TEXAS INSTRUMENTS

TUSB3200 USB With EQ 2-Channel Reference Design

User's Guide

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Digital Speaker Products

SLAU063

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Preface

Read This First

About This Manual

This specification describes a 2-channel USB speaker design that consists of a microphone input/speaker output configuration. This design also supports speaker parametric equalization. The example design described herein can be customized for specific applications.

How to Use This Manual

This document contains the following chapters:

- ❏ Chapter 1—Equipment
- ❏ Chapter 2—Detailed Descriptions of USBEQCDCREF1
- ❏ Appendix A—Schematic

Information About Cautions and Warnings

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

- TUSB3200 — TI Literature Number SLAS240
- TAS3001C — TI Literature Number SLAS226
- TLC320AD77 — TI Literature Number SLAS194
- TPA0112 — TI Literature Number SLOS 204A
- TPS7233Q — TI Literature Number SLVS102G
- TLV2362 — TI Literature Number SLOS195B

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This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

Trademarks

Cool Edit is a trademark of Syntrillium Software Corporation.

Contents

Figures

Chapter 1

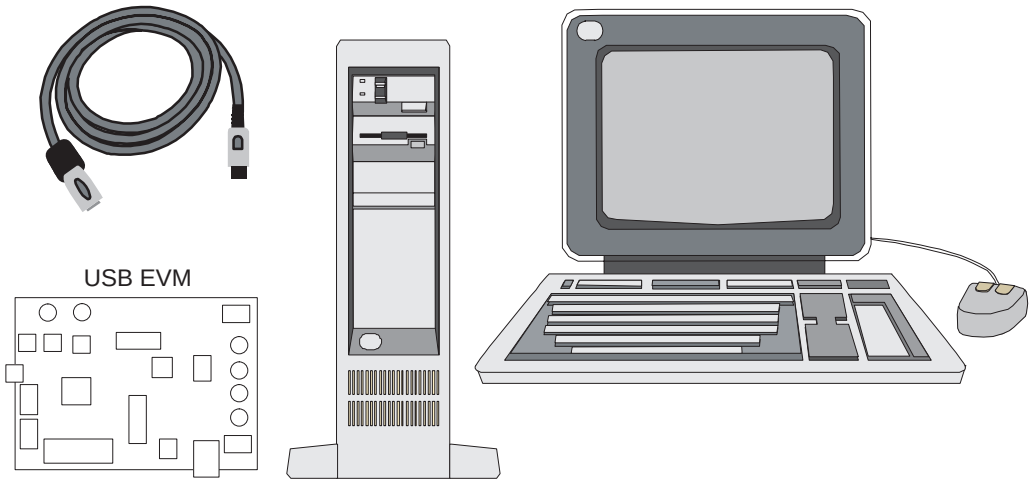
Equipment

Topic Page

1.1 Hardware Equipment

Figure 1–1 shows the equipment necessary to perform evaluation of the USBEQCDCREF1.

Figure 1–1. USBEQCDCREF1 Design Platform Equipment



1.2 Operating Procedure

The USBEQCDCREF1 requires an EPROM with firmware. This EPROM is inserted in the 8-pin DIP socket.

Caution

If the EPROM is inserted incorrectly, damage may occur to the EPROM and/or the USBEQCDCREF1.

1) Install the USB audio drivers.
2) Before connecting a 5-V dc power supply to PJ1 on the board, confirm that the center pin of the 2.5-mm power connector is positive (+), then connect the power.
3) Connect the USB cable from the board to the USB Port on the PC. After enumeration, you can access the Windows Audio Mixer Panel.
4) Put a CD into the PC CD ROM drive.
5) Use the Windows CD Player to play music.
6) Use the Windows Audio Mixer to control the volume, bass, treble, and balance of the audio.
7) To record, Cool Edit™ software is recommended. Install it and configure it for 48-kHz mono recording.
8) Connect the microphone on the headset to the microphone connector.
9) Open the advanced panel on the windows audio mixer and turn on and set up the record mixer.

10) Start recording with the Cool Edit application and speak into the microphone.
11) When completed, use Cool Edit to play the recording back through the speakers or headphone.

Note 1:

When played at an average listening level, the current does not exceed the 500-mA limit for USB power. Therefore, this board can run bus-powered. With USB bus power, an external power supply is not needed. For louder listening, a more efficient speaker can be used and still not exceed the 500-mA specification.

Note 2:

For IMAC users, use the latest Operating System 9.0.4. or greater with multimedia update.

1.3 EVM Board Layout

Figure 1–2. Picture of USBEQCDCREF1 Design Platform (Top View)

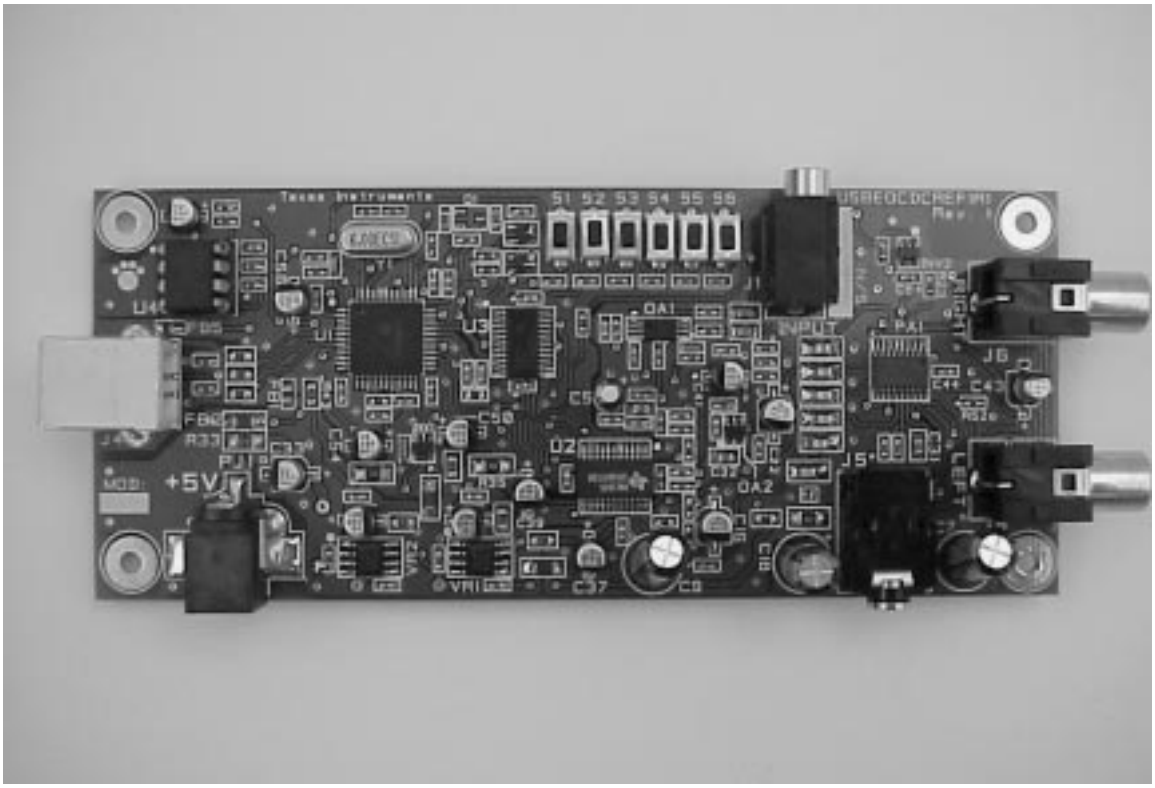
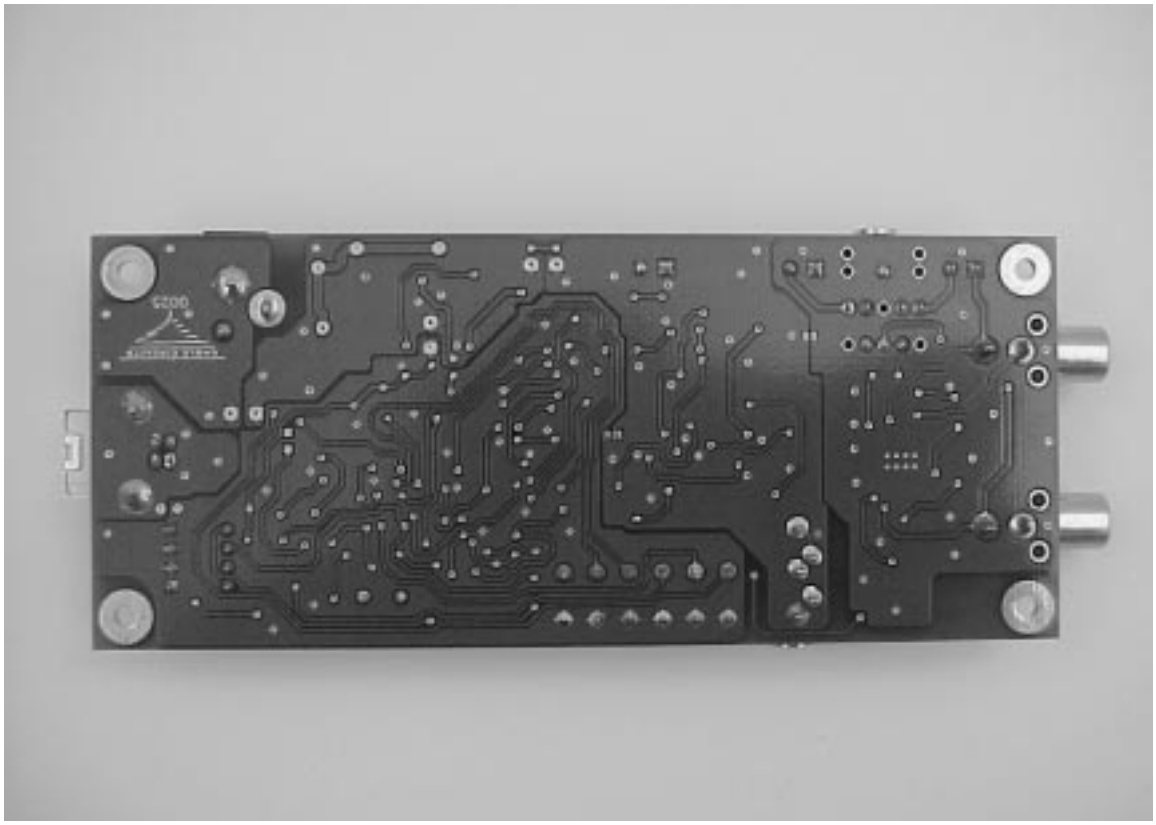


Figure 1–3. Picture of USBEQCDCREF1 Design Platform (Bottom View)



Chapter 2

Detailed Descriptions of USBEQCDCREF1

Topic Page

2.1 Power Supply

The dc power supply generates the following dc current sources:

- 3.3 V dc ± 5% with a maximum current of 200 mA
- 5 V dc ± 5% with a maximum current of 500 mA

2.2 USB Interface Function

The USB interface is based on the Texas Instruments TUSB3200 universal serial bus device. The device includes a transceiver that supports 12 Mbps (full speed) data transfers. The TUSB3200 conforms to USB Specification Version 1.1 and USB Audio Class Specification 1.0. The USB receives isochronous audio and control data from the USB I/O connector. The USB separates the received digital audio data into separate left and right channels.

The TUSB3200 sends the digital audio data to the TAS3001 digital equalizer function via the I^2S port at one of the following sampling frequencies: 32 kHz, 44.1 kHz, or 48 kHz. The sampling frequency is defined only during initialization and can not change while the device is in normal operation.

The TUSB3200 generates the control for the digital equalizer and the Codec. The TUSB3200 controls the circuit in the four functional modes: reset, initialization, mute, and operation.

1) Reset mode—When powering up the circuit wakes up in reset state. While in reset state the system is not operating, the TUSB3200, TAS3001, and TLC320AD77 are reset, and the TPA0112 is muted. The circuit remains reset for 1.5 ms. Once the reset signal is de-asserted, the circuits are in their
default mode and ready for initialization.
2) Initialization mode—The reset signal false-triggers the initialization process, which starts by downloading the firmware from the EEPROM to the TUSB3200 chip and the TAS3001 equalizer chip. The initialization process defines every variable in the TUSB3200, and sets the TAS3001 chips to the required setting for the design. It also loads the operating code into the SRAM of the TUSB3200.
3) Mute mode—In mute mode there is no USB audio data transmission. The TUSB3200 mutes the TPA0112 power amplifier.
4) Operational mode—During operational mode, when the configuration select switch is set to 2.0, the TUSB3200 receives digital audio data. The TUSB3200 separates the digital audio into two channels that are sent to the TAS3001. Using the equalization settings, the TAS3001 performs equalization, volume, bass, treble, and DRC adjustments on the data. The equalized output is passed to the TLC320AD77 Codec. The Codec converts the digital data into two analog output signals (left and right). Each of the two analog outputs is then amplified by the two 2-watt power amplifier channels of the TPA0112. The two amplified signals are then available to drive the two speakers (left and right). The power amplifier is held in mute unless music is playing.

The TUSB3200 sends the control commands to the digital equalizer functions via the I^2C control port. The TUSB3200 sends the digital audio data to the digital equalizer function via the I^2S port at one of the following sampling frequencies: 22.05 kHz, 44.1 kHz, or 48 kHz. The sampling frequency is defined only during initialization and can not change while the device is in normal operation.

The design includes a mono microphone input (also configurable into two line inputs). The TLC320AD77 Codec converts the one/two analog signals into digital form. The Codec sends the digital data serially to TUSB3200 via the I^2S serial bus.

Additionally, the TPA0112 power amplifier can drive a set of headphones. By plugging headphones into the headphone connector, J5, the speaker output is muted. The TPA0112 contains internal circuitry to automatically adjust its gain to an appropriate listening level for headphones.

2.3 Left/Right Speaker Digital Equalizer

The speaker's digital equalizer is implemented based on a TAS3001C 32-bit processor that performs digital audio signal processing, providing parametric equalization, bass, treble, and volume control, as well as dynamic range compression. The TAS3001C provides digital stereo audio input, scaled and mixed before processing. Using the USB interface, the user may control volume, treble, bass, and equalization. During initialization, the USB interface function downloads the EQ control parameters serially via the I^2C control port. They can also be downloaded locally from the TUSB3200.

The TAS3001C receives audio data from the USB interface serially using the I^2S format at one of the following sampling frequencies: 32 kHz, 44.1 kHz, or 48 kHz.

2.4 Stereo Audio Codec

The design of the audio Codec is based on the 24-bit delta-sigma stereo audio Codec TLC320AD77. During normal operations, the Codec receives digital audio data from the TAS3001C that is converted into analog data. The Codec also receives a microphone analog input that is converted into a serial I^2S digital signal and sent to the TUSB3200. The TUSB3200 formats this data into USB data packets and sends them to the PC. Full duplex record/playback is supported on this reference design.

2.5 Power Amplifier

The power amplifier consists of a TPA0112 audio power amplifier. The TPA0112 provides two single-ended/BTL (bridge tied load) 2-W amplifiers. They are dedicated for the left and right speakers. The two amplifiers are connected to BTL. They can be switched to single-ended by one of the amplifier's control pins and used to drive headphones. The amplifier is rated to deliver less than 0.75% distortion at one watt output (typical).

2.6 Microphone

The microphone is designed to receive one standard mono microphone analog input with a 3.5-mm microphone connector. The analog microphone signal is amplified with a gain of 20 dB. The amplified signal is fed into one of the two Codec analog inputs. It is mixed by the TAS3001 and can be heard on both the right and left speakers.

2.7 GPIO Controls

The GPIO control consists of six pushbutton switches programmed into the firmware of the TUSB3200.

Some examples of their function are:

- No equalization
- Flat response equalization
- Jazz equalization
- Rock equalization
- Classical equalization
- Bass ±
- Treble ±
- Volume ±
- System mute
- Microphone mute

2.8 Power-On Reset

The power-on reset generates a 3.3-V active low asynchronous reset that sets all of the device functions to the default state. The power-on reset holds the USB signal low (below 2 V) for 1.5 ms.

2.9 Clock Generation

The clock generation generates 6-MHz clock signal 50% duty cycle square wave at 3.3 V p–p.

2.10 EEPROM

EEPROM consists on a 64K-bit serial EPROM. The device is I^2C serial bus compatible. The EEPROM function contains the firmware to run the application.

2.11 Digital Equalization

The six push buttons on the reference board were programmed to send six different equalizations from the TUSB3200 to the TAS3001.

S1 **Allpass—**This function does not provide any equalization. It can be used to demonstrate the improvement made by using digital equalization.

S2 **Jazz—**Provides a brighter high end to accentuate percussion and overtones.

S3 **Voice—**An equalization that limits speaker's frequency response to the voice band and improves recognition of the human voice.

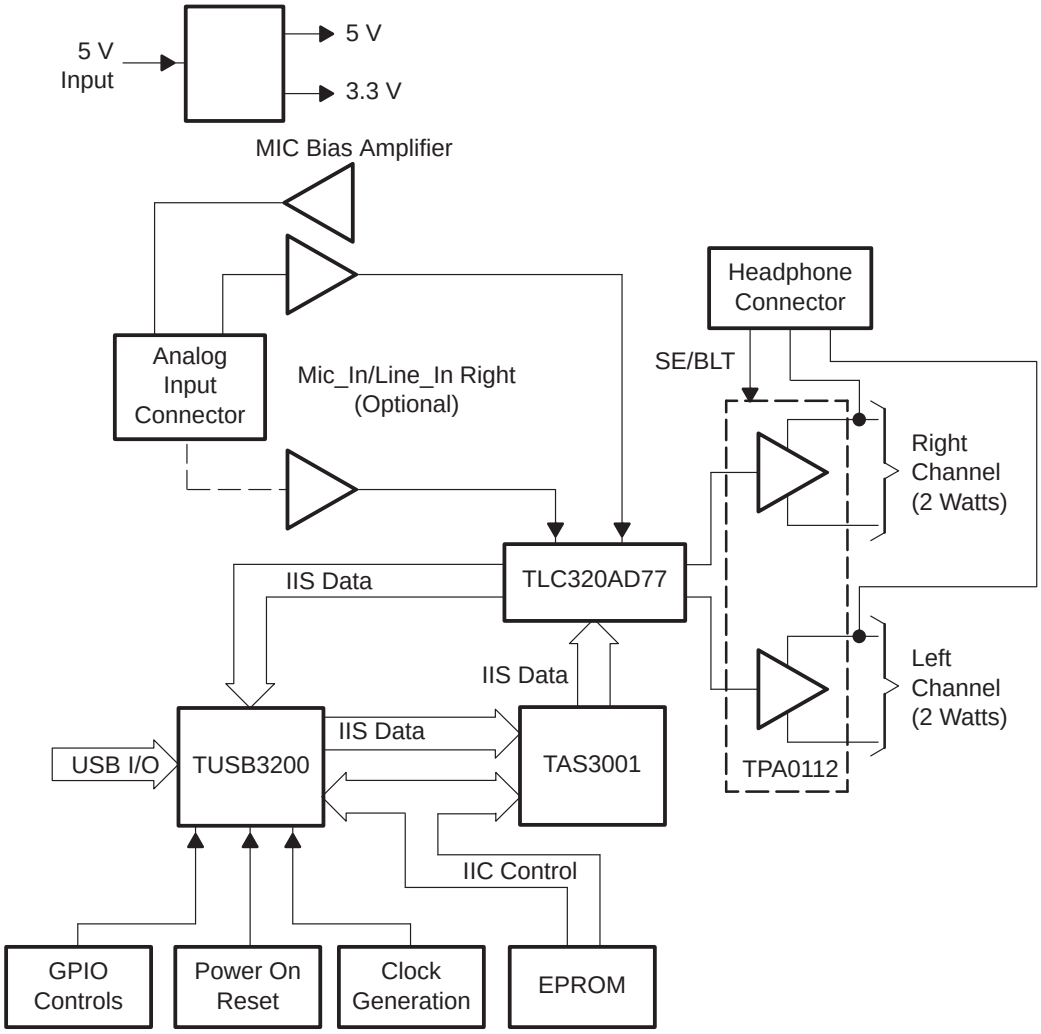
S4 **Extra-Bright—**Demonstrates additional high frequency of the speaker. May be annoying on some types of music.

S5 **Flat—**Provides a smooth, uncolored sound.

S6 **Rock—**Generally, rock is has a boosted low frequency response. Since these many speakers are small, they do not produce this effect very well. Two sets of firmware are provided, each with a different rock equalization. The SPKR 3.0 contains a rock equalization for the keyboard speakers. The SPKR_HP 3.0 firmware has a rock equalization, which works well on headphones.

2.12 Block Diagram

Figure 2–1. Speakers With Microphone Application Block Diagram



Appendix A

Schematics

USB Speaker Equalizer Board W/MODS

Line/MIC IN

J1 3.5mm STEREO

Input Amp and Bias

C48 .33ufd, R7 10K, OA1:B TLV2362PWR, R9 10K/249K, C14 100pfd
C63 .33ufd, R11 10K, R55 0.0, R53 1.6K, OA2 TLV2460CDBV, R21 4.99K, C32 1.0ufd
OA1:A TLV2362PWR, R54 10K, C47 100pfd
5VA_OA12, VMID_OA1, AGND

STUFF OPTIONS For Line/MIC IN:

MIC IN:
R53 IN, R55 IN
R9 = 249K, C63 OUT

Line IN:
R53 OUT, R55 OUT
R9=10K, C63 IN

VMID Supply

R50 49.9K, R22 2.55K, R31 2.55K, R49 1.0K, R24 1.0K, C16 10ufd/6.3V
AVDD, VMID_OA1, VMID_LM, VMID_RIN, AGND

Anti-Alias Filter

R4 499, R10 499, R16 499, R13 499, C8 1000pfd, C20 1000pfd
AINLP, AINLM, AINRM, AINRP

Vref Filter

C1 1.0ufd, C2 0.1ufd, C3 0.1ufd, C5 15ufd/6.3V, C4 0.1ufd
VREFM, VREFP, VRFILT, AGND

U1 TLC320AD77

AVDD, DVDD, DGND, AGND
SCLK, LRCLK, MCLK, RESET, SDIN_AD77, SDOUT_AD77
AINRM, AINRP, AINLM, AINLP
VCOM, AOUTL, AOUTR
C9 100ufd/25V, C6 0.1ufd

Left/Right Reversed on J5 (Will Be Corrected on Future Boards)

HeadPhone OUT
5VA_PA1, R29 4.99K, SE/BTL, J5 3.5mm Stereo SW, GND_5VA_PA1
C7 100ufd/25V, C18 100ufd/25V

2 Watt Power Amp

PA1 TPA0112PWP
C13 1.0ufd, C19 1.0ufd, C10 1.0ufd, C21 1.0ufd, C29 1.0ufd, C30 1.0ufd, C31 1.0ufd
R20 100K, R52 100K, R23 100, R56 47.5K, R57 47.5K
SHUTDOWN, 5VA_PA1, GND_5VA_PA1

PowerAmp OUT

J2 Left OUT, J6 Right OUT

R56/R57 Pulled High to Correct Gain Setting.

TUSB3200 EPROM

EPROM 24LC64, R45 4.99K, R46 4.99K
SCL, SDA, 3.3VD_STC, DGND

Add And1 to Aid I2C Transactions With EQ1

AND1 74AHC1G08, 3.3VD_STC, DGND

R25 4.99K, R60 49.9

INV2 74AHC1G14, 5VA_PA1, SHUTDOWN, GND_5VA_PA1

USB I/O

J4 USB_TYPEB-RA
R26 1.5K, R27 27.4, R28 27.4
C12 47pfd, C15 47pfd, FB5 FB0805, GND_USB, DGND
DP, DM

STC TUSB3200

C25 27pfd, C26 27pfd, Y1 6MHz
C27 1000pfd, C28 100pfd, R48 3.09K
R51 100, DGND, GND_3.3VA, 3.3VA_STC
MCLK, SDOUT_AD77, SDOUT_STC, LRCLK, SCLK, P1.5, RESET, 5VD_STC, 3.3VD_STC
R36 10K, R40 100K, C17 10ufd/6.3V
R15 4.99K, R59 49.9, R17 4.99K, R30 4.99K, R39 4.99K
S1, S2, S3, S4, S5, S6
R18 4.99K, R58 4.99K, R19 4.99K

EQ1 TAS3001

SDOUT_STC, SDOUT_AD77, SDIN_AD77, MCLK, LRCLK, SCLK, SDA, SCL, RESET, DVDD
C24 1500pfd, C23 .068ufd, R47 27.4

INV1 74AHC1G14

P1.2, 3.3VD_STC, VR1_EN, To VR1

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Project: USB Speaker Equalizer	
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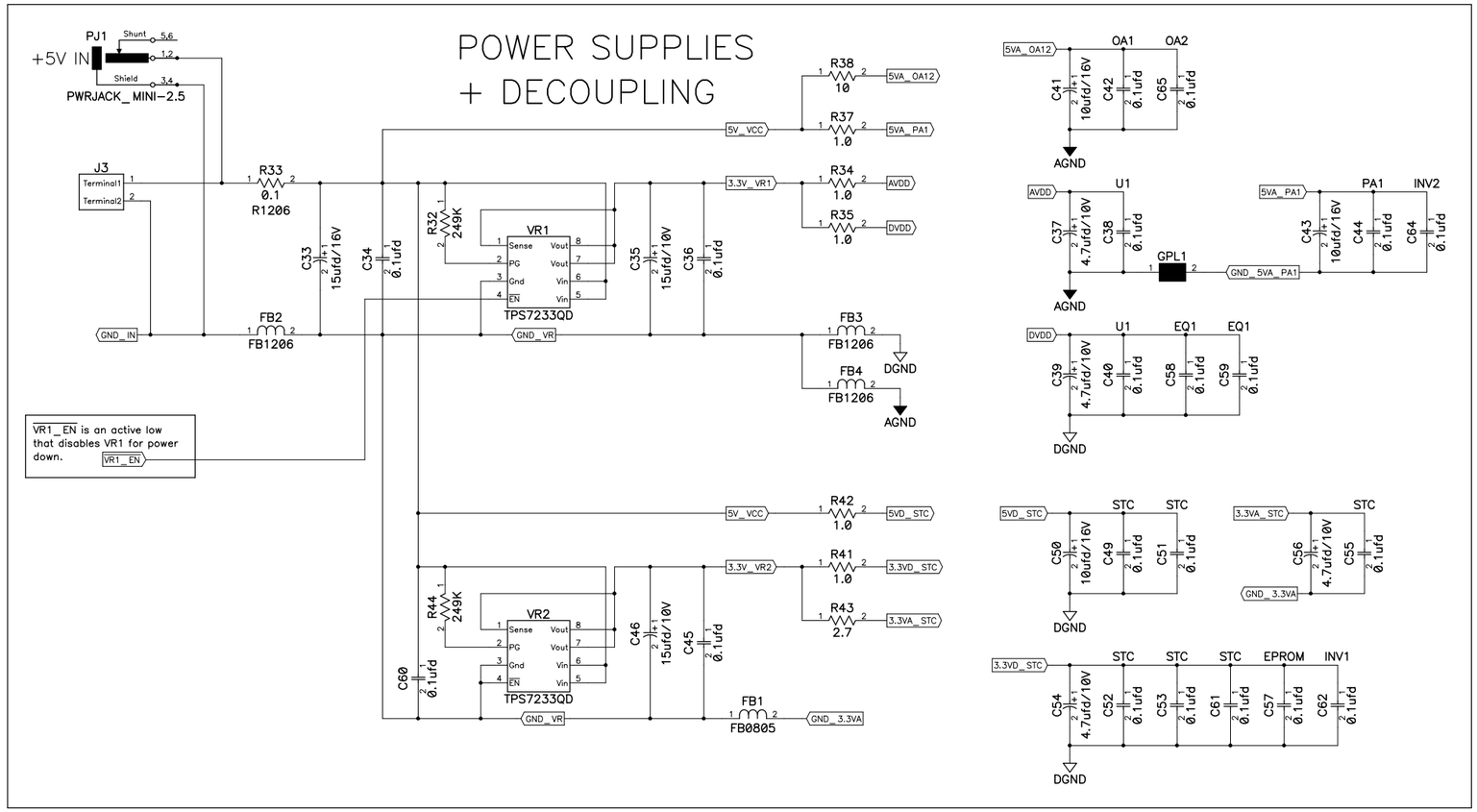
Date: Thu Jan 27, 2000 Time: 16:22:38	Rev: 0 Sheet 1 of 2
Filename: USB_SpeakerEQ-MODS.sch	Drawn By: FS/LDN

USB Speaker Equalizer Board



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