Beaglebone Audio Extension Technical Reference Manual

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Version	Author	Date	Comment
0.1	seifert	25.01.2011	Document setup and introduction started.
0.2	seifert	31.08.2016	Document update. Bus collision fix in schematic and board layout.
0.3	seifert	22.09.2016	Document update. Detailed jumper and header descriptions.
0.4	seifert	01.12.2017	Document update. Bus collision fix description in Appendix.
0.5	seifert	16.03.2018	Document update. Corrected Table 3 line 10 and Table 5 line 3.

Contents

1. Introduction

This technical reference manual describes the functionality of the IMS Beaglebone Audio Extension Board. First an overview of the features is given. After that available headers and connectors are shown and their functionality is described. Later in this manual the jumpers and default configuration settings are listed. At the end the usage with the Beaglebone board is described together with the header pinouts, examples and schematics in the appendix.

2. Overview

In this section an overview of the IMS Beaglebone Audio Extension Board is given. The IMS Beaglebone Audio Extension Board is build up using three ADAU1761 low-power codecs from Analog Devices Inc.

Each of the three codecs provides the following features:

- 24-bit stereo audio ADC and DAC: >98 dB SNR
- Sampling rates from 8 kHz to 96 kHz
- Flexible analog input/output mixers
- Stereo digital microphone inputs
- PLL supporting input clocks from 8 MHz to 27 MHz
- Microphone bias reference voltage
- Analog and digital I/O: 1.8 V to 3.65 V
- I2C and SPI control interfaces
- Digital audio serial data I/O: stereo (I2S) and time-division multiplexing (TDM) modes
- 32-lead, 5 mm × 5 mm LFCSP
- -40°C to +85°C operating temperature range

For complete informations please refer to the ADAU1761 datasheet [1].

The IMS Beaglebone Audio Extension Board itself is equipped with three 3-pole 3.5mm jacks for stereo microphone input (MIC_IN 1-3) and two 3-pole 3.5mm jacks for stereo headphones output (HP 1-2) shown in figure 1. With the headers P8 and P9 the IMS Beaglebone Audio Extension Board is connected to any compatible Beaglebone board e.g., Beaglebone Black, Beaglebone Green.

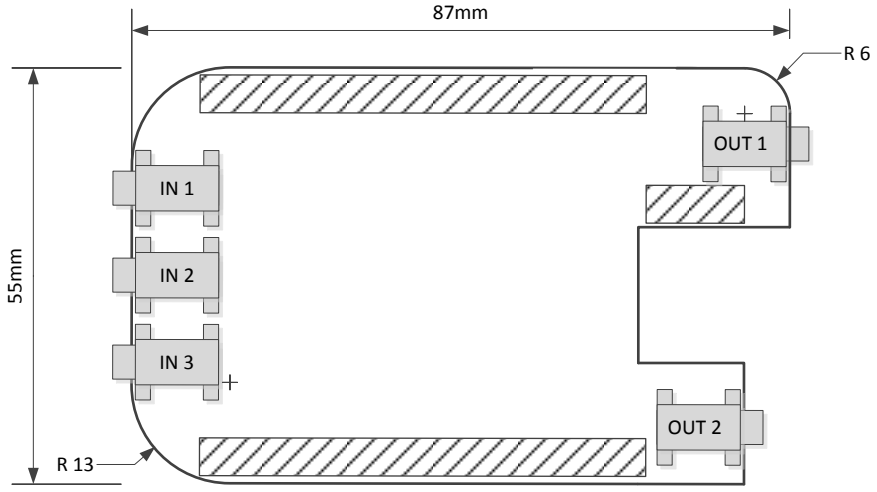

Figure 1: IMS Beaglebone Audio Extension Board outline

3. Board Parameters

- Supply Voltages
  - 3.3V from Beaglebone headers P8 and P9
- Internal Voltages from 3.3V supply
  - 3.3V for configuration EEPROM
  - 3.0V for audio codecs
  - 1.0V for hearing aid dummies or microphone bias

4. Components

- Power Management
  - Voltage Regulation (MAX8902A, MAX8902B)
- Audio (ADAU1761)
- Memory
  - Beaglebone configuration EEPROM (CAT24C256)
- Audio bus merger
  - 3-input logic OR-Gate (SN74LVC1G332DBVR)

5. Headers

The IMS Beaglebone Audio Extension Board headers can be classified as basic headers and extension headers. In the following sections the headers and their functionality will be described.

5.1. Basic Headers

For basic connectivity of the IMS Beaglebone Audio Extension Board the headers and connectors listed in table 1 and shown in figure 1 are used.

Name	Type	Description
IN 1	Audio	3.5mm stereo microphone input 1
IN 2	Audio	3.5mm stereo microphone input 2
IN 3	Audio	3.5mm stereo microphone input 3
OUT 1	Audio	3.5mm stereo headphone output 1
OUT 2	Audio	3.5mm stereo headphone output 2
P8	Digital	Connector for digital control and audio data transfers to/from Beaglebone.
P9	Digital	Connector for digital control and audio data transfers to/from Beaglebone.

Table 1: IMS Beaglebone Audio Extension Board basic connectors

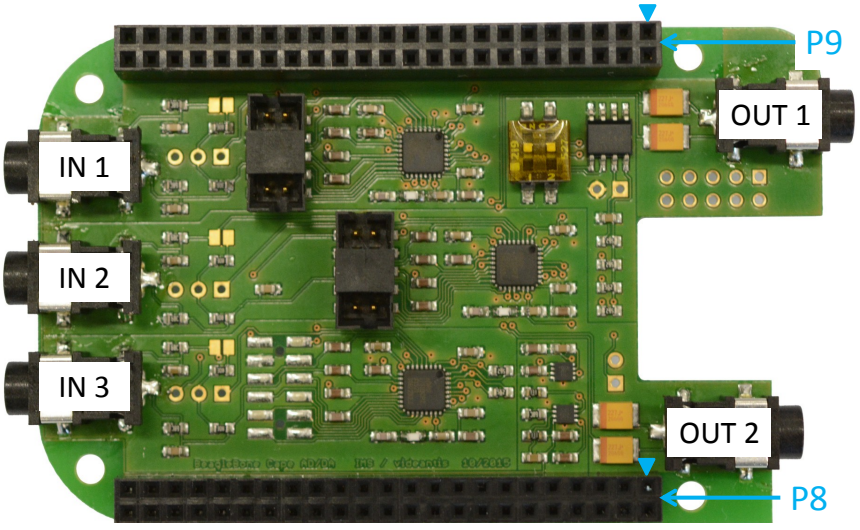

Figure 2: IMS Beaglebone Audio Extension Board headers

5.2. Extension Headers

When more specific connectivity is needed there are some extension headers that provide line level inputs, digital microphone inputs, and line-level outputs. A list of the connectors and headers is given in table 2 and shown in figure 2.

Name	Type	Description
X1	Mixed	10-pin audio extension header (2mm pitch)
X2	Mixed	10-pin audio extension header (2mm pitch)
X3	Mixed	12-pin audio extension header (2mm pitch)

Table 2: IMS Beaglebone Audio Extension Board extension headers

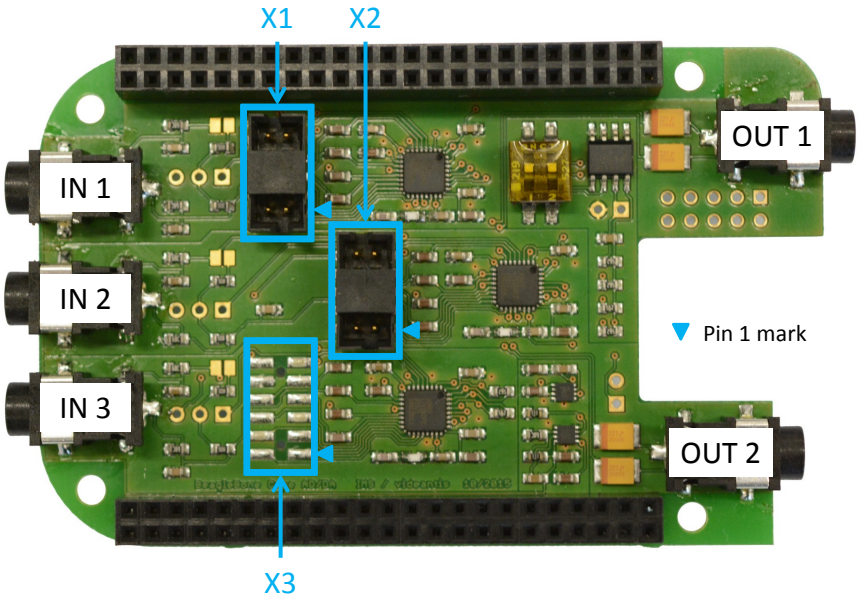

Figure 3: IMS Beaglebone Audio Extension Board headers

The pinouts of the X1 and X2 headers are symmetrical. Therefore, the pinout of the X1 header is shown in figure 4 and all headers are shown in appendix section A. All the signals with a suffix of 6 belong to the first codec IC1, the suffix 7 belongs to the second codec IC2 and so on. As codec 3 has no dedicated headphone output jack, the pins were added to the X3 header, which can be seen in section A.

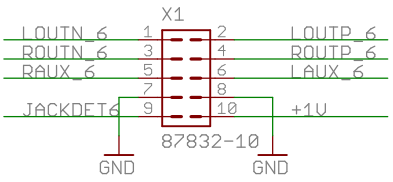

Figure 4: IMS Beaglebone Audio Extension Board X1 header pinout

Pin	Name	Description
1	LOUTN	Left differential line output, negative. Biased at AVDD/2.
2	LOUTP	Left differential line output, positive. Biased at AVDD/2.
3	ROUTN	Right Line Output, Negative. Biased at AVDD/2.
4	ROUTP	Right Line Output, Positive. Biased at AVDD/2.
5	RAUX	Right Channel Single-Ended Auxiliary Input. Biased at AVDD/2.
6	LAUX	Left Channel Single-Ended Auxiliary Input. Biased at AVDD/2.
7 & 8	-	GND connection.
9	JACKDET	Detect Insertion/Removal of Headphone Plug (JACKDET). Digital Microphone Stereo Input (MICIN).
10	+1V	+1V regulated power supply output. Enabled via X5 shown in figure 8

Table 3: IMS Beaglebone Audio Extension Board extension headers

For more information on the pins 1 to 10 of the headers X1-3 please refer to the ADAU1761 datasheet [1].

The digital general-purpose IOs are directly connected to the Beaglebone connectors P8 and P9. The functionality depends on the connected beaglebone board.

6. Jumpers

This section describes the configuration jumpers and their default configuration. Also the detailed functionality is given in case of non-default settings.

6.1. Microphone input configuration

On the IMS Beaglebone Audio Extension Board there are two jumpers for each microphone input configuration. Another jumper is used for an additional bias voltage supply for all microphone inputs and described in section 6.3. In table 4 the jumpers for each microphone input are listed and after that a schematic and functionality description is given.

Jumper	Microphone-Input	Description
JP11	IN 1	Mic. bias enable right channel.
JP12	IN 1	Mic. bias enable/selection left channel.
JP21	IN 2	Mic. bias enable right channel.
JP22	IN 2	Mic. bias enable/selection left channel.
JP31	IN 3	Mic. bias enable right channel.
JP32	IN 3	Mic. bias enable/selection left channel.

Table 4: IMS Beaglebone Audio Extension Board microphone input jumpers.

For better understanding the schematic of one of the microphone inputs is given in figure 5.

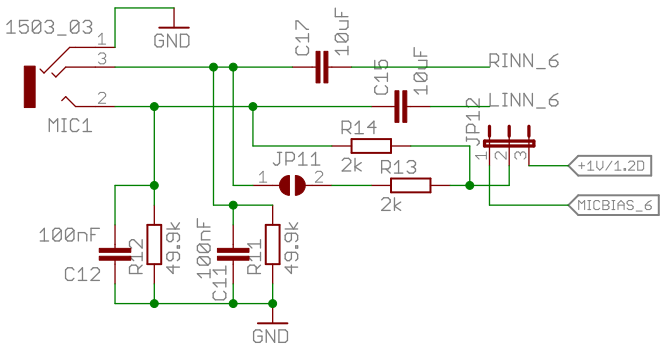

Figure 5: IMS Beaglebone Audio Extension Board microphone input 1 schematic.

As shown in figure 5 there are mainly two jumpers on each channel for bias voltage configuration. The jumper JPx2 (here x is 1-3) selects the bias voltage source between the bias output of the corresponding codec (in figure 5 codec 6) and a configurable voltage regulator that is set to 1 Volt output in default setting. When selecting one of the bias voltage sources, the supply will be connected to the left input channel (the tip of the 3.5mm input jack) accordingly. If there is also a bias

supply needed on the right channel (the ring of the 3.5mm input jack) the jumper JPx1 needs to be shorted. The possible settings of the jumpers are listed in table 5.

	JPx2	JPx1	Description
1	open	open	No bias supply on microphone input.
2	1-2	open	Bias supply of 3.5mm tip with configurable codec bias output.
3	2-3	open	Bias supply of 3.5mm tip with configurable voltage regulator output. 1 Volt by default.
4	1-2	shorted	Bias supply of 3.5mm tip and ring with configurable codec bias output.
5	2-3	shorted	Bias supply of 3.5mm tip and ring with configurable voltage regulator output. 1 Volt by default.

Table 5: IMS Beaglebone Audio Extension Board microphone jumper settings.

Figure 6 shows a detailed view of the microphone input jumpers.

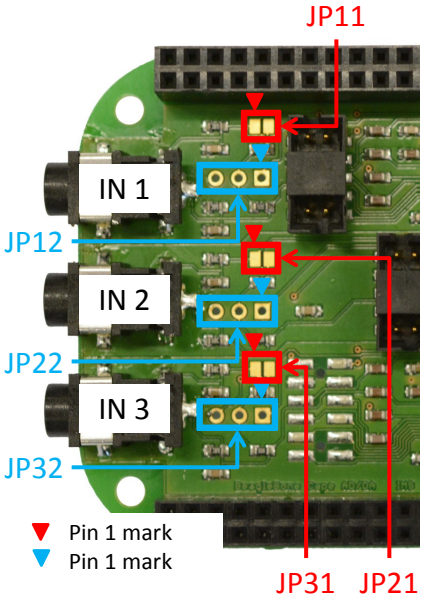

Figure 6: IMS Beaglebone Audio Extension Board microphone input jumpers.

For the voltage regulator settings for bias supply please refer to section 6.3.

6.2. Headphone Output

After the microphone input jumpers have been described, this section gives a detailed description of the headphone outputs. The schematic of one headphone output is given in figure 7, while the other headphone output is built up accordingly.

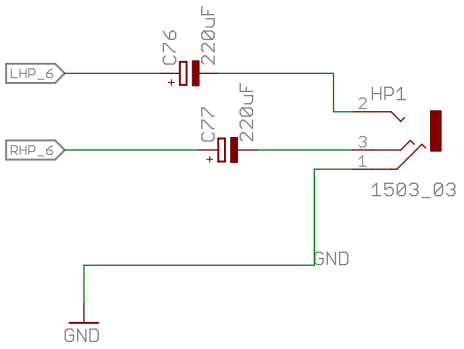

Figure 7: IMS Beaglebone Audio Extension Board headphone output 1 schematic.

There are DC-blocking capacitors built-in for headphones without built-in capacitors.

6.3. Power and EEPROM configuration

This section describes the jumpers for power and EEPROM configuration on the IMS Beaglebone Audio Extension Board. There are two jumpers and one dual switch used for the configuration, which is listed in table 6.

Jumper	Type	Description
X5	Power	1V voltage regulator enable if shorted.
X4	EEPROM	Write protect disabled if shorted.
S4	EEPROM	Address selection 00, if both switches on.

Table 6: IMS Beaglebone Audio Extension Board power and EEPROM jumpers.

The location of the jumpers is shown in 8.

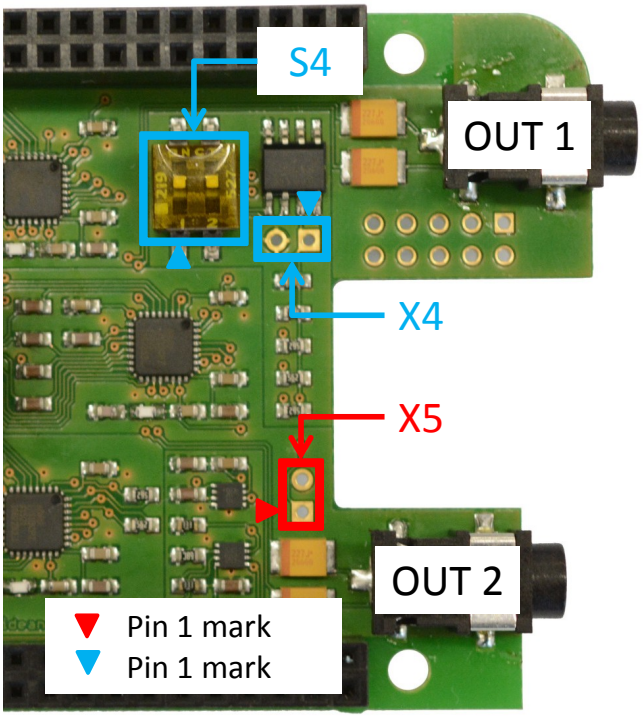

Figure 8: IMS Beaglebone Audio Extension Board power and clock jumpers.

6.3.1. Power configuration

The configuration of the microphone bias power supply is done using the X5 jumper. All configurations are listed in table 7.

	X5	Description
1	1-2	Voltage regulator enabled. Output voltage +1V configured with R51 and R52.
2	open	Voltage regulator disabled. (Default)

Table 7: IMS Beaglebone Audio Extension Board power jumper settings.

A detailed schematic of the regulator and jumper is given in figure 9.

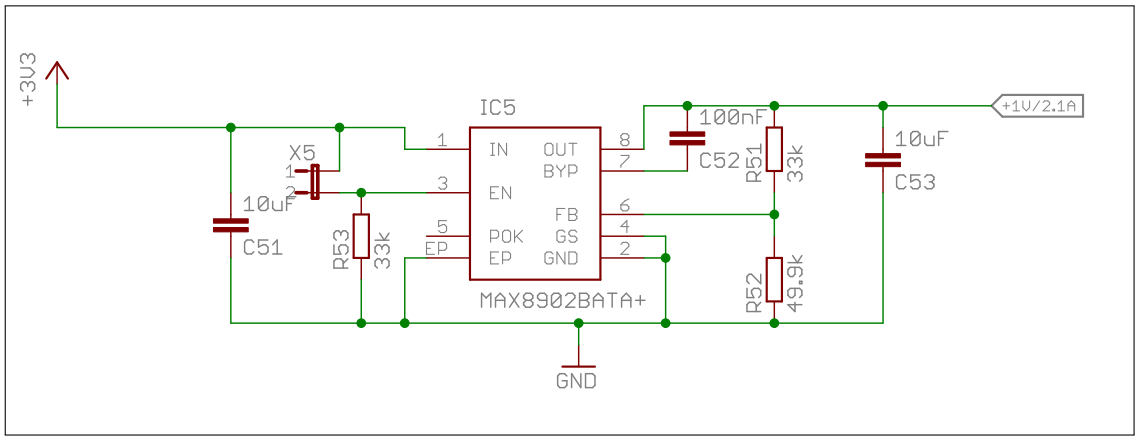

Figure 9: IMS Beaglebone Audio Extension Board voltage regulator circuit.

6.3.2. EEPROM configuration

The configuration of the EEPROM is done with one jumper and a switch. All jumper configurations are listed in table 8.

	X4	Description
1	1-2	EEPROM write protection disabled (only for initial programming).
2	open	EEPROM write protection enabled. (Default)

Table 8: IMS Beaglebone Audio Extension Board EEPROM jumper settings.

A detailed schematic of the EEPROM and jumper is given in figure 9.

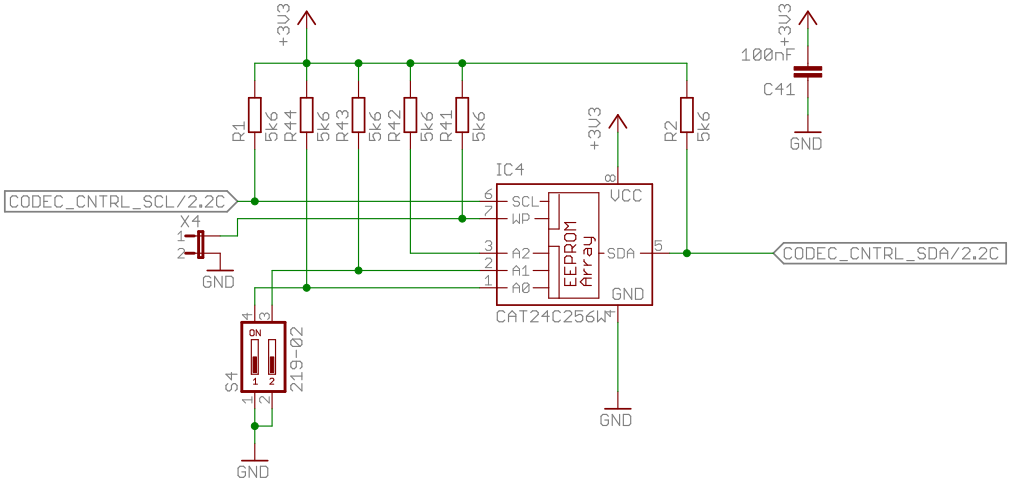

Figure 10: IMS Beaglebone Audio Extension Board EEPROM circuit.

6.4. Default settings

This section shows the default jumper settings in short tables.

	JPx2	JPx1	Description
	open	open	No bias supply on microphone input.

Table 9: IMS Beaglebone Audio Extension Board microphone jumper default settings.

	X5	Description
	open	Bias voltage regulator disabled. (Default)

Table 10: IMS Beaglebone Audio Extension Board power default jumper settings.

	X4	Description
	open	EEPROM write protection enabled. (Default)

Table 11: IMS Beaglebone Audio Extension Board EEPROM default jumper settings.

List of Figures

List of Tables

References

[1] Analog Devices Inc. Adau1761 - sigmadsp stereo, low power, 96 khz,24-bit audio codec with integrated pll. http://www.analog.com/static/imported-files/data_sheets/ADAU1761.pdf, 2009.

A. Header

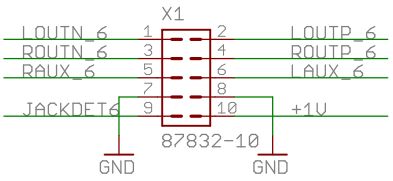

Figure 11: IMS Beaglebone Audio Extension Board X1 header pinout

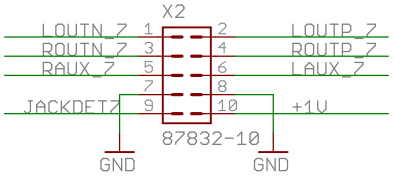

Figure 12: IMS Beaglebone Audio Extension Board X2 header pinout

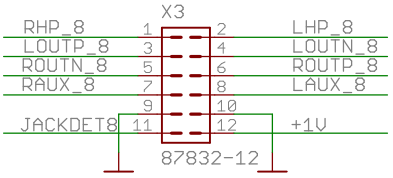

Figure 13: IMS Beaglebone Audio Extension Board X3 header pinout

B. Schematics

This section and its subsections show the detailed schematic of the IMS Beaglebone Audio Extension Board.

B.1. Audio component schematics

The microphone, codec and headphone output schematics are shown for one codec only, as all codecs are connected in the same manner using the indexes 6 to 8. Due to a non tri-state output of the codecs digital audio output pin, the digital audio bus signals of the three codecs CODEC_AUDIO_ADC_SDATA_A, CODEC_AUDIO_ADC_SDATA_B and CODEC_AUDIO_ADC_SDATA_C are merged by the OR gate (IC7) shown in Section B.2.2. This does only provide electrical data corruption. It does not remove data collision due to wrong output timing (like overlap) of the audio codecs. The correct timing slots have to be configured in the codec configuration registers for 4 or 8 channel TDM.

B.1.1. Microphone input

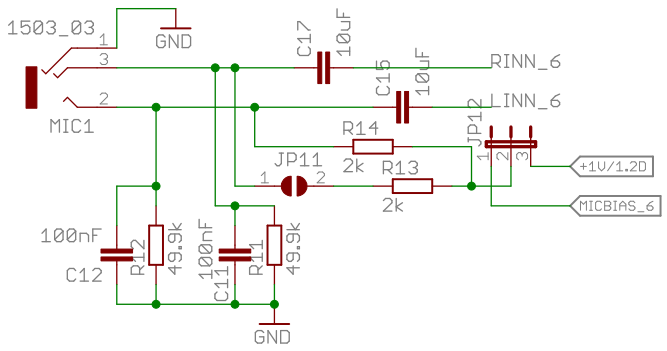

Figure 14: IMS Beaglebone Audio Extension Board microphone input schematic

B.1.2. Codec

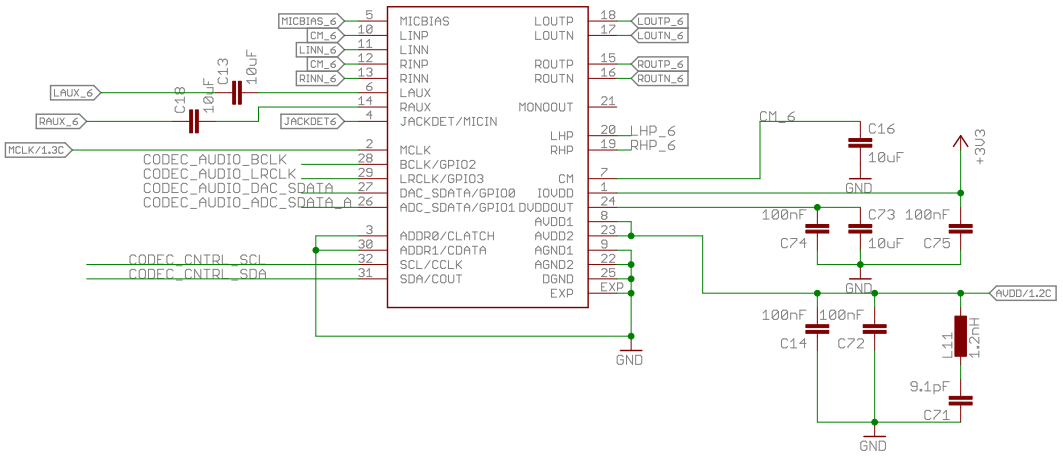

Figure 15: IMS Beaglebone Audio Extension Board codec schematic

B.1.3. Headphone output

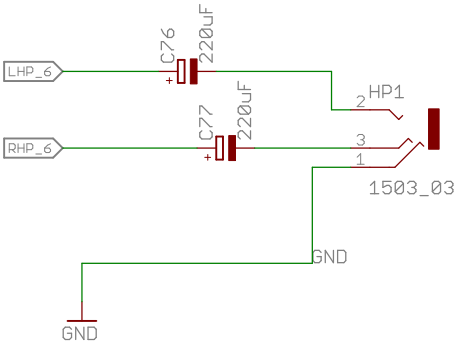

Figure 16: IMS Beaglebone Audio Extension Board headphone output schematic

B.2. Auxiliary component schematics

B.2.1. Power supplies

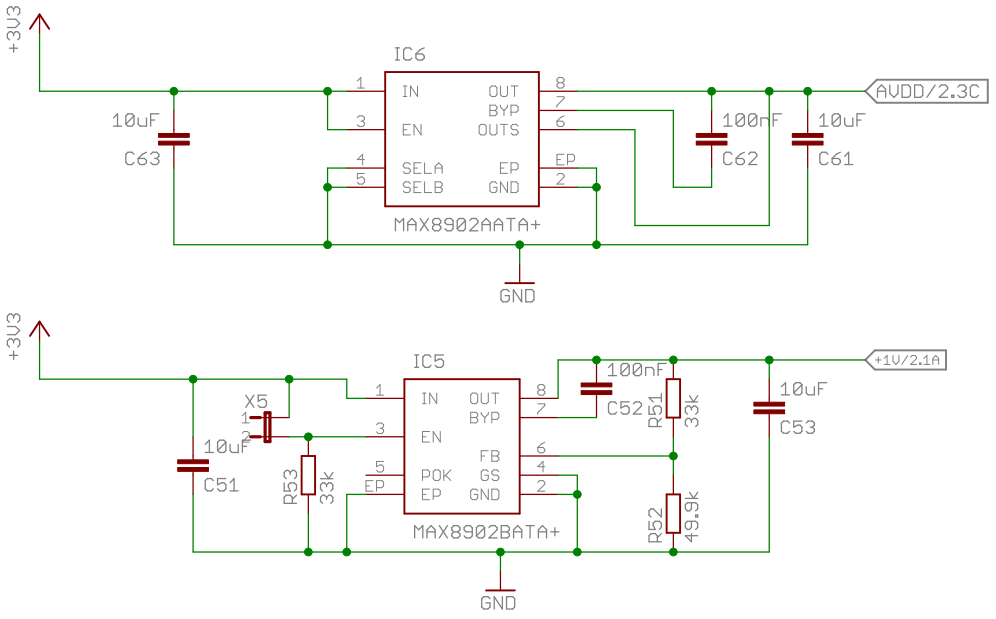

Figure 17: IMS Beaglebone Audio Extension Board power supplies schematic

B.2.2. Audio data bus

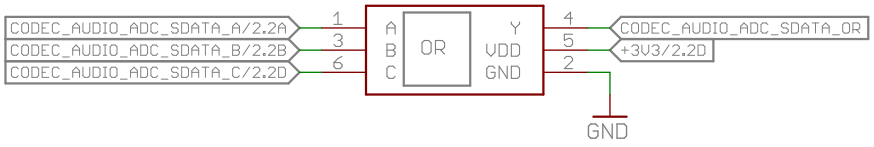

Figure 18: IMS Beaglebone Audio Extension Board ADC audio data bus merging OR gate

B.3. Connector schematics

This section shows the schematics of the pin headers of the IMS Beaglebone Audio Extension Board.

B.3.1. P6 & P8

On the P6 and P8 connectors, only the ground connections on P8 are used.

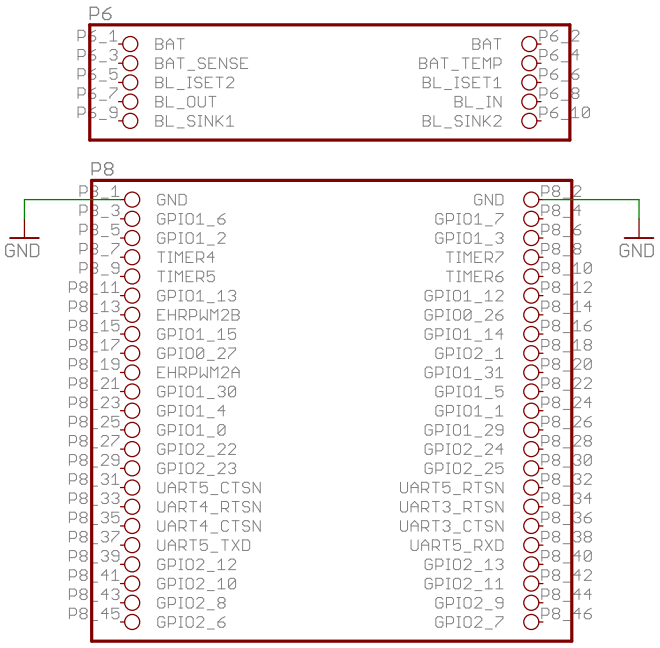

Figure 19: IMS Beaglebone Audio Extension Board schematic P6 & P8 headers

B.3.2. P9

On the P9 connector, all required connections to Beaglebone are provided.

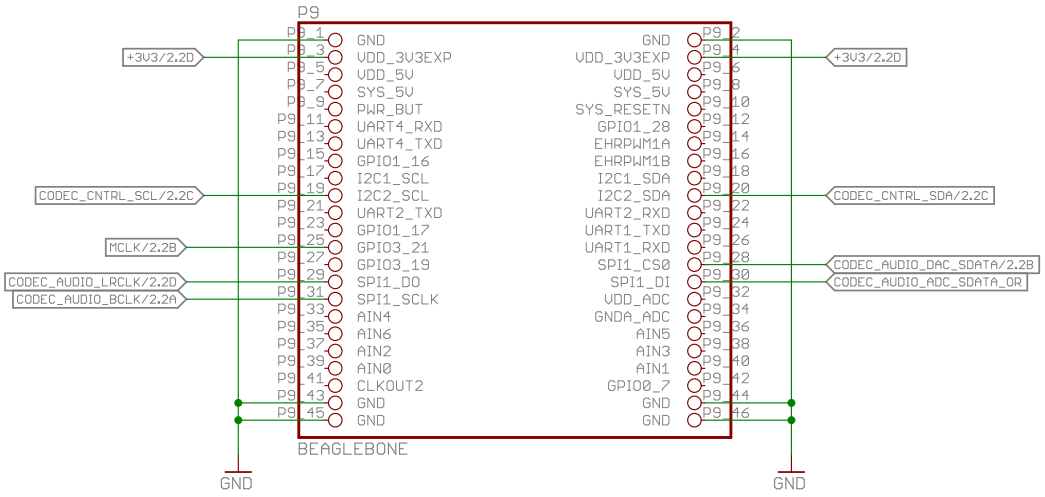

Figure 20: IMS Beaglebone Audio Extension Board schematic P9 header