MX93AUD-HAT-UM

MX93AUD-HAT Board User Manual

Rev. 1 — 14 April 2023 **User manual**

Document Information

Information	Content
Keywords	MX93AUD-HAT-UM, i.MX 93
Abstract	The MX93AUD-HAT is an entry level audio evaluation platform that is fully compatible with the MCIMX93-EVK. It includes a multi-channel codec, S/PDIF, and microphone interfaces. This document supports Board Revision A and B.

1 MX93AUD-HAT Overview

The MX93AUD-HAT is an entry level audio evaluation platform that is fully compatible with the MCIMX93-EVK. It includes a multi-channel codec, S/PDIF, and microphone interfaces.

For further information about MX93AUD-HAT, see http://www.nxp.com/.

1.1 Acronyms and abbreviations

The following table lists the acronyms and abbreviations used in this document.

Table 1. Acronyms and abbreviations

Term	Description
ADC	Analog-to-digital converter
DAC	Digital-to-analog converter
I^2S	Inter-IC sound
PDM	Pulse density modulation
S/PDIF	Sony / Philips Digital InterFace
I^2C	Inter-integrated circuit
LDO	Low dropout regulator
LED	Light-emitting diode

1.2 Related documentation

The table below lists and explains the additional documents and resources that you can refer to for more information on the MX93AUD-HAT board. Some of the documents listed below may be available only under a non-disclosure agreement (NDA). To request access to these documents, contact your local field applications engineer (FAE) or sales representative.

Table 2. Related documentation

Document	Description	Link / how to access
i.MX 93 Applications Processor Reference Manual	Intended for system software and hardware developers and application programmers who want to develop products with i.MX 93 MPU	IMX93RM
i.MX 93 Industrial Application Processors Data Sheet	Provides information about electrical characteristics, hardware design considerations, and ordering information	IMX93IEC
i.MX93 Hardware Developer's Guide	This document aims to help hardware engineers design and to test their i.MX 93 processor-based designs. It provides information about board layout recommendations and design checklists to ensure first-pass success and avoidance of board bring-up problems.	IMX93HDG

1.3 Board kit contents

The table below lists the items included in the MX93AUD-HAT hardware kit.

Table 3. Board kit contents

Item	Quantity
MX93AUD-HAT	1
Jumper sockets (installed)	5

1.4 Block diagram

The following figure shows the block diagram of the MX93AUD-HAT board.

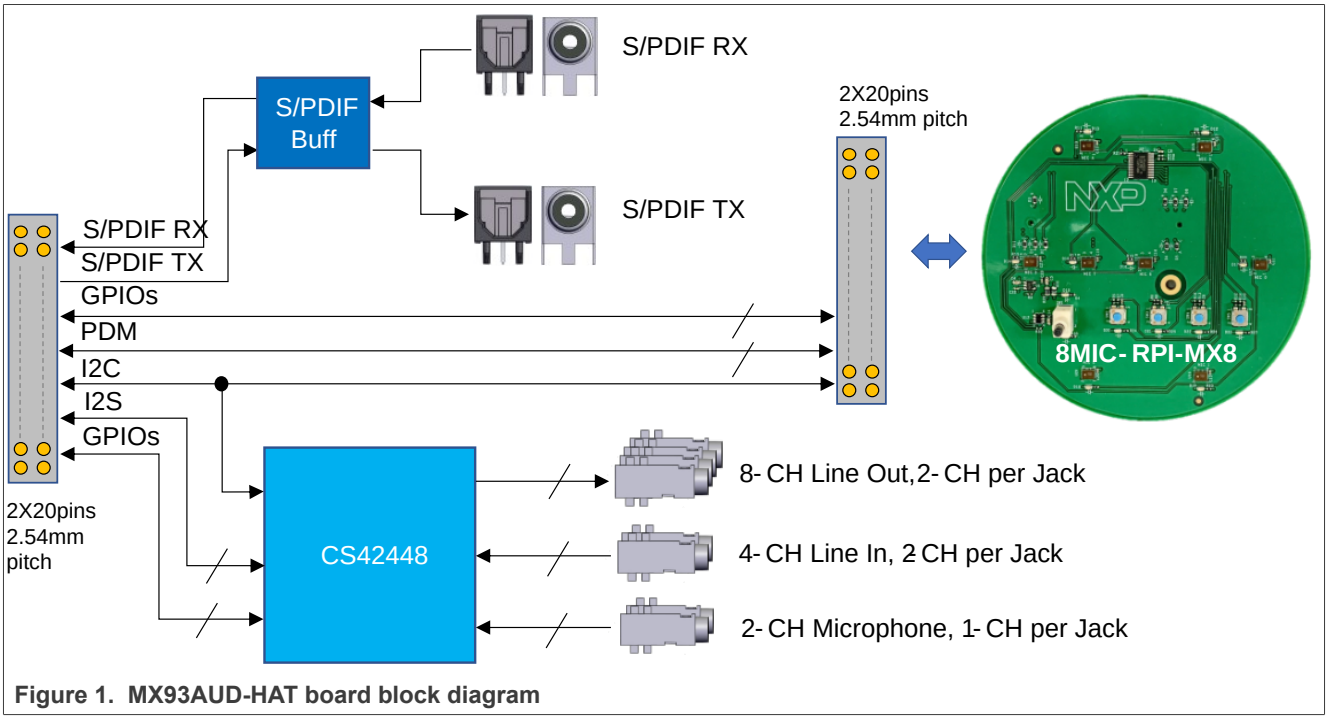

Figure 1. MX93AUD-HAT board block diagram

1.5 Board pictures

The following figures show the top and bottom side of the MX93AUD-HAT board, and also highlight the connectors, jumpers, and LED available on the board.

The outline size of the board is 119 x 63 x 1.6 mm.

The following figure shows the top side of the board, and highlights the connectors available on the board (see Section 1.7 for detail).

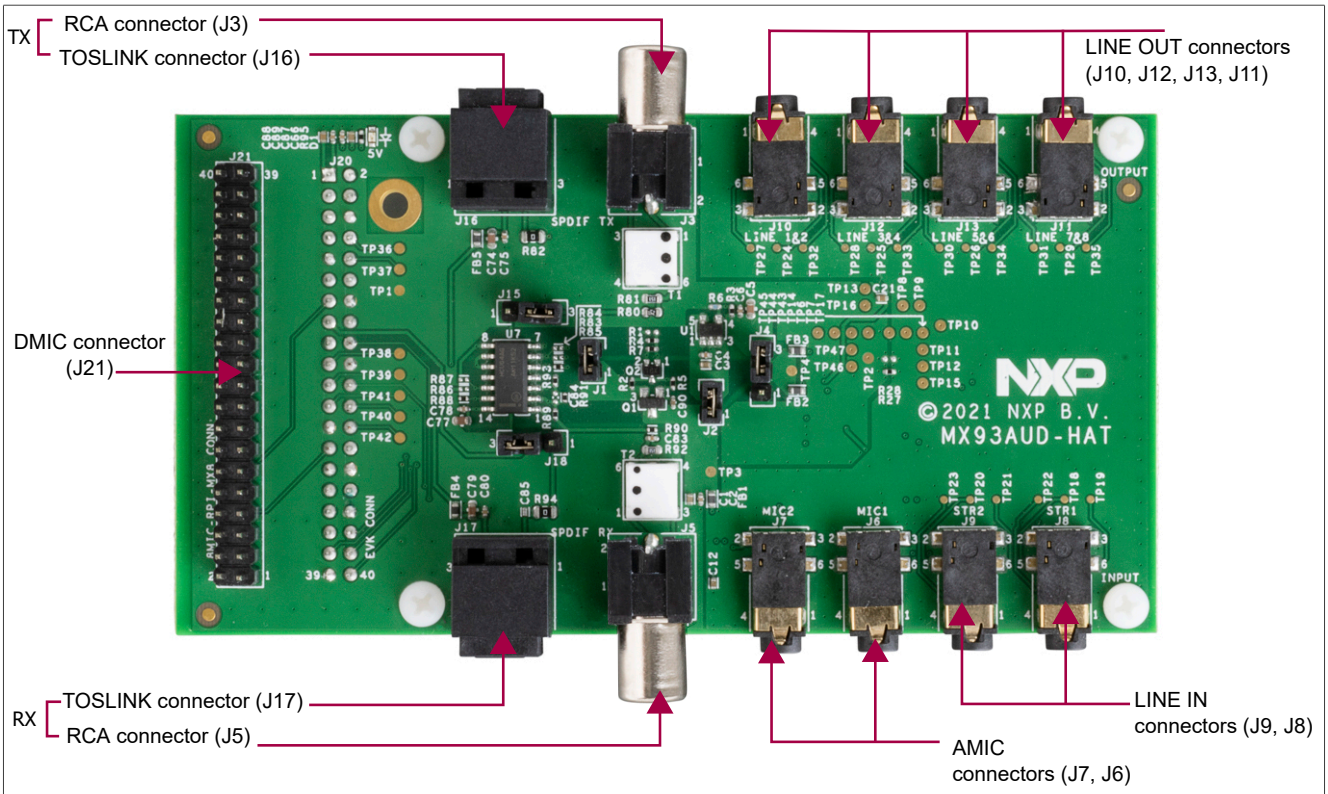

Figure 2. MX93AUD-HAT top-side view

The following figure shows the bottom side of the board, and highlights the connector available on bottom side of the board.

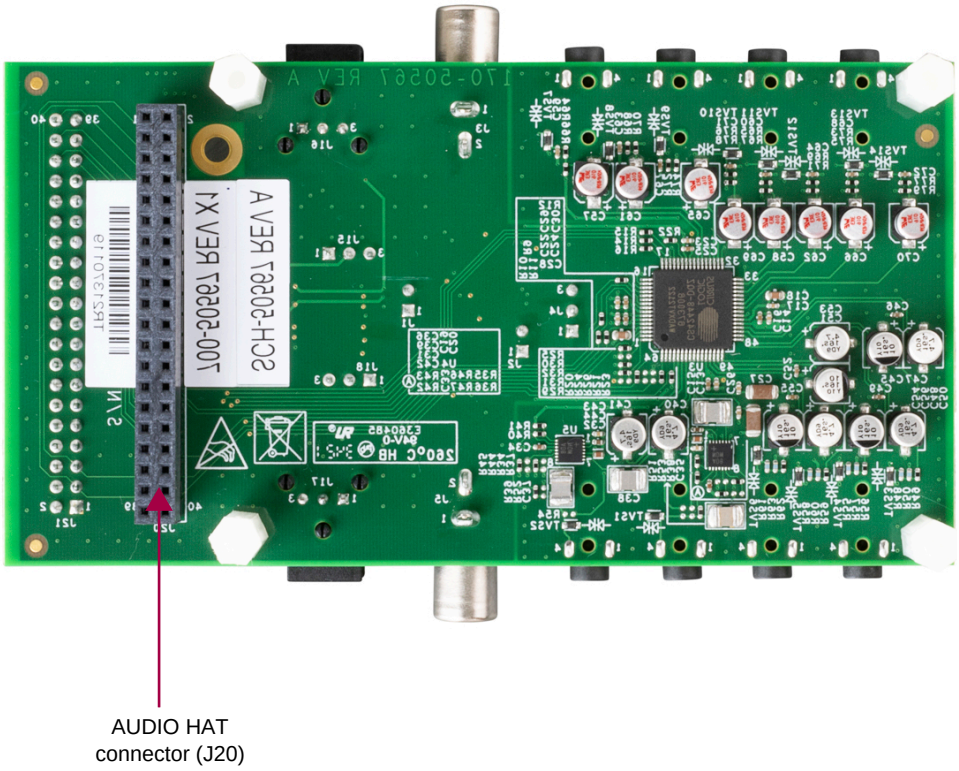

Figure 3. MX93AUD-HAT bottom-side view

The following figure shows the top side of the board, and highlights the jumpers and LEDs available on the board (seeSection 1.8 and Section 1.9 for detail).

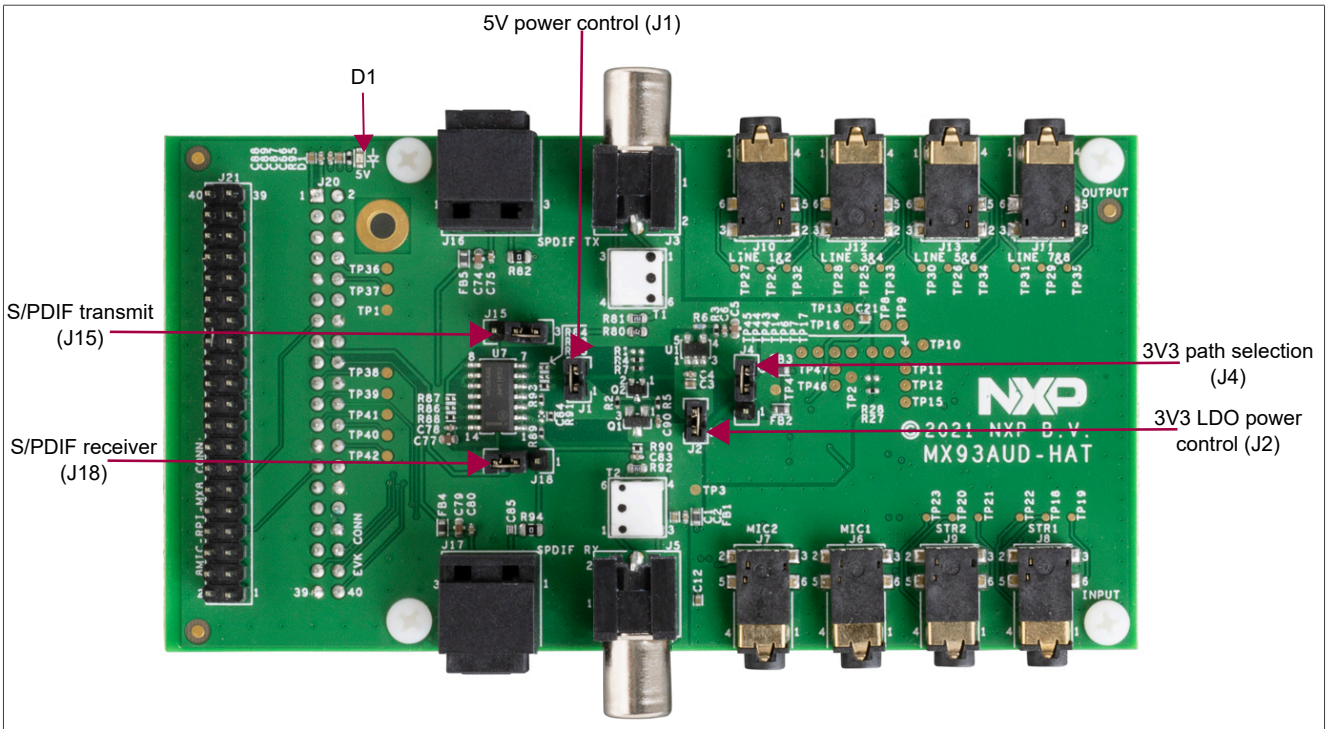

Figure 4. MX93AUD-HAT jumpers and LED

1.6 Board features

The table below lists the features of MX93AUD-HAT board.

Table 4. Board main features

Board feature	Processor feature used	Description
Interfacing with Main board		40-pin connector used for MX93AUD-HAT board connection with the motherboard such as MCIMX93-EVK.
Power	3.3 V	MX93AUD-HAT board can be powered either by onboard 3.3 V or 3.3 V from motherboard.
I2C	I2C	MX93AUD-HAT is configured through the I2C interface at address 1001 000x.
Audio	I2S	Supports one onboard codec CS42448 that provides six multi-bit analog-to-digital and eight multi-bit digital-to-analog delta-sigma converters.
	PDM	MX93AUD-HAT board supports one PDM interface (J21) to connect to the digital microphone board.
	S/PDIF	MX93AUD-HAT board provides two TOSLINK+RCA ports for S/PDIF receive and transmit.

1.7 Connectors

The following table describes the connectors available on the MX93AUD-HAT board.

Table 5. Connectors

Part identifier	Connector type	Description
J20	2x20-pin connector	Audio Hat connector. It is 2.54 mm pitch, female connector, responsible for communication with motherboard, such as MCIMX93-EVK and so on. See Section 1.7.1 for more detail.
J21	2x20-pin connector	It is used to provide PDM interface and is used for connection with digital microphone board 8MIC-RPI-MX8.
J3	RCA connector	Coaxial cable connector for digital audio signals transmission
J16	TOSLINK connector	Optical fiber connector for digital audio signals transmission
J5	RCA connector	Coaxial cable receiver connector for digital audio signals
J17	TOSLINK connector	Optical fiber receiver connector for digital audio signals
J6	PJ31360, 3.5 mm audio jack	Single-ended analog input connector for CS42448 audio codec (AIN5B/AIN5A/AIN6B/AIN6A pins)
J7		
J8		Differential analog input connector for CS42448 audio codec (AIN1+/-, AIN2+/-, AIN3+/-, AIN4+/- pins)
J9		
J10	PJ31360, 3.5 mm audio jack	CS42448 audio codec Line 1 and Line 2 analog output connector
J12		CS42448 audio codec Line 3 and Line 4 analog output connector
J13		CS42448 audio codec Line 5 and Line 6 analog output connector
J11		CS42448 audio codec Line 7 and Line 8 analog output connector

1.7.1 Audio Hat connector

Figure 5 shows the description of each pin of the 2x20-pin connector. This connector supports I2S, 4-lane PDM, S/PDIF I/O, I^2C and some control pins, all signals are 3.3 V logic level.

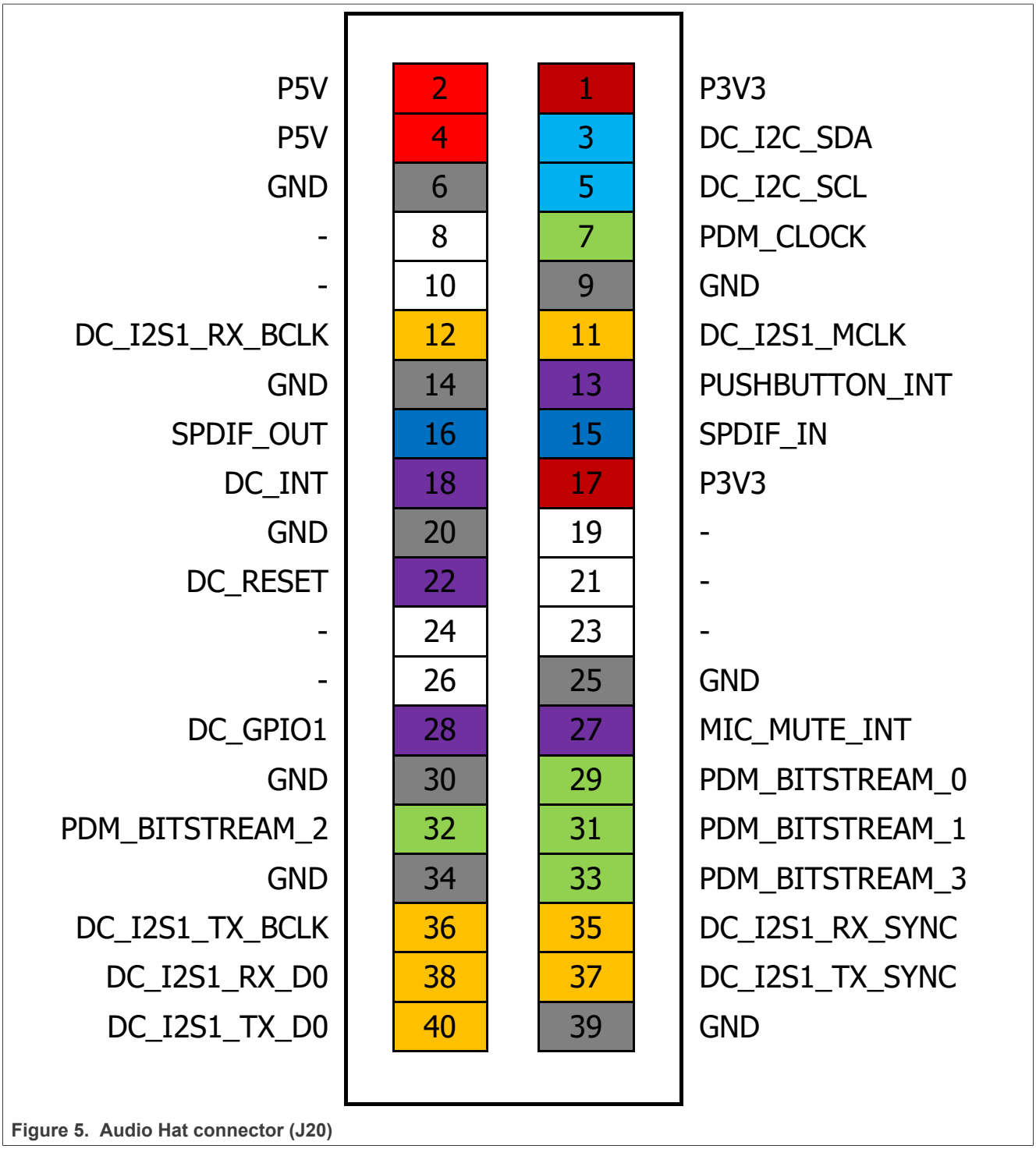

Figure 5. Audio Hat connector (J20)

Table 6 describes the pin description of the J20 connector. All signals are grouped by functions and their directions are mentioned with respect to MX93AUD-HAT board.

Table 6. Audio Hat connector pin description with GPIO mapping

Pin Number	Pin Name	GPIO Mapping	I/O	Voltage (V)	Description
3	DC_I2C_SDA	GPIO2_I2C4.SDA	I/O	3.3	I^2C bus
5	DC_I2C_SCL	GPIO3_I2C4.SCL	I	3.3	
7	PDM_CLOCK	GPIO4	I	3.3	PDM interface for 8MIC-RPI-MX8 board
29	PDM_BITSTREAM_0	GPIO5	O	3.3	
31	PDM_BITSTREAM_1	GPIO6	O	3.3	
32	PDM_BITSTREAM_2	GPIO12	O	3.3	
33	PDM_BITSTREAM_3	GPIO13	O	3.3	
11	DC_I2S1_MCLK	GPIO17	I	3.3	I2S interface, include 1-lane RX and 1-lane TX. MX93AUD-HAT board (CS42448) as slave device by default
12	DC_I2S1_RX_BCLK	GIO18	I	3.3	
35	DC_I2S1_RX_SYNC	GPIO19	I	3.3	
38	DC_I2S1_RX_D0	GPIO20	O	3.3	
36	DC_I2S1_TX_BCLK	GPIO16	I	3.3	
37	DC_I2S1_TX_SYNC	GPIO26	I	3.3	
40	DC_I2S1_TX_D0	GPIO21	I	3.3	
15	SPDIF_IN	GPIO22	O	3.3	S/PDIF I/O
16	SPDIF_OUT	GPIO23	I	3.3	
13	PUSHBUTTON_INT	GPIO27	O	3.3	Button interrupt signal from 8MIC-RPI-MX8 board
27	MIC_MUTE_INT	GPIO0	I	3.3	Mute signal to 8MIC-RPI-MX8 board
18	DC_INT	GPIO24	O	3.3	CS42448 interrupt signal
22	DC_RESET	GPIO25	I	3.3	Reset CS42448, active low
28	DC_GPIO1	GPIO1	I	3.3	Power control signal, active high
1, 17	P3V3	-	Pi	3.3	3.3 V power supply
2,4	P5V	-	Pi	5.0	5.0 V power supply
9, 14, 20, 25,30, 39	GND	-	P	0	Ground

1.8 Jumpers

To facilitate the development and debugging and for the diversity of functions, some jumpers have been added to the MX93AUD-HAT board. The following table describes the jumpers available on the board.

Table 7. Jumper Description

Part identifier	Jumper type	Name/Function	Settings
J1	1x2 header	5 V power control	• Open: Disconnect 5 V power supply from the motherboard to the MX93AUD-HAT board

Table 7. Jumper Description*...continued*

Part identifier	Jumper type	Name/Function	Settings
			• Shorted: Connect 5 V power supply from the motherboard to the MX93AUD-HAT board [Default setting]
J2	1x2 header	3V3 LDO power control	• Open: Disconnect 3.3 V LDO U1 input path • Shorted: Connect 3.3 V LDO U1 input path [Default setting]
J4	1x3 header	3.3 V path selection	• 1-2 shorted: 3.3 V source from motherboard • 2-3 shorted: 3.3 V source from on board LDO (default setting)
J15	1x3 header	S/PDIF transmit	• 1-2 shorted: TOSLINK port is used for S/PDIF transmit • 2-3 shorted: RCA port is used for S/PDIF transmit (default setting)
J18	1x3 header	S/PDIF receiver	• 1-2 shorted: TOSLINK port is used as S/PDIF receiver • 2-3: RCA port is used as S/PDIF receiver (default setting)

1.9 LED

The MX93AUD-HAT board has one LED with detail as below:

- LED color - Red
- Part Identifier - D1
- LED name - 5 V
- Description - LED for 5 V power supply. When On, indicates that 5 V power supply is available on board.

2 Function Description

This chapter describes the features and different interfaces of MX93AUD-HAT board.

2.1 Power

Two types of power supply paths are available on the MX93AUD-HAT board.

- For the first power supply path, source is motherboard that provides 5 V power to the board. The DC_GPIO1 signal controls the 5 V supply to either ON or OFF. Setting DC_GPIO1 as high, enables the 5 V supply on the board. The onboard LDO (U1) converts the 5 V power supply to 3.3 V power supply.
- For the second power supply path, motherboard supplies 3.3 V power direct to the board. The power supply path does not pass through onboard LDO (U1).

For both supply paths, it is ensured that the ripple is small enough and the PSRR is large enough, which is beneficial to the audio signal.

2.2 Reset

The MX93AUD-HAT board is reset through DC_RESET [GPIO25] input signal coming from motherboard through J20 connector.

Hold DC_RESET signal low until the power supply and clocks are stable or a reset occurs after power up. If the analog or digital supplies drop below the recommended operating condition, it is recommended to activate the reset signal to prevent power-glitch-related issues. A time delay of approximately 400 ms is required after applying power to the device or after exiting a reset state.

2.3 I2C

The MX93AUD-HAT board is configured through the I2C interface at address 1001 000x. The default address can be changed using pins AD0/CS and AD1/CDIN of the CS42448 codec (U3). For more detail, refer to the MX93AUD-HAT board schematics.

I^2C bus on this board supports standard speed mode 100 kHz. The signal timings for a read and write cycle are shown in Figure 6 and Figure 7. A Start condition is defined as a falling transition of SDA while the clock is high. A Stop condition is a rising transition while the clock is high. All other transitions of SDA occur while the clock is low.

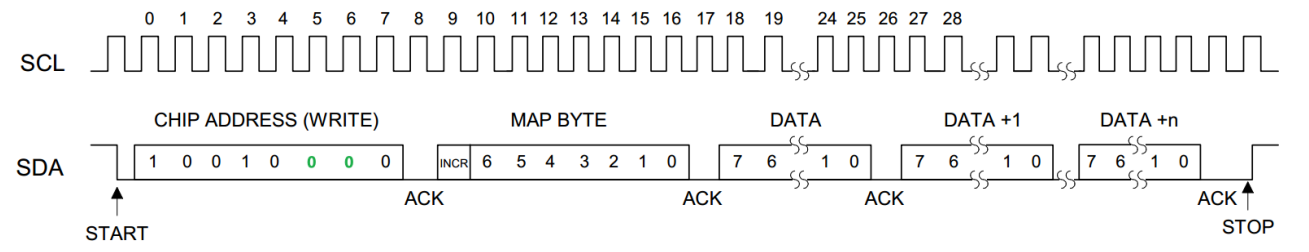

Figure 6. I2C Write Timing

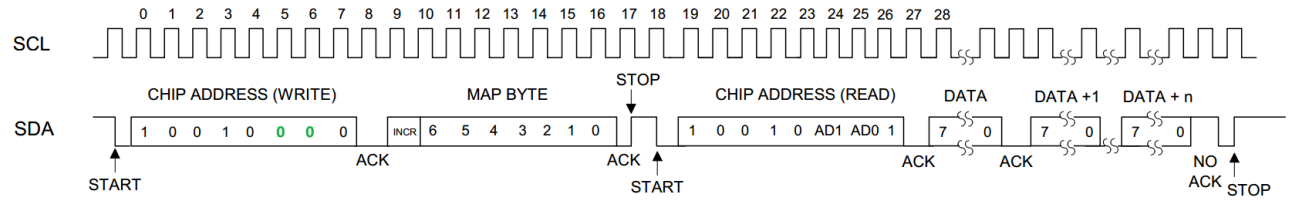

Figure 7. I2C Read Timing

2.4 I2S

I^{2}S (Inter-IC Sound) provides audio processing feature. It is an electrical serial bus interface standard used for connecting digital audio devices together. The ADC and DAC serial ports of the audio codec CS42448 available on this board support the I²S, Left-Justified, Right-Justified, One-Line Mode (OLM), and TDM digital interface formats with varying bit depths from 16 to 32. The I2S interface of ADC consists of SCLK, LRCK, and one-lane SDOUT and the I2S interface of DAC consists of SCLK, LRCK, and one-lane SDIN. The below table describes the audio feature summary.

Table 8. Audio feature summary

Digital input/output	Interface format	Analog output/input channel allocation form/to digital I/O
ADC_SDOUT1	I²S, LJ, RJ	AIN 1, 2
	OLM	AIN 1, 2, 3, 4, 5, 6
	TDM	AIN 1, 2, 3, 4, 5, 6 (two additional channels from AUX_SDIN)
DAC_SDIN1	I²S, LJ, RJ	AOUT 1, 2
	OLM	AOUT 1, 2, 3, 4, 5, 6
	TDM	AOUT 1, 2, 3, 4, 5, 6, 7, 8

2.5 S/PDIF

S/PDIF (Sony/Phillips Digital Interface) is a consumer audio connection standard for transmitting high-quality digital audio. It can carry two channels of uncompressed PCM audio or compressed 5.1/7.1 surround sound such as Dolby Digital or DTS audio. The S/PDIF interface and the associated connectors can be implemented in two different ways “optical and coaxial”. On MX93AUD-HAT board, it supports two pairs of RCA and TOSLINK connectors (see Section 1.7). The NRZ signal transmission speed of TOSLINK connectors can support 25 Mbit/s. Different communication media can be switched with J15 and J18. For detail, see Section 1.8.

2.6 PDM

PDM (Pulse density modulation) is a form of modulation used to represent an analog signal in the digital domain. It is a high frequency stream of 1-bit digital samples. In a PDM signal, the relative density of the pulses corresponds to the analog signal's amplitude.

The PDM interface is available on the MX93AUD-HAT board at J21 connector, it supports 4-lane data with one clock. The digital microphone board 8MIC-RPI-MX8 can be connected to this connector.

3 Board Errata

None

4 Revision history

The following table summarizes revisions to this document.

Table 9. Revision history

Revision	Date	Topic cross-reference	Description
1	14 April 2023	-	Initial public release

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