The partial reset reconfigures the McBSPs, but does not reset or reconfigure the AIC23.

Full and partial resets are supported because it was determined that the full reset causes an audible *click* or *pop* to occur as a result of the reset and reconfigure of the AIC23. Specifically, writing a zero to the POWEROFF bit (bit 7) of the power down control register in order to power up the AIC23 causes the click/pop. This can be observed by manually changing the state of the bit on the host GUI application's Registers dialog. This annoying click/pop is avoided by using the partial reset when starting or stopping the PLAY and RECORD (AIC23 only) commands. The full reset is used by the RESET command when initializing the application and when changing the sampling frequency.

Chapter 6

Host Software Development Support

Figure 6–1 provides a block diagram of the C54x DSK/EVM software components and their relationships. The nonshaded, shadowed boxes represent the software that comprises the host software development components for the C54x DSK/EVM. The dashed-outline boxes are the components used by the TLV320AIC23 EVM host software.

The user mode API is shown in the center of the block diagram. This API is provided as a Win32 user mode DLL that enables users to access and control the TLV320AIC23 EVM from the user's own host applications. This DLL is common across all Windows platforms, so host applications are not OS-specific. The user mode API Win32 DLL is implemented in the evmdsk54x.dll executable. The evmdsk54x.dll source is located in the 5402DSK\ evmdsk54xdll subdirectory in the TLV320AIC23 EVM software distribution.

The low-level board drivers are shown in the bottom center of the block diagram. These drivers provide OS-specific board support for Windows 9X, NT 4.0, and Windows 2000. These drivers present a common interface to the user mode DLL. The OS-independent parallel port driver used by the TLV320AIC23 EVM software is implemented in the ppc54x.dll, dlportio.dll, and dlportio.sys executables. The ppc54x.dll source is located in the 5402DSK\ ppc54xdll subdirectory in the TLV320AIC23 EVM software distribution.

The left side of the block diagram shows the debugger support which consists of a DLL that enables the TI code composer debugger to communicate with the TLV320AIC23 EVM's and DSK's JTAG TBC over the parallel port or the TLV320AIC23 EVM's JTAG TBC over the PCI bus.

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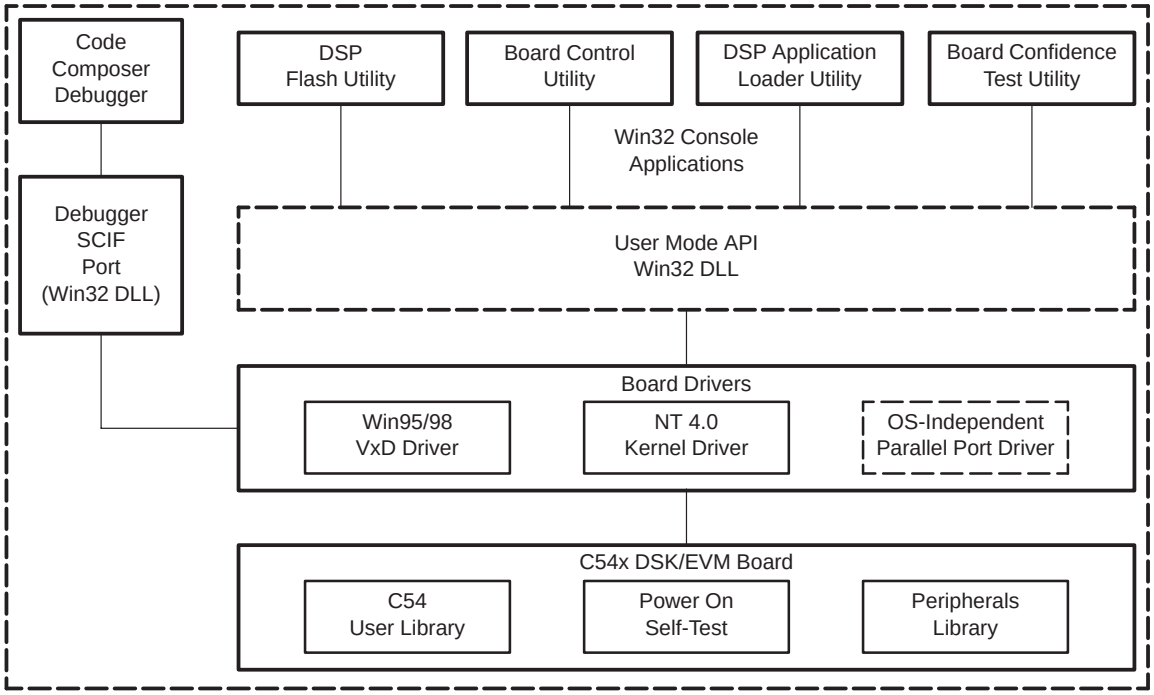
Each software component is discussed in detail in the following subsections.

Figure 6–1. C54x DSK/EVM Host Software Development Block Diagram



6.1 User Mode API

6.1.1 Functional Overview

A common Win32 DLL (emvdsk54x.dll) provides the user mode interface to the C54x DSK/EVM. This DLL provides the API that allows host application code to run on any supported version of Windows without recompilation. The intelligent processing of C54x DSK/EVM registers and handling of data transfers is performed by the DLL. The DLL makes calls to the board driver to get access to the board's resources and PCI configuration registers (EVM only). The advantage of this approach is that the board drivers can support different types of C54x DSK/EVM boards in the future, such as special-purpose or multiple-DSP versions, and code maintenance can be done in one place. This eliminates the need of distributing various versions of the low-level drivers. A DLL is easy to update since it only involves copying over the previous version.

The common API user mode DLL provides the following capabilities:

- ❏ Open board connection with exclusive option (includes board initialization)
- ❏ Board initialization
- ❏ Close board connection
- ❏ Board resetting

- DSP reset control
- Board information (number and type of DSPs, revision, etc.)
- Loading of C54x COFF application from a file using HPI
- Read/write C54x memory using HPI
- Read/write GP bus registers (EVM only)
- Generation of interrupt to C54x
- Enabling and disabling of interrupts from C54x EVM/DSK
- Hot swap software support (switch read/LED control)
- DLL error display control (enable/disable/redirection)
- DLL revision information

6.1.2 API Summary

Table 6–1 provides a summary of the API function calls that are used by the TLV320AIC23 EVM software. Parameters and parameter type definitions are described in later sections. API function calls not used by the TLV320AIC23 EVM user software are not covered here. See the appropriate C54x DSK/EVM software user's guide document for full details on this interface.

Table 6–1. User Mode API Calls Used by the AIC23 Codec Tester EVM Software

Evmdsk54x_close()	Close a driver connection to a board
evmdsk54x_reset_board()	Completely reset a board
evmdsk54x_coff_load()	Load a COFF image into DSP memory
evmdsk54x_hpi_open()	Open the HPI for a DSP
Evmdsk54x_open()	Open a driver connection to a board
evmdsk54x_hpi_close()	Close the HPI for a DSP
evmdsk54x_hpi_read()	Read DSP memory using the HPI
evmdsk54x_hpi_write()	Write DSP memory using the HPI
evmdsk54x_hpi_read_single()	Read a single 16-bit value from DSP memory
evmdsk54x_hpi_write_single()	Write a single 16-bit value to DSP memory

6.1.3 API Detail

This section provides the details of the API calls, including function prototypes and parameter descriptions. Parameter definitions are provided as appropriate. Details of type definitions and enumerations are covered in the appropriate C54x DSK/EVM software user's guide document.

6.1.3.1 evmdsk54x_open()

- Description
  - Open a driver connection to a board.
- Prototype
  - DLL32_ENTRY HANDLE evmdsk54x_open(int board_index, EVMDSK54X_BOARD_TYPE boardType, EVMDSK54X_OPEN_TYPE openType, BOOL exclusive_flag);
- Parameters
  - board_index—corresponds to the board number for which the handle is requested.
  - exclusive_flag—indicates exclusive ownership of the board.
  - boardType—Specifies whether the board is a TYPE_C5402_DSK or a TYPE_C5410_DSK.
  - openType—Specifies either a parallel or PCI connect. Note that the 5402 DSK only supports a parallel connection. If a PCI connection is specified for the DSK, an INVALID_HANDLE_VALUE is returned.

6.1.3.2 evmdsk54x_close()

- Description
  - Close a driver connection to a board
- Prototype
  - DLL32_ENTRY BOOL evmdsk54x_close(HANDLE hDevice);
- Parameters
  - hDevice—Board handle returned from the call to evmdsk54x_open.

6.1.3.3 evmdsk54x_reset_board()

- Description
  - Resets the board to a known state.
- Prototype
  - DLL32_ENTRY BOOL evmdsk54x_reset_board(HANDLE hDevice);
- Parameters
  - hDevice—Board handle returned from the call to evmdsk54x_open.

6.1.3.4 evmdsk54x_coff_load()

- Description
  - Load a COFF image into DSP memory.
- Prototype
  - DLL32_ENTRY BOOL evmdsk54x_coff_load(HANDLE hDevice,
    LPVOID lp_hpi,
    char *filename,
    BOOL verboseFlag,
    BOOL clear_bss_flag,
    BOOL dump_flag,
    ULONG dspNum);
- Parameters
  - hDevice—Board handle returned from the call to evmdsk54x_open.
  - lp_hpi—A pointer to the HPI map object returned from the call to evmdsk54x_hpi_open().
  - filename—The name of the COFF file.
  - verboseFlag—Display basic COFF file information via the standard output stream.
  - clear_bss_flag—Initialize all bss section variable to zero.
  - dump—Display all data via the standard output stream.
  - dspNum—Specifies the DSP to load the COFF file into. Allows up to four DSPs to be supported on a board.

6.1.3.5 evmdsk54x_hpi_open()

- Description
  - Opens the host port interface (HPI) to the DSPs and assures mutual exclusion to the DSPs HPI as well as memory.
- Prototype
  - DLL32_ENTRY LPVOID evmdsk54x_hpi_open(HANDLE hDevice);
- Parameters
  - hDevice—Board handle returned from the call to evmdsk54x_open.

6.1.3.6 evmdsk54x_hpi_close()

- Description
  - Closes the host port interface (HPI) to the DSP.
- Prototype
  - DLL32_ENTRY BOOL evmdsk54x_hpi_close(LPVOID pBd_);
- Parameters
  - pBp—Handle returned from the call to evmdsk54x_hpi_open.

6.1.3.7 evmdsk54x_hpi_read()

- Description
  - Read DSP memory using the HPI.
- Prototype
  - DLL32_ENTRY BOOL evmdsk54x_hpi_read(LPVOID pBp,
    PULONG p_buffer,
    PULONG p_length,
    ULONG src_addr,
    int memSpace,
    ULONG dspNum);
- Parameters
  - pBp—Handle returned from the call to evmdsk54x_hpi_open.
  - p_buffer—Pointer to the buffer to read data into.
  - p_length—Number of 16-bit words to read.
  - src_addr—DSP memory address to read from.
  - memSpace—Indicates whether to read from DATA memory or from PROGRAM memory.
  - dspNum—Specifies the DSP number. Allows up to four DSPs to be supported on a board.

6.1.3.8 evmdsk54x_hpi_write()

- Description
  - Write DSP memory using the HPI.
- Prototype
  - DLL32_ENTRY BOOL evmdsk54x_hpi_write(LPVOID pBp,
    PULONG p_buffer,
    PULONG p_length,
    ULONG dest_addr,
    int memSpace,
    ULONG dspNum);
- Parameters
  - pBp—Handle returned from the call to evmdsk54x_hpi_open.
  - p_buffer—Pointer to the buffer to read data into.
  - p_length—Number of 16-bit words to write.
  - src_addr—DSP memory address to read from.
  - memSpace—Indicates whether to write to data memory or program memory.
  - dspNum—Specifies the DSP number. Allows up to four DSPs to be supported on a board.

6.1.3.9 evmdsk54x_hpi_read_single()

- Description
  - Read a single 16-bit value from DSP memory.
- Prototype
  - DLL32_ENTRY BOOL evmdsk54x_hpi_read_single(LPVOID pBp,
    PULONG p_data,
    ULONG src_addr,
    int memSpace,
    ULONG dspNum);
- Parameters
  - pBp—Handle returned from the call to evmdsk54x_hpi_open.
  - p_data—Pointer to the buffer to read data into.
  - src_addr—DSP memory address to read from.
  - memSpace—Indicates whether to read from DATA memory or from PROGRAM memory.
  - dspNum—Specifies the DSP number. Allows up to four DSPs to be supported on a board.

6.1.3.10 evmdsk54x_hpi_write_single()

- Description
  - Write a single 16-bit value to DSP memory.
- Prototype
  - DLL32_ENTRY BOOL evmdsk54x_hpi_write_single(LPVOID pBp,
    PULONG p_data,
    ULONG dest_addr,
    int memSpace,
    ULONG dspNum);
- Parameters
  - pBp—Handle returned from the call to evmdsk54x_hpi_open.
  - p_data—Pointer to the buffer to read data into.
  - dest_addr—DSP memory address to write to.
  - memSpace—Indicates whether to write to data memory or program memory.
  - dspNum—Specifies the DSP number. Allows up to four DSPs to be supported on a board.

6.2 Board Drivers

6.2.1 Functional Overview

The board drivers for the C54x DSK/EVM provide the low-level software interface to the DSK/EVM board. These low-level drivers are not intended to be directly accessible to user mode applications. A user mode Win32 DLL that provides a consistent API across all supported Windows platforms hides the details of accessing these low-level drivers.

The TLV320AIC23 EVM user software does not directly use the board drivers. It adheres to the recommended programming model, using only the user mode Win32 DLL to access the C54x DSK/EVM. For this reason, this section of the document is kept brief, providing only an overview of the functionality supported by the board drivers.

The purpose of the board driver functions is to allow the user mode DLL to access and control the C54x DSK/EVM. These functions provide a basic interface that provides access to the board in all supported Windows environments. The user mode DLL provides intelligent processing and control functions that call low-level board driver functions to access board resources and PCI/PPC configuration data.

The following list summarizes the board driver capabilities:

- **OS Support**—Three drivers will be developed: an NT kernel driver to support NT 4.0 and Windows 2000, a virtual device driver (VxD) to support Windows 9X (both for PCI access), and an OS independent low-level driver for parallel port access. The drivers provide OS-specific driver functions in addition to the board-related functions. The NT driver will be usable without administrator privileges.

- **Host Port Interface Access**—Read, write, send interrupt, and receive interrupt routines are provided. These allow applications to access the C54x's HPI for board configuration and application loading.

- **JTAG TBC Register Access**—JTAG TBC registers are mapped to host application accessible address space via PCI for the TLV320AIC23 EVM or accessible via the parallel port for TLV320AIC23 EVM and DSK. This allows applications, such as the debugger, to use the on-board TBC. This will be an exclusive operation per target board to prevent multiple applications from simultaneously accessing the same TBC device.

- **Interrupt Handling**—The receipt of an interrupt from the C54x DSK/EVM sets Win32 events to notify the user mode code of an interrupt occurrence.

- **Board Reset**—This is accomplished by accessing a register on the C54x DSK/EVM platform. This resets all of the target board, except for the C54x device itself. It does not reset the PCI bus (EVM only) or the host system.

- **DSP Reset**—This is accomplished by accessing a register on the C54x DSK/EVM platform. This resets the DSP, which is necessary to control application loading over the parallel port (DSK only) or the PCI bus (EVM only).

6.2.2 PPC Driver API

This API is provided with the C54x DSK or TLV320AIC23 EVM to support access via the parallel port. The software is more of a DLL than a driver. It translates calls into command sequences for transmission via the dlportio parallel port driver. The PPC driver API is not covered here since the TLV320AIC23 EVM user software does not directly access this interface. For details of this interface see the appropriate C54x DSK/EVM software user's guide document.

Appendix A

BOMs, Board Layers, and Schematics

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A.1 TLV320AIC23EVM Bill of Materials

TEXAS INSTRUMENTS SEMICONDUCTORS								
Item Number	**DESCRIPTION**	**REF DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR**	**ALT. PART NUMBER**	**MFG/ VENDOR**
1	TLV320AIC23PW	U1	1	Texas Instruments	TLV320AIC23PW	TI		
2	TPA102	U8	1	Texas Instruments	TPA102DGNR	TI		
3	TPS7133D, 3.3V LDO REGULATOR 8–SOP	U10, U11	2	Texas Instruments	TPS7133QD	TI	296–2658–5	Digi-Key
4	TPS76750D, 5.0V 1A LDO REG 8–SOP	U9	1	Texas Instruments	TPS76750QD	TI	296–2739–5	Digi-Key
5	SN74AHCU04ADGVR	U7	1	Texas Instruments	SN74AHCU04DGVR	TI		
6	SN74ALB16244DGGR	U5, U6	2	Texas Instruments	SN74ALB16244DGGR	TI		
7	TUSB3200	U3	1	Texas Instruments	TUSB3200CPAH	TI		

SEMICONDUCTORS								
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**	**ALTERNATE PART NUMBER**
8	RECTIFIER 1 AMP 50V SMA SMD	D1	1	Diodes Inc.	S1AT	S1ADITR–ND	Digi-Key	
9	LED GREEN DIFF 1206 SMD	D2, D4	2	Chicago Miniature	CMD15–21VGD/TR8	L62305TR–ND	Digi-Key	
10	LED H.E. RED DIFF 1206 SMD	D3	1	Chicago Miniature	CMD15–21VRD/TR8	L62301TR–ND	Digi-Key	
11	CS8427 CZ	U2	1	Crystal Semiconductor	CS8427 CZ	CS8427 CZ	Insight	
12	AT24C64–10TC–2.7	U4	1	Microchip Technology	24LC64	24LC64–I/SN–ND	Digi-Key	AT24C64–10TC–2.7 / ATMEL
13	6MHz	X1	1	ESC INC.	ECS–60–32–4	X413–ND	Digi-Key	

A.1 TLV320AIC23EVM Bill of Materials (continued)

CAPACITORS								
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**	**ALTERNATE PART NUMBER**
14	CAP 33PF 50V CERM CHIP 0805 SMD	C46, C47	2	Panasonic	ECJ–2VC1H330J	PCC330CGTR–ND	Digi-Key	
15	CAP 47PF 50V CERM CHIP 0805 SMD	C10, C12, C14, C44, C45	5	Panasonic	ECJ–2VC1H470J	PCC470CGTR–ND	Digi-Key	
16	CAP 100PF 50V CERM CHIP 0805 SMD	C49	1	Panasonic	ECJ–2VC1H101J	PCC101CGTR–ND	Digi-Key	
17	CAP 1000PF 50V CERM CHIP 0805	C48	1	Panasonic	ECJ–2VC1H102J	PCC102CGTR–ND	Digi-Key	
18	CAP 2200PF 50V CERM CHIP 0805	C38	1	Panasonic	ECJ–2VB1H222K	PCC222BNTR–ND	Digi-Key	
19	CAP 10000PF 50V CERM CHIP 0805	C35, C36	2	Panasonic	ECJ–2VB1H103K	PCC103BNTR–ND	Digi-Key	
20	CAP 68000PF 50V CERM X7R 0805	C37	1	Panasonic	ECJ–2YB1H683K	PCC1838TR–ND	Digi-Key	
21	CAP 0.1UF 50V CERAMIC X7R 0805	C1, C3, C5, C7, C8, C9, C18, C24, C25, C26, C27, C28, C30, C32, C33, C34, C39, C40, C42, C43, C50, C51, C52, C53, C54, C55, C56, C57	28	Panasonic	ECJ–2YB1H104K	PCC1840TR–ND	Digi-Key	
22	CAP 0.47UF 35V TANT TE Series	C11, C13, C16, C17	4	Panasonic	ECS–T1VY474R	PCS6474TR–ND	Digi-Key	PCS5474TR–ND/ Digi-Key
23	CAP 1.0UF 25V TANT TE Series	C15, C20	2	Panasonic	ECS–T1EY105R	PCS5105TR–ND	Digi-Key	
24	CAP 10UF 6.3V TANT TE Series	C19, C23, C29, C31	4	Panasonic	ECS–T0JY106R	PCS1106TR–ND	Digi-Key	
25	CAP 10UF 16V TANT TE Series	C2, C4, C6	3	Panasonic	ECS–T1CX106R	PCS3106TR–ND	Digi-Key	
26	CAP 220UF 25V ELECT VS SMD	C21, C22	2	Panasonic	ECE–V1EA221UP	PCE3187TR–ND	Digi-Key	

A.1 TLV320AIC23EVM Bill of Materials (continued)

RESISTORS							
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**
27	RES 0.0 OHM 1/10W 5% 0805 SMD	R43 DO NOT INSTALL	1	Panasonic	ERJ–6GEY0R00V	P0.0ATR–ND	Digi-Key
28	RES 22.1 OHM 1/10W 1% 0805 SMD	R37, R38	3	Panasonic	ERJ–6ENF22R1V	P22.1CTR–ND	Digi-Key
29	RES 75.0 OHM 1/10W 1% 0805 SMD	R25	1	Panasonic	ERJ–6ENF75R0V	P75.0CTR–ND	Digi-Key
30	RES 100 OHM 1/10W 1% 0805 SMD	R12, R14, R27	3	Panasonic	ERJ–6ENF1000V	P100CTR–ND	Digi-Key
31	RES 301 OHM 1/10W 1% 0805 SMD	R26	1	Panasonic	ERJ–6ENF3010V	P301CTR–ND	Digi-Key
32	RES 681 OHM 1/10W 1% 0805 SMD	R4	1	Panasonic	ERJ–6ENF6810V	P681CTR–ND	Digi-Key
33	RES 1.00K OHM 1/10W 1% 0805 SMD	R3, R41	2	Panasonic	ERJ–6ENF1001V	P1.00KCTR–ND	Digi-Key
34	RES 1.50K OHM 1/10W 1% 0805 SMD	R39	1	Panasonic	ERJ–6ENF1501V	P1.50KCTR–ND	Digi-Key
35	RES 3.01K OHM 1/10W 1% 0805 SMD	R40	1	Panasonic	ERJ–6ENF3011V	P3.01KCTR–ND	Digi-Key
36	RES 5.11K OHM 1/10W 1% 0805 SMD	R5, R6, R7, R8, R11, R28	6	Panasonic	ERJ–6ENF5111V	P5.11KCTR–ND	Digi-Key
37	RES 10.0K OHM 1/10W 1% 0805 SMD	R1, R2, R9, R10, R23, R24, R34, R35, R36, R42	10	Panasonic	ERJ–6ENF1002V	P10.0KCTR–ND	Digi-Key
38	RES 20.0K OHM 1/10W 1% 0805 SMD	R16, R18, R19, R20	4	Panasonic	ERJ–6ENF2002V	P20.0KCTR–ND	Digi-Key
39	RES 47.5K OHM 1/10W 1% 0805 SMD	R13, R15, R21, R22, R29, R30, R31, R32	8	Panasonic	ERJ–6ENF4752V	P47.5KCTR–ND	Digi-Key
40	RES 100K OHM 1/10W 1% 0805 SMD	R33	1	Panasonic	ERJ–6ENF1003V	P100KCTR–ND	Digi-Key

A.1 TLV320AIC23EVM Bill of Materials (continued)

INDUCTORS, TRANSFORMERS, FERRITE BEADS							
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**
41	FERRITE BEAD	FB1, FB2, FB3, FB4, FB5	5	Panasonic	EXC–ML20A390U	P10191TR–ND	Digi-Key
42	TRANSFORMER	TR1	1	Mini–Circuits	T1–1T–KK81		Mini–Circuits

Jacks, Connectors, Switches, Headers							
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**
43	TERM BLOCK VERT 2POS 5.08MM PCB	J3, J4, J14	3	On Shore Technology	EDZ500/2DS	ED1975–Nd	Digi-Key
44	SAMTEC–TFM–140	J1, J2	2	SAMTEC	TFM–140–01–S–D	TFM–140–01–S–D	Arrow
45	RCA PHONO JACK, PCB	J5, J8	2	DGS		16PJ097	
46	RCA PHONO JACK, PCB	J11, J12	2	DGS		16PJ097	Mouser
47	RCA PHONO JACK, PCB	J6, J9	2	DGS		16PJ097	Mouser
48	MICROPHONE	J7	1	DGS		161–3101	Mouser
49	PHONE JACK, 3.5mm STEREO	J10	1	DGS		161–3504	Mouser
50	CONN 2.1MM PWRJACK RT ANGLE PCB	J13	1	Switchcraft Inc.	RAPC722	SC1153–ND	Digi-Key
51	USB_TYEB–RA	J15	1	Assmann Electronics	AU–Y1007	AE1085–ND	Digi-Key
52	SWITCH LIGHT TOUCH 160GF SMD	SW1	1	Panasonic	EVQ–PPBA25	P8086STR–ND	Digi-Key
53	ST SINGLE M HEADER GOLD 01 POS	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20	20	Sullins Electronics	PZC01SAAN	S1011–01–ND	Digi-Key
54	ST SINGLE M HEADER GOLD 02 POS	JU1, JU2, JU3, JU4, JU8	5	Sullins Electronics	PZC02SAAN	S1011–02–ND	Digi-Key
55	ST SINGLE M HEADER GOLD 03 POS	JU5, JU6, JU7	3	Sullins Electronics	PZC03SAAN	S1011–03–ND	Digi-Key

A.2 TLV320DAC23EVM Bill of Materials

TEXAS INSTRUMENTS SEMICONDUCTORS								
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR**	**ALT. PART NUMBER**	**MFG/ VENDOR**
1	TLV320DAC23PW	U1	1	Texas Instruments	TLV320AIC23PW	TI		
2	TPA102	U8	1	Texas Instruments	TPA102DGNR	TI		
3	TPS7133D, 3.3V LDO REGULATOR 8–SOP	U10, U11	2	Texas Instruments	TPS7133QD	TI	296–2658–5	Digi-Key
4	TPS76750D, 5.0V 1A LDO REG 8–SOP	U9	1	Texas Instruments	TPS76750QD	TI	296–2739–5	Digi-Key
5	SN74AHCU04ADGVR	U7	1	Texas Instruments	SN74AHCU04DGVR	TI		
6	SN74ALB16244DGGR	U5, U6	2	Texas Instruments	SN74ALB16244DGGR	TI		
7	TUSB3200	U3	1	Texas Instruments	TUSB3200CPAH	TI		

SEMICONDUCTORS								
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**	**ALTERNATE PART NUMBER**
8	RECTIFIER 1 AMP 50V SMA SMD	D1	1	Diodes Inc.	S1AT	S1ADITR–ND	Digi-Key	
9	LED GREEN DIFF 1206 SMD	D2, D4	2	Chicago Miniature	CMD15–21VGD/TR8	L62305TR–ND	Digi-Key	
10	LED H.E. RED DIFF 1206 SMD	D3	1	Chicago Miniature	CMD15–21VRD/TR8	L62301TR–ND	Digi-Key	
11	CS8427 CZ	U2	1	Crystal Semiconductor	CS8427 CZ	CS8427 CZ	Insight	
12	AT24C64–10TC–2.7	U4	1	Microchip Technology	24LC64	24LC64–I/SN–ND	Digi-Key	AT24C64–10TC–2.7/ ATMEL
13	6MHz	X1	1	ESC INC.	ECS–60–32–4	X413–ND	Digi-Key	

A.2 TLV320DAC23EVM Bill of Materials (continued)

CAPACITORS								
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**	**ALTERNATE PART NUMBER**
14	CAP 33PF 50V CERM CHIP 0805 SMD	C46, C47	2	Panasonic	ECJ–2VC1H330J	PCC330CGTR–ND	Digi-Key	
15	CAP 47PF 50V CERM CHIP 0805 SMD	C10, C12, C14, C44, C45	5	Panasonic	ECJ–2VC1H470J	PCC470CGTR–ND	Digi-Key	
16	CAP 100PF 50V CERM CHIP 0805 SMD	C49	1	Panasonic	ECJ–2VC1H101J	PCC101CGTR–ND	Digi-Key	
17	CAP 1000PF 50V CERM CHIP 0805	C48	1	Panasonic	ECJ–2VC1H102J	PCC102CGTR–ND	Digi-Key	
18	CAP 2200PF 50V CERM CHIP 0805	C38	1	Panasonic	ECJ–2VB1H222K	PCC222BNTR–ND	Digi-Key	
19	CAP 10000PF 50V CERM CHIP 0805	C35, C36	2	Panasonic	ECJ–2VB1H103K	PCC103BNTR–ND	Digi-Key	
20	CAP 68000PF 50V CERM X7R 0805	C37	1	Panasonic	ECJ–2YB1H683K	PCC1838TR–ND	Digi-Key	
21	CAP 0.1UF 50V CERAMIC X7R 0805	C1, C3, C5, C7, C8, C9, C18, C24, C25, C26, C27, C28, C30, C32, C33, C34, C39, C40, C42, C43, C50, C51, C52, C53, C54, C55, C56, C57	28	Panasonic	ECJ–2YB1H104K	PCC1840TR–ND	Digi-Key	
22	CAP 0.47UF 35V TANT TE Series	C11, C13, C16, C17	4	Panasonic	ECS–T1VY474R	PCS6474TR–ND	Digi-Key	PCS5474TR–ND / Digi-Key
23	CAP 1.0UF 25V TANT TE Series	C15, C20	2	Panasonic	ECS–T1EY105R	PCS5105TR–ND	Digi-Key	
24	CAP 10UF 6.3V TANT TE Series	C19, C23, C29, C31	4	Panasonic	ECS–T0JY106R	PCS1106TR–ND	Digi-Key	
25	CAP 10UF 16V TANT TE Series	C2, C4, C6	3	Panasonic	ECS–T1CX106R	PCS3106TR–ND	Digi-Key	
26	CAP 220UF 25V ELECT VS SMD	C21, C22	2	Panasonic	ECE–V1EA221UP	PCE3187TR–ND	Digi-Key	

A.2 TLV320DAC23EVM Bill of Materials (continued)

RESISTORS							
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**
27	RES 0.0 OHM 1/10W 5% 0805 SMD	R43 DO NOT INSTALL	1	Panasonic	ERJ–6GEY0R00V	P0.0ATR–ND	Digi-Key
28	RES 22.1 OHM 1/10W 1% 0805 SMD	R37, R38	3	Panasonic	ERJ–6ENF22R1V	P22.1CTR–ND	Digi-Key
29	RES 75.0 OHM 1/10W 1% 0805 SMD	R25	1	Panasonic	ERJ–6ENF75R0V	P75.0CTR–ND	Digi-Key
30	RES 100 OHM 1/10W 1% 0805 SMD	R12, R14, R27	3	Panasonic	ERJ–6ENF1000V	P100CTR–ND	Digi-Key
31	RES 301 OHM 1/10W 1% 0805 SMD	R26	1	Panasonic	ERJ–6ENF3010V	P301CTR–ND	Digi-Key
32	RES 681 OHM 1/10W 1% 0805 SMD	R4	1	Panasonic	ERJ–6ENF6810V	P681CTR–ND	Digi-Key
33	RES 1.00K OHM 1/10W 1% 0805 SMD	R3, R41	2	Panasonic	ERJ–6ENF1001V	P1.00KCTR–ND	Digi-Key
34	RES 1.50K OHM 1/10W 1% 0805 SMD	R39	1	Panasonic	ERJ–6ENF1501V	P1.50KCTR–ND	Digi-Key
35	RES 3.01K OHM 1/10W 1% 0805 SMD	R40	1	Panasonic	ERJ–6ENF3011V	P3.01KCTR–ND	Digi-Key
36	RES 5.11K OHM 1/10W 1% 0805 SMD	R5, R6, R7, R8, R11, R28	6	Panasonic	ERJ–6ENF5111V	P5.11KCTR–ND	Digi-Key
37	RES 10.0K OHM 1/10W 1% 0805 SMD	R1, R2, R9, R10, R23, R24, R34, R35, R36, R42	10	Panasonic	ERJ–6ENF1002V	P10.0KCTR–ND	Digi-Key
38	RES 20.0K OHM 1/10W 1% 0805 SMD	R16, R18, R19, R20	4	Panasonic	ERJ–6ENF2002V	P20.0KCTR–ND	Digi-Key
39	RES 47.5K OHM 1/10W 1% 0805 SMD	R13, R15, R21, R22, R29, R30, R31, R32	8	Panasonic	ERJ–6ENF4752V	P47.5KCTR–ND	Digi-Key
40	RES 100K OHM 1/10W 1% 0805 SMD	R33	1	Panasonic	ERJ–6ENF1003V	P100KCTR–ND	Digi-Key

A.2 TLV320DAC23EVM Bill of Materials (continued)

INDUCTORS, TRANSFORMERS, FERRITE BEADS							
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**
41	FERRITE BEAD	FB1, FB2, FB3, FB4, FB5	5	Panasonic	EXC–ML20A390U	P10191TR–ND	Digi-Key
42	TRANSFORMER	TR1	1	Mini–Circuits	T1–1T–KK81		Mini–Circuits

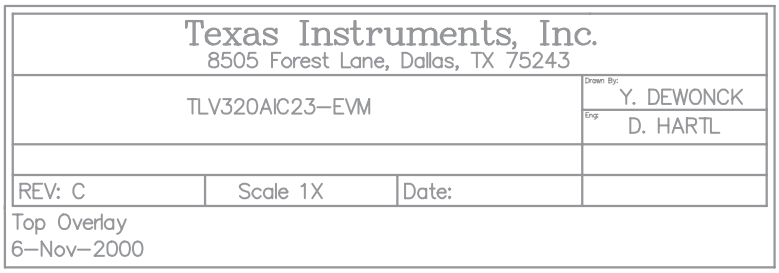
Jacks, Connectors, Switches, Headers							
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**
43	TERM BLOCK VERT 2POS 5.08MM PCB	J3, J4, J14	3	On Shore Technology	EDZ500/2DS	ED1975–Nd	Digi-Key
44	SAMTEC–TFM–140	J1, J2	2	SAMTEC	TFM–140–01–S–D	TFM–140–01–S–D	Arrow
45	RCA PHONO JACK, PCB	J5, J8	2	DGS		16PJ097	Mouser
46	RCA PHONO JACK, PCB	J11, J12	2	DGS		16PJ097	Mouser
47	RCA PHONO JACK, PCB	J6, J9	2	DGS		16PJ097	Mouser
48	MICROPHONE	J7	1	DGS		161–3101	Mouser
49	PHONE JACK, 3.5mm STEREO	J10	1	DGS		161–3504	Mouser
50	CONN 2.1MM PWRJACK RT ANGLE PCB	J13	1	Switchcraft INC.	RAPC722	SC1153–ND	Digi-Key
51	USB_TYEB–RA	J15	1	Assmann Electronics	AU–Y1007	AE1085–ND	Digi-Key
52	SWITCH LIGHT TOUCH 160GF SMD	SW1	1	Panasonic	EVQ–PPBA25	P8086STR–ND	Digi-Key

A.2 TLV320DAC23EVM Bill of Materials (continued)

Jacks, Connectors, Switches, Headers (continued)							
Item Number	**DESCRIPTION**	**REFERENCE DESIGNATORS**	**QTY**	**MFG**	**MFG PART NUMBER**	**VENDOR PART NUMBER**	**VENDOR**
53	ST SINGLE M HEADER GOLD 01 POS	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20	20	Sullins Electronics	PZC01SAAN	S1011–01–ND	Digi-Key
54	ST SINGLE M HEADER GOLD 02 POS	JU1, JU2, JU3, JU4, JU8	5	Sullins Electronics	PZC02SAAN	S1011–02–ND	Digi-Key
55	ST SINGLE M HEADER GOLD 03 POS	JU5, JU6, JU7	3	Sullins Electronics	PZC03SAAN	S1011–03–ND	Digi-Key

A.3 Board Layers

Figure A–1. Top Silkscreen



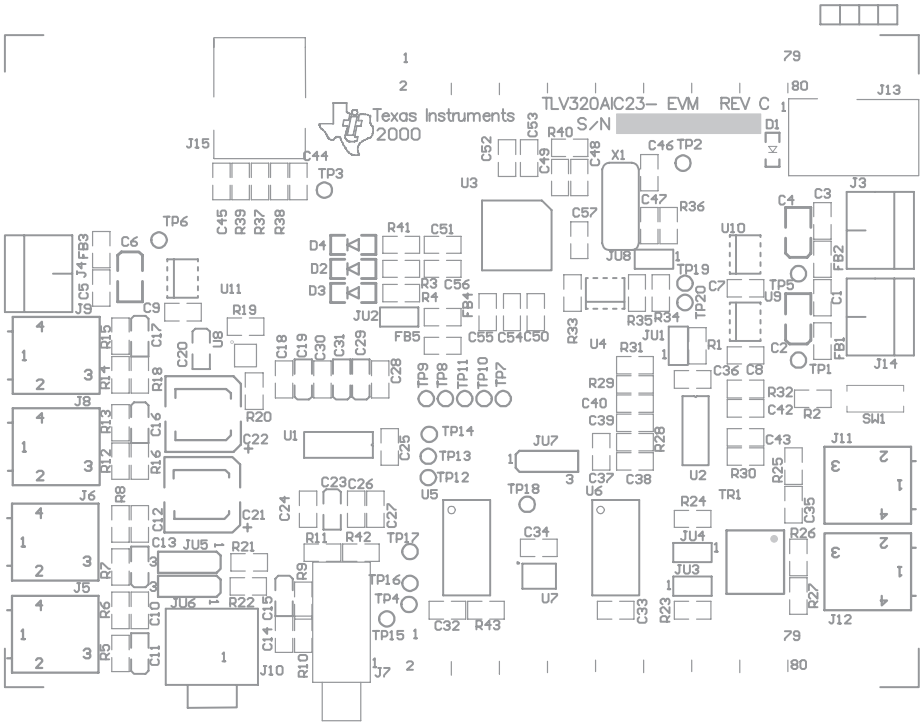


Figure A–2. Bottom Silkscreen

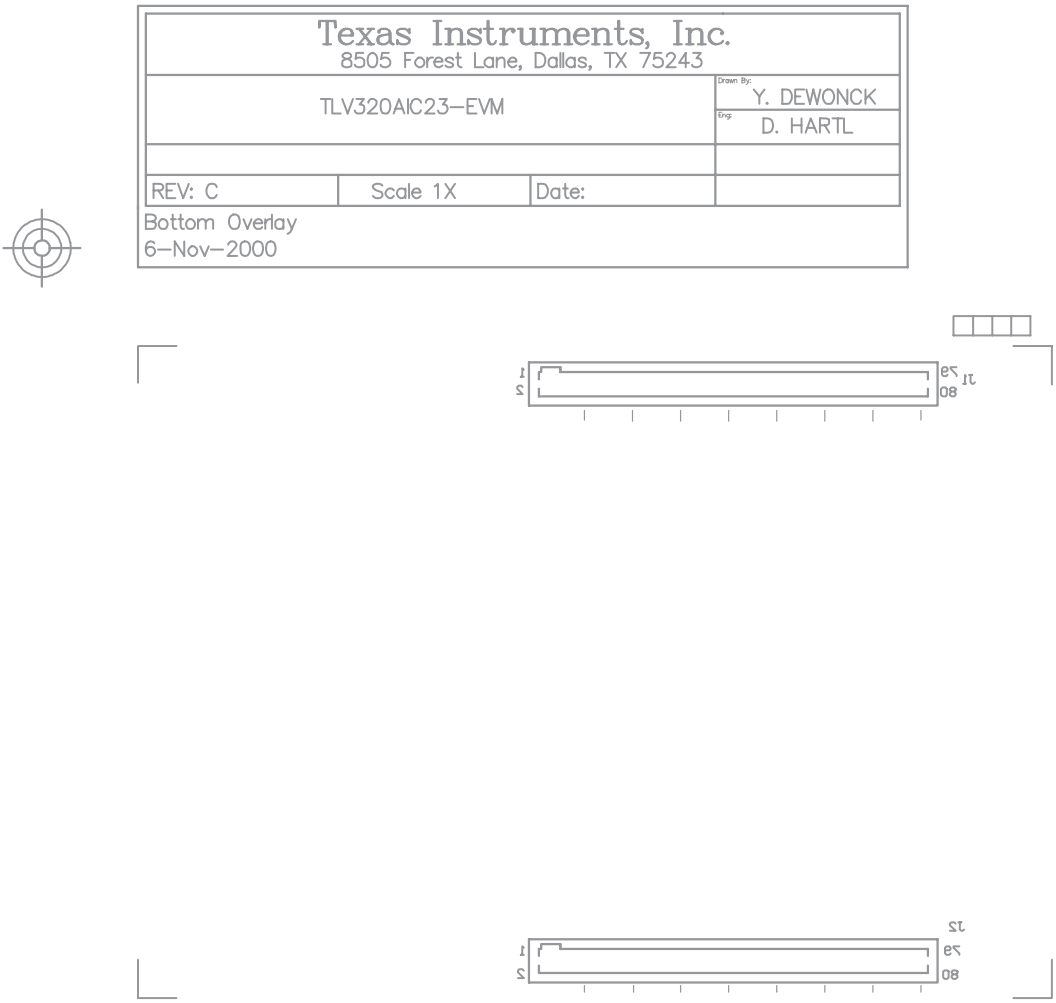
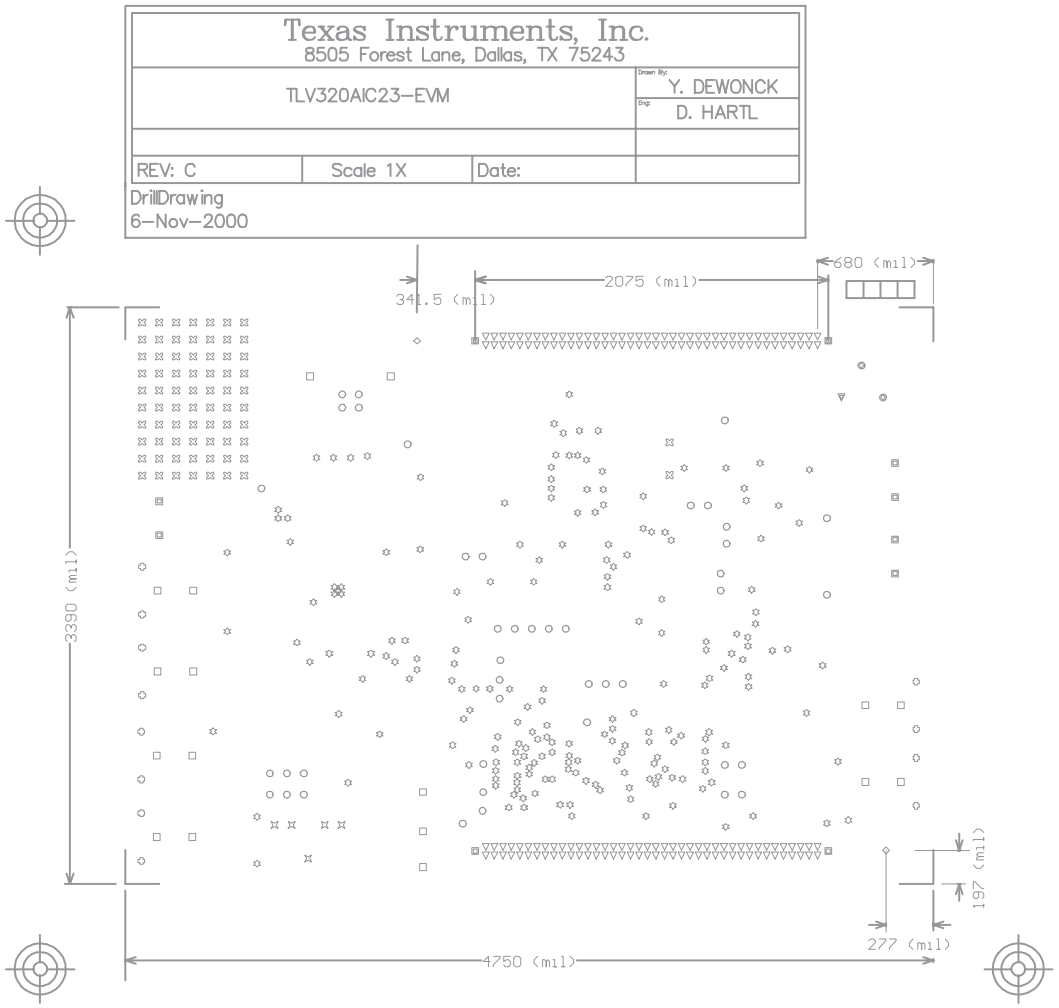


Figure A–3. Drill Drawing



Notes:

1. PWB TO BE FABRICATED TO MEET OR EXCEED IPC–6012, CLASS 3 STANDARDS AND WORKMANSHIP SHALL CONFORM TO IPC-A-600, CLASS 3 - CURRENT REVISIONS
2. BOARD MATERIAL AND CONSTRUCTION TO BE UL APPROVED AND MARKED ON THE FINISHED BOARD.
3. LAMINATE MATERIAL: COPPER–CLAD FR–4
4. COPPER WEIGHT: 1oz FINISHED
5. FINISHED THICKNESS: .062 +/– .010
6. MIN PLATING THICKNESS IN THROUGH HOLES: .001"
7. SMOBC / HASL
8. LPI SOLDERMASK BOTH SIDES USING APPROPRIATE LAYER ARTWORK: COLOR = GREEN
9. LPI SILKSCREEN AS REQUIRED: COLOR – WHITE
10. VENDER INFORMATION TO BE INCORPORATED ON BACK SIDE WHENEVER POSSIBLE
11. MINIMUM COPPER CONDUCTOR WIDTH IS: 8 MILS MINIMUM CONDUCTOR SPACING IS: 6 MILS

□	17	90mil	2.286mm	PTH
○	43	37mil	0.9398mm	PTH
▽	160	25mil	0.635mm	PTH
☼	204	13mil	0.3302mm	PTH
⌑	5	42mil	1.0668mm	PTH
⌔	12	70mil	1.778mm	PTH
⊠	72	30mil	0.762mm	PTH
◇	2	125mil	3.175mm	NPTH
⧈	10	53mil	1.3462mm	PTH
◎	2	125mil	3.175mm	PTH
▽	1	140mil	3.556mm	PTH
	528	Total		

Figure A–4. Copper Layer 1

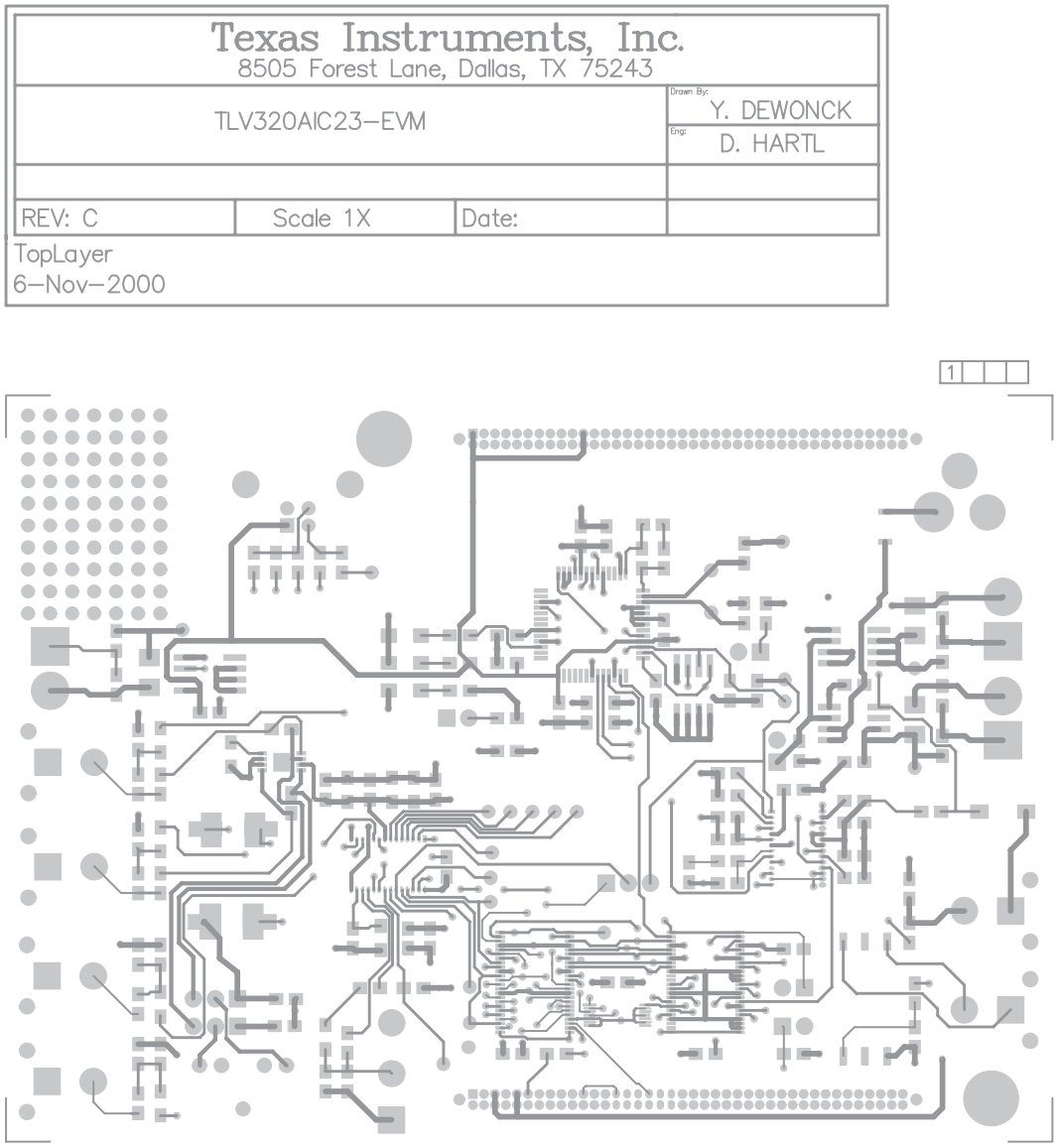


Figure A–5. Copper Layer 2

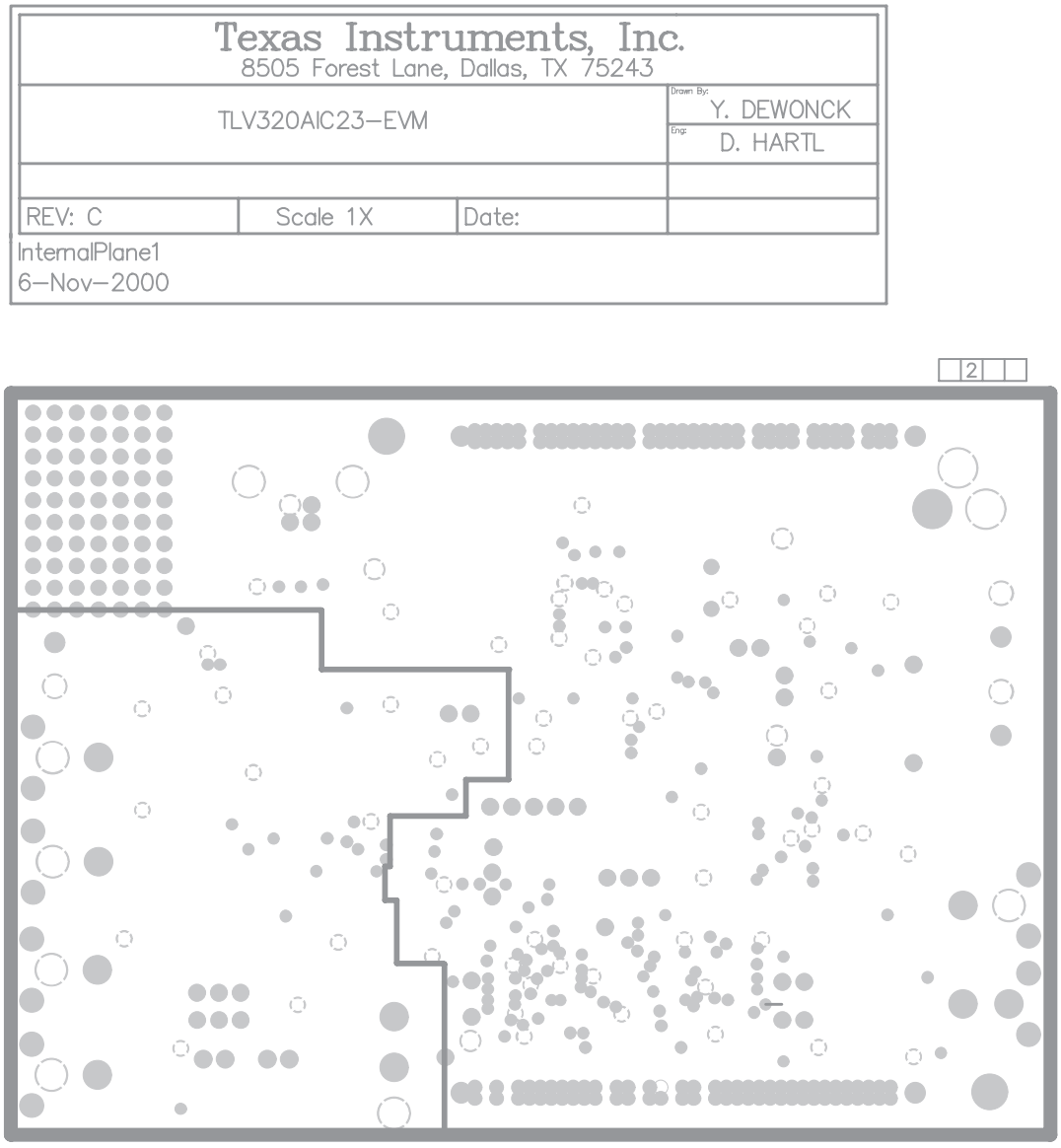


Figure A–6. Copper Layer 3

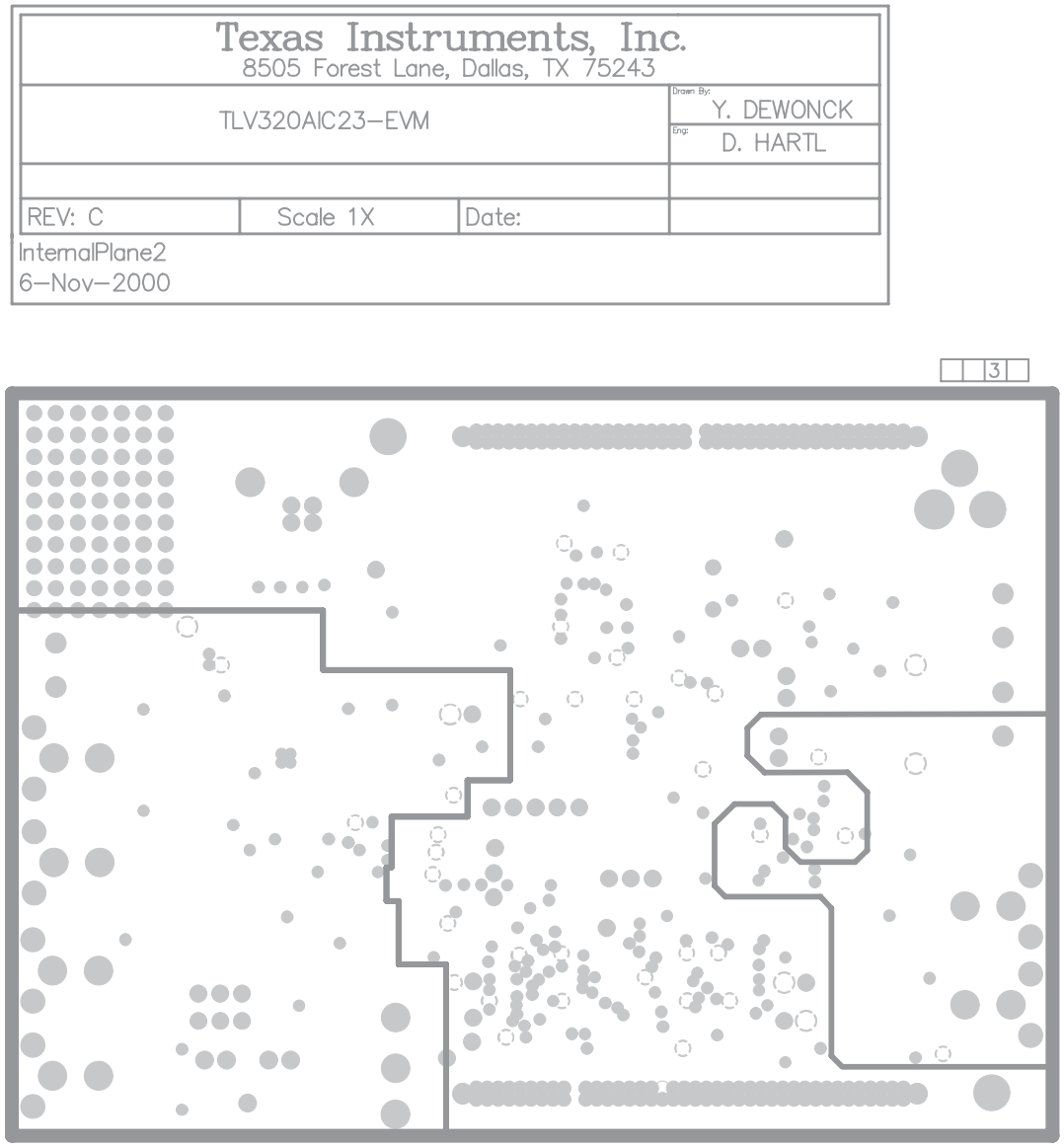
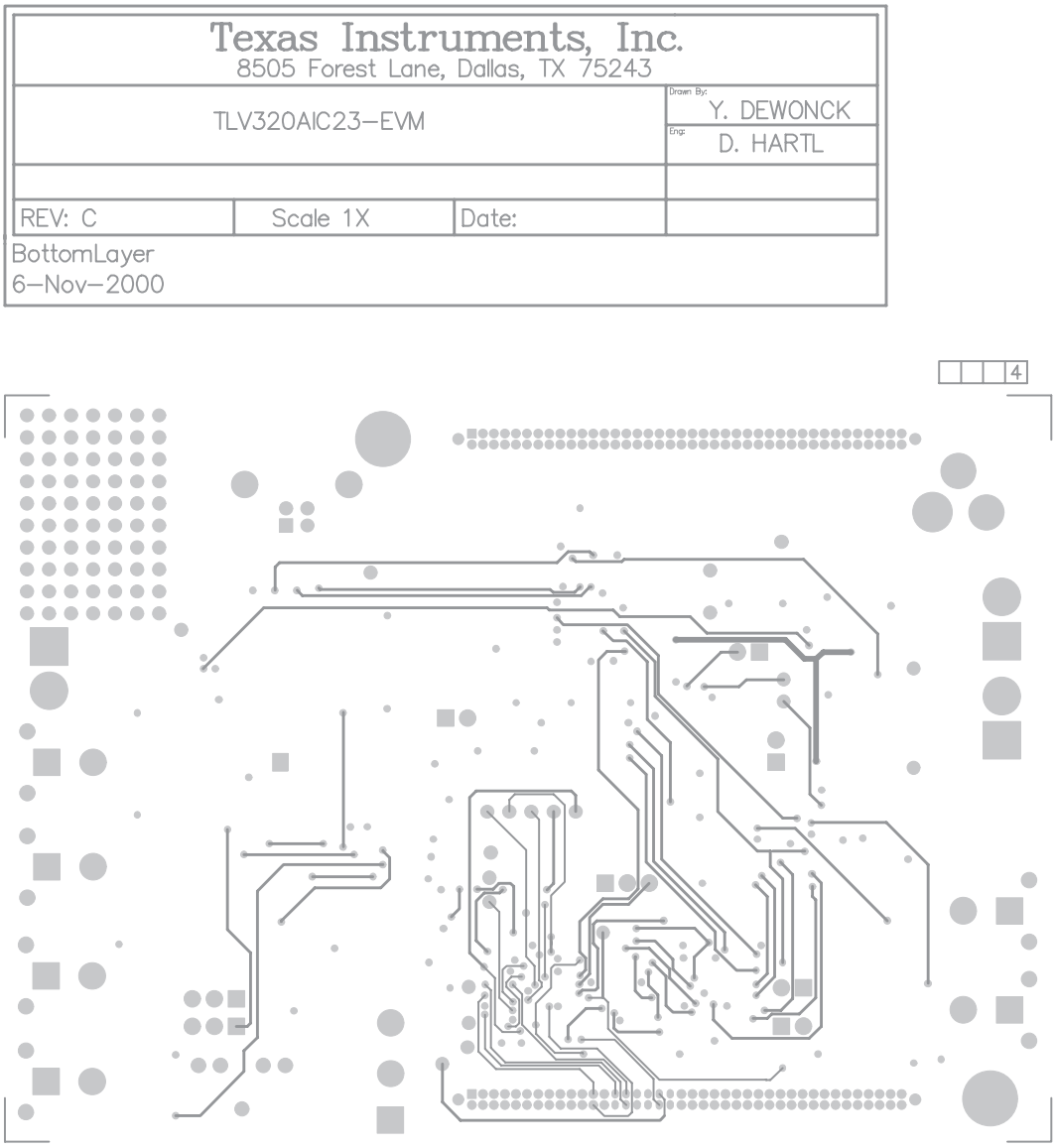


Figure A–7. Copper Layer 4



A.4 TLV320AIC23EVM and TLV320DAC23EVM Schematics

Figure A–8. TLV320AIC23EVM and TLV320DAC23EVM Schematics

ANALOG IN

J5 LEFT LINE IN
R5 4.99K Ohms 1%
R6 4.99K Ohms 1%
C10 47pfd/50V
C11 0.47ufd/35V
LLINEIN

J6 RIGHT LINE IN
R7 4.99K Ohms 1%
R8 4.99K Ohms 1%
C12 47pfd/50V
C13 0.47ufd/35V
RLINEIN

J7 MIC IN
R10 10K Ohms 1%
C14 47pfd/50V
C15 1.0ufd/16V
R11 4.99K Ohms 1%
MICIN
R9 10K Ohms 1%
MICBIAS
AGND

ANALOG OUT

LOUT
C16 0.47ufd/35V
R12 100 Ohms 1%
R13 47.5K Ohms 1%
LOUT_J8
J8 LOUT

ROUT
C17 0.47ufd/35V
R14 100 Ohms 1%
R15 47.5K Ohms 1%
ROUT_J9
J9 ROUT
AGND

R16 20K Ohms 1%
R18 20K Ohms 1%
R20 20K Ohms 1%
R19 20K Ohms 1%
LOUT_PA
ROUT_PA

U8
IN1− Vo1
IN2− Vo2
Shutdown Vdd +3.3VA
Bypass GND
TPA102DGN
C20 1.0ufd/16V
AGND

JU5
JU6
Head Phones
J10
AGND

JU5/JU6
1–2: AIC HPOUT (Non–Buffered)
2–3: AIC L/R OUT (U8 Driver)

U1
LLINEIN 19 LLINEIN
RLINEIN 20 RLINEIN
MICIN 18 MICIN
17 MICBIAS
SDIN_AIC 23 SDIN
SCLK_AIC 24 SCLK
DIN_AIC 4 DIN
LRCIN_AIC 5 LRCIN
BCLK_AIC 3 BCLK
MCLK_AIC 25 XTI/MCLK
TP13 26 XTO
CS_AIC 21 CS
MODE_AIC 22 MODE
+3.3VD 1 BVDD, 27 DVDD, 28 DGND
DGND
LOUT 12 LOUT
ROUT 13 ROUT
LHPOUT 9 LHPOUT
RHPOUT 10 RHPOUT
DOUT 6 DOUT_AIC
LRCOUT 7 LRCOUT_AIC
CLKOUT 2 TP14
HPVDD 8, AVDD 14 +3.3VA
VMID 16
HPGND 11, AGND 15
TLV320AIC23CPW
C23 10ufd.6.3V
C24 0.1ufd/50V
AGND

C21 220ufd/25V
C22 220ufd/25V
LHPOUT_JU5
RHPOUT_JU6
R21 47.5K Ohms 1%
R22 47.5K Ohms 1%
AGND

Buffer I/O
SDIN_AIC
SCLK_AIC
DIN_AIC
LRCIN_AIC
BCLK_AIC
MCLK_AIC
CS_AIC

TP11
TP10
TP16
TP17
TP15
TP12
TP7

TP9
TP8
TP18
DOUT_AIC
LRCOUT_AIC
MODE_AIC

Buffer I/O
DOUT_AIC
LRCOUT_AIC
MODE_AIC

JU3 – AIC23 MODE
IN: SPI OUT: I2C
JU3
+3.3VD
R23 10K OHM 1%
DGND

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Project: TLV320AIC23 EVM BOARD					
Size: CX	Page Title: DUT I/O				
Engineers: Frank Arnold					
Date: Mon Jun 18, 2001	Time: 18:08:14	Rev: 2	Mod: 0	Sheet 1 of 4	
Filename: TLV320AIC23EVMR3.SCH				Drawn By: LDN	
File Location: \\vette02\DSG\Schematics\EVMBoards\TLC320AIC23					

TUSB3200 (USB)

CDATI_USB
CSYNC_USB
CDATO_USB
MCLKO_USB
CSCLK_USB

CS8427 (SPDIF)

SDIN_SPDIF
ILRCLK_SPDIF
OLRCLK_SPDIF
SDOUT_SPDIF
RMCK_SPDIF
BCLK_SPDIF

U6

74ALB16244DGG

U5

74ALB16244DGG

U7:B

74AHCU04ADGV

U7:A

74AHCU04ADGV

R24
10K OHM 1%

R43
0.0 OHM 5%

JU4

JU4
IN: USB CLOCKS/DATA
OUT: SPDIF CLOCKS/DATA

EEPROM

SCL
SDA

JU7

JU7
1-2:
USB MODE: SDIN AIC = SDA EEPROM
SPDIF MODE: SDIN AIC = SDOUT1 DSP
2-3: SDIN AIC = SDA EEPROM
(REFER TO JU4)

TLV320AIC23

BCLK_AIC
LRCIN_AIC
LRCOUT_AIC
DOUT_AIC
DIN_AIC
MCLK_AIC
SCLK_AIC
MODE_AIC
SDIN_AIC

DSP

Samtec Card Connectors
(Underside of Board)

J1

J2

DGND

+5V

+3.3VD

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Size: CX	Page Title: Buffer I/O				
Engineers: Frank Arnold					
Date: Mon Jun 18, 2001	Time: 18:08:18	Rev: 2	Mod: 0	Sheet 2 of 4	
Filename: TLV320AIC23EVMR3.SCH				Drawn By: LDN	
File Location: \\vette02\DSG\Schematics\EVMBoards\TLC320AIC23					

SPDIF IN

J11 RCA
C35 .01ufd/50V
R25 75.0 OHM 1%
C36 .01ufd/50V
DGND

RXP_SPDIF
RXN_SPDIF

Buffer I/O

SDIN_SPDIF
ILRCLK_SPDIF

EEPROM

U4 24LC64
A0 A1 A2 GND Vcc WP SCL SDA
+3.3VD
JU8
R36 10K OHM 1%
R35 10K OHM 1%
R34 10K OHM 1%
SCL
SDA
DGND

TO Pwr Supply

+5V

USB JACK

J15 USB
Vcc Gnd Shield Shield Data- Data+
R39 22.1 OHM 1%
R37 22.1 OHM 1%
R38 22.1 OHM 1%
PUR
DP
DM
C45 47pfd/50V
C44 47pfd/50V
DGND

From SW1 (Pwr Supply)

MRESET

U2 CS8427-CZ

RXP_SPDIF
RXN_SPDIF
SDIN_SPDIF
SDA
SCL
R31 47.5K Ohms 1%
R32 47.5K Ohms 1%
+3.3VD
ILRCLK_SPDIF
BCLK_SPDIF
RESET
+5V
INT
RXP RXN SDIN SDA/CDOUT SCL/CCLK AD0/CS AD1/CDIN ILRCLK ISCLK RST H/S VA+ FILT AGND
TXP TXN SDOUT OLRCK OSCLK OMCK RMCK EMPH RERR TCBL INT U VD+ DGND
TXP_SPDIF
SDOUT_SPDIF
OLRCLK_SPDIF
BCLK_SPDIF
MCLKO_USB
RMCK_SPDIF
R30 47.5K Ohms 1%
R29 47.5K Ohms 1%
DGND
R28 5.11K OHM 1%
C37 .068ufd/50V
C38 2200pfd/50V

SPDIF

SPDIF OUT

R26 332 OHM 1%
R27 100 OHM 1%
TR1 T1-1T-KK81
J12 RCA
DGND

Buffer I/O

SDOUT_SPDIF
OLRCLK_SPDIF
RMCK_SPDIF
BCLK_SPDIF
TP20
TP19
SCL
SDA

USB

C47 33pfd/50V
X1 6.00 MHz
C46 33pfd/50V
C49 100pfd/50V
C48 1000pfd/50V
R40 3.32K OHM 1%
MCLKO_USB
R33 100K OHM 1%
+5V
DGND
+3.3VD
RESET
INT
R41 1.00K OHM 1%
D4 Green

U3 TUSB3200CPAH

AVSS AVDD PLLFILO PWMO PLLO PUR DP DM MRESET TEST EXTEN RSTO DVSS DVDD
PLLFIU XTAL XTALO MCLK2 MCLK1 MCLK2 MCLKO SCL SDA CSCHNE DVDDS DVSS
CRESET CDATI DVDD CDATO CSYNC CSCLK P1.7 P1.6 P1.5 P1.4 P1.3 DVDDS DVSS
P3.0 P3.1 XINT P3.3 P3.4 P3.5 NC PLLOEN P1.0 P1.1 P1.2
CDATI_USB
CDATO_USB
CSYNC_USB
CSCLK_USB

CDATI_USB CDATO_USB CSYNC_USB CSCLK_USB

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Project: TLV320AIC23 EVM BOARD					
Size: CX	Page Title: SPDIF AND USB I/O				
Engineers: Frank Arnold					
Date: Mon Jun 18, 2001	Time: 18:08:20	Rev: 2	Mod: 0	Sheet 3 of 4	
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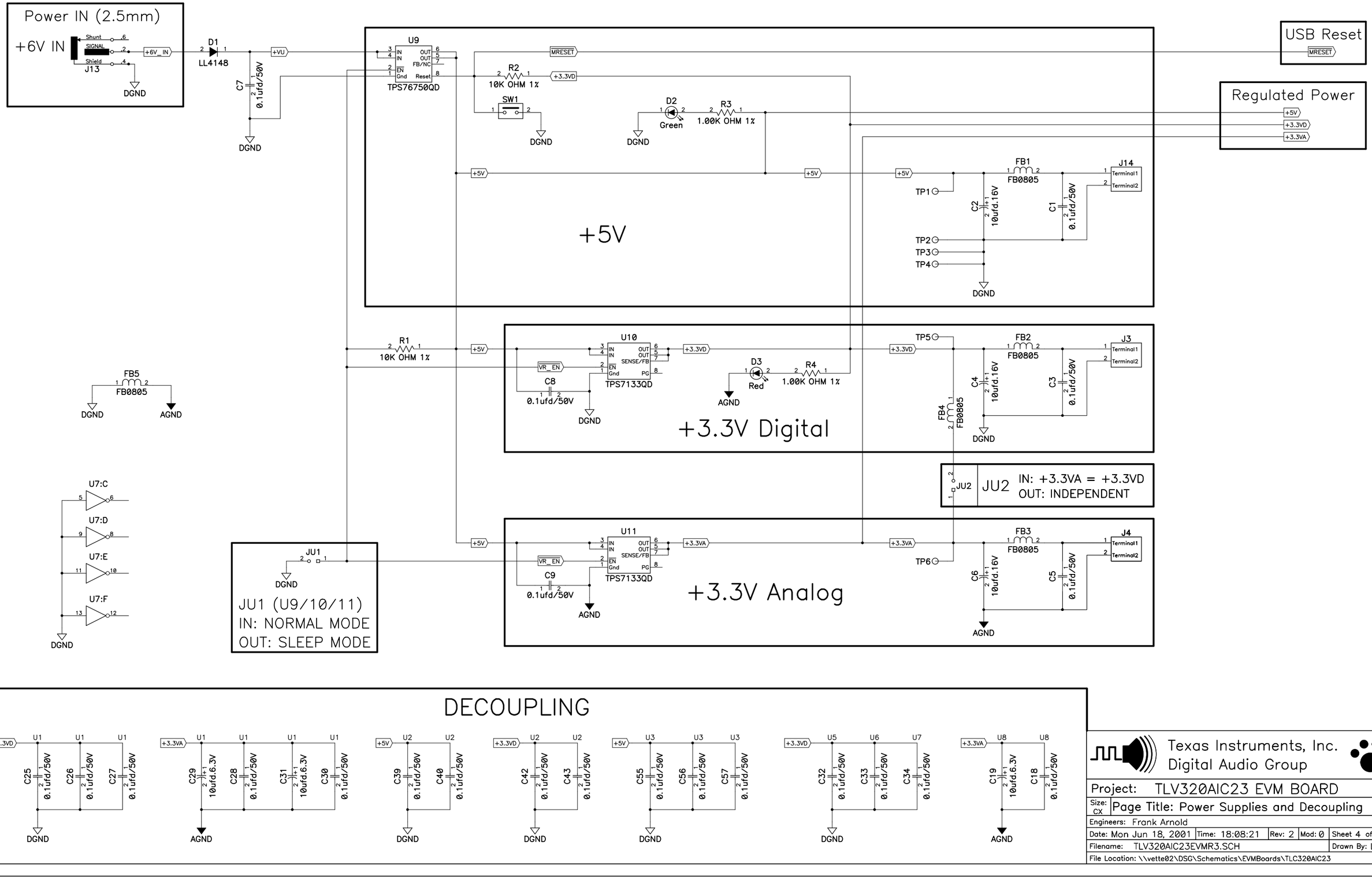
File Location: \\vette02\DSG\Schematics\EVMBoards\TLC320AIC23					


Power IN (2.5mm)
+6V IN
Shunt
SIGNAL
Shield
J13
DGND
+6V_IN
D1
LL4148
+VU
C7
0.1ufd/50V
DGND
U9
IN
IN
EN
Gnd
OUT
OUT
FB/NC
Reset
TPS76750QD
MRESET
R2
10K OHM 1%
+3.3VD
SW1
DGND
D2
Green
R3
1.00K OHM 1%
USB Reset
MRESET
Regulated Power
+5V
+3.3VD
+3.3VA
+5V
+5V
+5V
FB1
FB0805
J14
Terminal1
Terminal2
TP1
C2
10ufd.16V
C1
0.1ufd/50V
TP2
TP3
TP4
DGND
+5V
FB5
FB0805
DGND
AGND
R1
10K OHM 1%
+5V
U10
IN
IN
EN
Gnd
OUT
OUT
SENSE/FB
PG
TPS7133QD
VR_EN
C8
0.1ufd/50V
DGND
+3.3VD
D3
Red
R4
1.00K OHM 1%
AGND
+3.3V Digital
TP5
+3.3VD
FB2
FB0805
J3
Terminal1
Terminal2
C4
10ufd.16V
C3
0.1ufd/50V
FB4
FB0805
DGND
JU2
JU2
IN: +3.3VA = +3.3VD
OUT: INDEPENDENT
U7:C
U7:D
U7:E
U7:F
DGND
JU1
DGND
JU1 (U9/10/11)
IN: NORMAL MODE
OUT: SLEEP MODE
+5V
U11
IN
IN
EN
Gnd
OUT
OUT
SENSE/FB
PG
TPS7133QD
VR_EN
C9
0.1ufd/50V
AGND
+3.3VA
+3.3VA
+3.3V Analog
TP6
FB3
FB0805
J4
Terminal1
Terminal2
C6
10ufd.16V
C5
0.1ufd/50V
AGND
DECOUPLING
+3.3VD
U1
C25
0.1ufd/50V
C26
0.1ufd/50V
C27
0.1ufd/50V
DGND
+3.3VA
U1
C29
10ufd.6.3V
C28
0.1ufd/50V
C31
10ufd.6.3V
C30
0.1ufd/50V
AGND
+5V
U2
C39
0.1ufd/50V
C40
0.1ufd/50V
DGND
+3.3VD
U2
C42
0.1ufd/50V
C43
0.1ufd/50V
DGND
+5V
U3
C55
0.1ufd/50V
C56
0.1ufd/50V
C57
0.1ufd/50V
DGND
+3.3VD
U5
C32
0.1ufd/50V
U6
C33
0.1ufd/50V
U7
C34
0.1ufd/50V
DGND
+3.3VA
U8
C19
10ufd.6.3V
C18
0.1ufd/50V
AGND
Texas Instruments, Inc.
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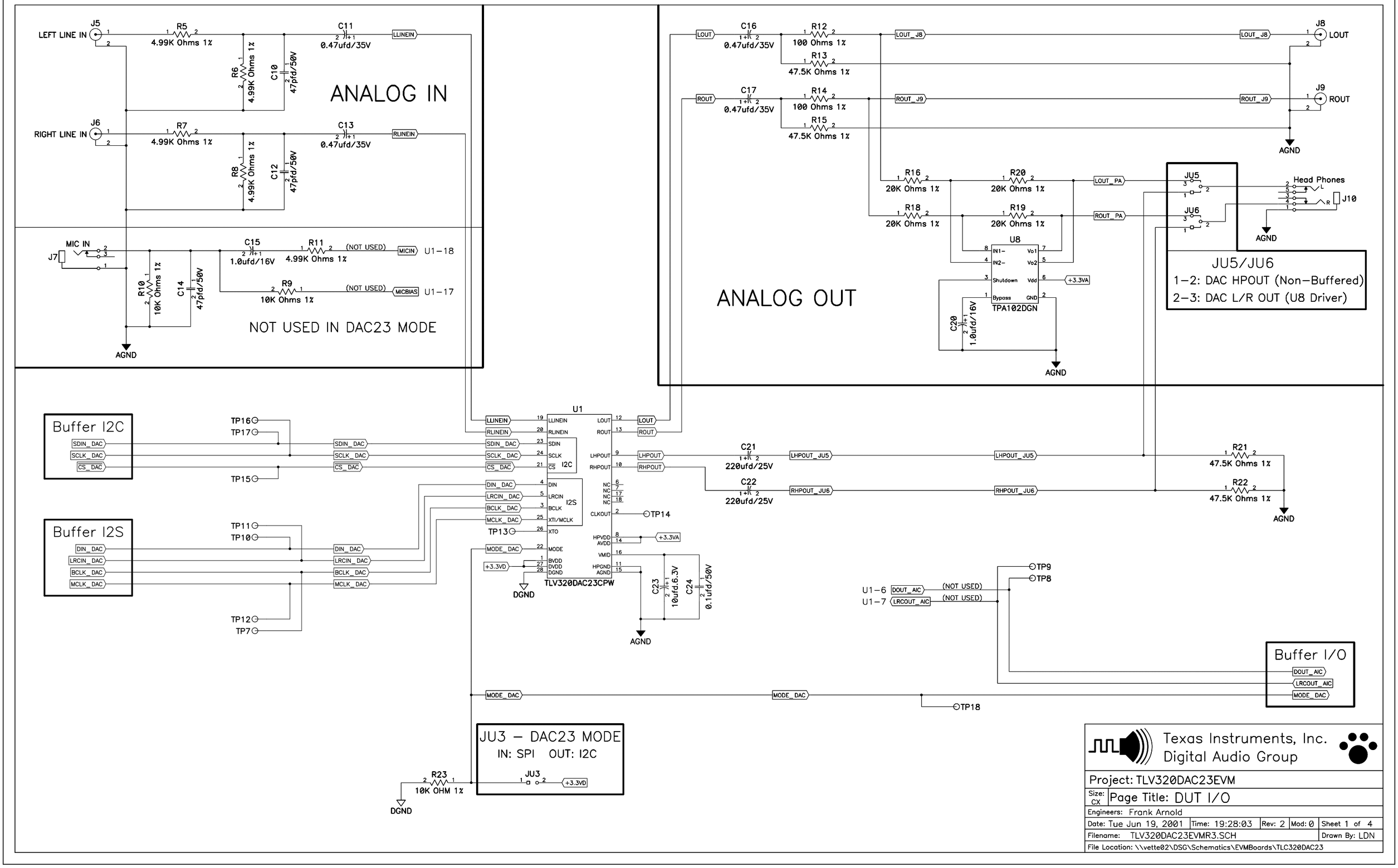
Project: TLV320AIC23 EVM BOARD
Size: CX
Page Title: Power Supplies and Decoupling
Engineers: Frank Arnold
Date: Mon Jun 18, 2001
Time: 18:08:21
Rev: 2
Mod: 0
Sheet 4 of 4
Filename: TLV320AIC23EVMR3.SCH
Drawn By: LDN
File Location: \\vette02\DSG\Schematics\EVMBoards\TLC320AIC23


ANALOG IN
LEFT LINE IN
J5
R5
4.99K Ohms 1%
R6
4.99K Ohms 1%
C10
47pfd/50V
C11
0.47ufd/35V
LLINEIN
RIGHT LINE IN
J6
R7
4.99K Ohms 1%
R8
4.99K Ohms 1%
C12
47pfd/50V
C13
0.47ufd/35V
RLINEIN
MIC IN
J7
R10
10K Ohms 1%
C14
47pfd/50V
C15
1.0ufd/16V
R11
4.99K Ohms 1%
(NOT USED)
MICIN
U1-18
R9
10K Ohms 1%
(NOT USED)
MICBIAS
U1-17
NOT USED IN DAC23 MODE
AGND
ANALOG OUT
LOUT
C16
0.47ufd/35V
R12
100 Ohms 1%
R13
47.5K Ohms 1%
LOUT_J8
J8
LOUT
ROUT
C17
0.47ufd/35V
R14
100 Ohms 1%
R15
47.5K Ohms 1%
ROUT_J9
J9
ROUT
AGND
R16
20K Ohms 1%
R18
20K Ohms 1%
R20
20K Ohms 1%
R19
20K Ohms 1%
LOUT_PA
ROUT_PA
U8
IN1-
IN2-
Shutdown
Bypass
Vo1
Vo2
Vdd
GND
+3.3VA
TPA102DGN
C20
1.0ufd/16V
AGND
JU5
JU6
Head Phones
J10
AGND
JU5/JU6
1-2: DAC HPOUT (Non-Buffered)
2-3: DAC L/R OUT (U8 Driver)
Buffer I2C
SDIN_DAC
SCLK_DAC
CS_DAC
TP16
TP17
TP15
Buffer I2S
DIN_DAC
LRCIN_DAC
BCLK_DAC
MCLK_DAC
TP11
TP10
TP12
TP7
U1
LLINEIN
RLINEIN
SDIN
SCLK
CS
I2C
DIN
LRCIN
BCLK
XTI/MCLK
XTO
I2S
MODE
BVDD
DVDD
DGND
TLV320DAC23CPW
LOUT
ROUT
LHPOUT
RHPOUT
NC
CLKOUT
TP14
TP13
HPVDD
AVDD
VMID
HPGND
AGND
+3.3VA
+3.3VD
C23
10ufd.6.3V
C24
0.1ufd/50V
DGND
AGND
C21
220ufd/25V
C22
220ufd/25V
LHPOUT_JU5
RHPOUT_JU6
R21
47.5K Ohms 1%
R22
47.5K Ohms 1%
AGND
U1-6
U1-7
DOUT_AIC
LRCOUT_AIC
(NOT USED)
(NOT USED)
TP9
TP8
Buffer I/O
DOUT_AIC
LRCOUT_AIC
MODE_DAC
MODE_DAC
MODE_DAC
TP18
JU3 - DAC23 MODE
IN: SPI OUT: I2C
JU3
+3.3VD
R23
10K OHM 1%
DGND
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Project: TLV320DAC23EVM
Size: CX
Page Title: DUT I/O
Engineers: Frank Arnold
Date: Tue Jun 19, 2001
Time: 19:28:03
Rev: 2
Mod: 0
Sheet 1 of 4
Filename: TLV320DAC23EVMR3.SCH
Drawn By: LDN
File Location: \\vette02\DSG\Schematics\EVMBoards\TLC320DAC23

TUSB3200 (USB)

CDATI_USB
CSYNC_USB
CDATO_USB
MCLKO_USB
CSCLK_USB

CS8427 (SPDIF)

SDIN_SPDIF
ILRCLK_SPDIF
OLRCLK_SPDIF
SDOUT_SPDIF
RMCK_SPDIF
BCLK_SPDIF

U6

74ALB16244DGG

U5

74ALB16244DGG

U7:B

74AHCU04ADGV

U7:A

74AHCU04ADGV

R24
10K OHM 1%

R43
0.0 OHM 5%

JU4

JU4
IN: USB CLOCKS/DATA
OUT: SPDIF CLOCKS/DATA

EEPROM

SCL
SDA

I2S

BCLK_DAC
LRCIN_DAC
LRCOUT_AIC
DOUT_AIC
DIN_DAC
MCLK_DAC
MODE_DAC

TLV320DAC23

I2C

SCLK_DAC
CS_DAC
SDIN_DAC

JU7

JU7
1–2:
USB MODE: SDIN DAC = SDA EEPROM
SPDIF MODE: SDIN DAC = SDOUT1 DSP
2–3: SDIN DAC = SDA EEPROM
(REFER TO JU4)

J1

J2

DSP

Samtec Card Connectors
(Underside of Board)

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Size: CX	Page Title: Buffer I/O				
Engineers: Frank Arnold					
Date: Tue Jun 19, 2001	Time: 19:28:05	Rev: 2	Mod: 0	Sheet 2 of 4	
Filename: TLV320DAC23EVMR3.SCH				Drawn By: LDN	
File Location: \\vette02\DSG\Schematics\EVMBoards\TLC320DAC23					

SPDIF IN

J11 RCA
C35 .01ufd/50V
R25 75.0 OHM 1%
C36 .01ufd/50V
DGND

RXP_SPDIF
RXN_SPDIF

Buffer I/O

SDIN_SPDIF
ILRCLK_SPDIF

EEPROM

U4 24LC64
A0 A1 A2 GND Vcc WP SCL SDA
+3.3VD
JU8
R36 10K OHM 1%
R35 10K OHM 1%
R34 10K OHM 1%
SCL
SDA
DGND

TO Pwr Supply

+5V

USB JACK

J15 USB
Vcc Gnd Shield Shield Data- Data+
DGND

R39 22.1 OHM 1% PUR
R37 22.1 OHM 1% DP
R38 22.1 OHM 1% DM
C45 47pfd/50V
C44 47pfd/50V
DGND

From SW1 (Pwr Supply)

MRESET

U2 CS8427-CZ

RXP_SPDIF
RXN_SPDIF
SDIN_SPDIF
SDA
SCL
R31 47.5K Ohms 1%
R32 47.5K Ohms 1%
+3.3VD
ILRCLK_SPDIF
BCLK_SPDIF
RESET
+5V
INT
+3.3VD
DGND
TXP_SPDIF
SDOUT_SPDIF
OLRCLK_SPDIF
BCLK_SPDIF
MCLKO_USB
RMCK_SPDIF
BCLK_SPDIF
R30 47.5K Ohms 1%
R29 47.5K Ohms 1%
+3.3VD
R28 5.11K OHM 1%
C37 .068ufd/50V
C38 2200pfd/50V
DGND

SPDIF

SPDIF OUT

R26 332 OHM 1%
R27 100 OHM 1%
TR1 T1-1T-KK81
J12 RCA
DGND

Buffer I/O

SDOUT_SPDIF
OLRCLK_SPDIF
RMCK_SPDIF
BCLK_SPDIF
TP20
TP19
SCL
SDA
MCLKO_USB
CDATI_USB
CDATO_USB
CSYNC_USB
CSCLK_USB

USB

C47 33pfd/50V
X1 6.00 MHz
C46 33pfd/50V
DGND
C49 100pfd/50V
C48 1000pfd/50V
R40 3.32K OHM 1%
+3.3VD
R33 100K OHM 1%
+5V
DGND
MCLKO_USB

U3 TUSB3200CPAH

AVSS AVDD PLLFILI PLLFILO PWMO PLLO PUR DP DM MRESET TEST EXTEN RSTO DVSS DVDD
XTALI XTALO MCLK2 MCLKI MCLKO2 MCLKO SCL SDA CSCHNG DVDDS DVSS
CRESET CDATI DVDD CDATO CSYNC CSCLK P1.7 P1.6 P1.5 P1.4 P1.3 DVDDS DVSS
P3.0 P3.1 XINT P3.3 P3.4 P3.5 NC PLLOEN P1.0 P1.1 P1.2
PUR DP DM MRESET RESET
CDATI_USB
+3.3VD
CDATO_USB
CSYNC_USB
CSCLK_USB
+5V
INT
DGND
+3.3VD
R41 1.00K OHM 1%
D4 Green
DGND

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Project: TLV320DAC23EVM					
Size: CX	Page Title: SPDIF AND USB I/O				
Engineers: Frank Arnold					
Date: Tue Jun 19, 2001	Time: 19:28:07	Rev: 2	Mod: 0	Sheet 3 of 4	
Filename: TLV320DAC23EVMR3.SCH				Drawn By: LDN	
File Location: \\vette02\DSG\Schematics\EVMBoards\TLC320DAC23					

Power IN (2.5mm)

+6V IN

Shunt
SIGNAL
Shield
J13

+6V_IN

D1
LL4148

+VU

C7
0.1ufd/50V

DGND

U9
TPS76750QD
IN
IN
OUT
OUT
FB/NC
EN
Gnd
Reset

MRESET

R2
10K OHM 1%

+3.3VD

SW1

D2
Green

R3
1.00K OHM 1%

USB Reset
MRESET

Regulated Power
+5V
+3.3VD
+3.3VA

+5V

+5V

FB1
FB0805

J14
Terminal1
Terminal2

TP1
TP2
TP3
TP4

C2
10ufd.16V

C1
0.1ufd/50V

+5V

R1
10K OHM 1%

U10
TPS7133QD
IN
IN
OUT
OUT
SENSE/FB
EN
Gnd
PG

VR_EN

C8
0.1ufd/50V

+3.3VD

D3
Red

R4
1.00K OHM 1%

AGND

+3.3V Digital

TP5

FB2
FB0805

J3
Terminal1
Terminal2

C4
10ufd.16V

C3
0.1ufd/50V

FB4
FB0805

FB5
FB0805

JU2
JU2
IN: +3.3VA = +3.3VD
OUT: INDEPENDENT

U7:C
U7:D
U7:E
U7:F

JU1
JU1 (U9/10/11)
IN: NORMAL MODE
OUT: SLEEP MODE

U11
TPS7133QD
IN
IN
OUT
OUT
SENSE/FB
EN
Gnd
PG

+3.3VA

C9
0.1ufd/50V

+3.3V Analog

TP6

FB3
FB0805

J4
Terminal1
Terminal2

C6
10ufd.16V

C5
0.1ufd/50V

DECOUPLING

C25 C26 C27 0.1ufd/50V

C29 10ufd.6.3V
C28 C31 0.1ufd/50V
C30 10ufd.6.3V

C39 C40 0.1ufd/50V

C42 C43 0.1ufd/50V

C55 C56 C57 0.1ufd/50V

C32 C33 C34 0.1ufd/50V

C19 10ufd.6.3V
C18 0.1ufd/50V

Texas Instruments, Inc.
Digital Audio Group

Project: TLV320DAC23EVM

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Engineers: Frank Arnold

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