Evaluating XENSIV™ MEMS microphones using PSOC™ 6 and XENSIV™ Audio Shield

Getting started guide

About this document

Scope and purpose

The user guide discusses how to use and evaluate Infineon's digital XENSIV™ MEMS microphones with PSOC™ 62S2 evaluation kit equipped with XENSIV™ Audio Shield. It familiarizes you with the XENSIV™ Audio Shield and guides you through the initial setup process.

Intended audience

This document is intended for design, verification, test, and software engineers interested in evaluating XENSIV™ MEMS microphones and get in-depth understanding of the functionality and connectivity options of Infineon's XENSIV™ Audio Shield – including those who want to integrate these components into their own audio-based projects.

About this product group

Target applications

XENSIV™ Audio Shield enables the development and prototyping of stereo and multi-microphone solutions for smart devices, including smartphones, smart watches, and smart glasses with in the PSOC™ 6 environment. These solutions can provide advanced audio applications such as speech detection, beamforming, and sound localization. The board facilitates the evaluation and optimization of these solutions, allowing developers to create enhanced audio experiences for various wearable and mobile devices.

Key applications include voice-activated interfaces, noise reduction, and 3D audio tracking, all of which can be developed and refined using the XENSIV™ Audio Shield capabilities.

Product family

XENSIV™ MEMS microphones

PSOC™ 62S2

Safety precautions

Note: Please note the following warnings regarding the hazards associated with development systems

Table 1 Safety precautions

	**Caution:** *The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.*

Table of contents

1 Introduction

This document serves as a comprehensive guide to evaluate Infineon's digital XENSIV™ MEMS microphones in conjunction with XENSIV™ Audio Shield and the PSOC™ 62S2 evaluation kit (CY8CEVAL-062S2). This document aims to provide a detailed overview of the hardware and software components involved. It also explains procedures for evaluating the performance of the XENSIV™ MEMS microphones in various audio modes.

Infineon's XENSIV™ MEMS microphones are designed to provide high-quality audio capture and playback capabilities, making them an ideal choice for a wide range of applications, including voice assistants, smart home devices, and industrial audio systems.

XENSIV™ Audio Shield is a versatile development platform to easily evaluate XENSIV™ MEMS microphones with the PSOC™ 62S2 evaluation kit, letting you create complex audio systems with minimal hardware and software designing efforts.

The user guide is intended for developers, engineers, and technical professionals who want to evaluate the capabilities of the XENSIV™ MEMS microphones and XENSIV™ Audio Shield, including those who are looking to integrate these components into their own audio-based projects. This document provides a detailed overview of the hardware and software components involved and step-by-step instructions for setting up and evaluating the system.

1.1 Prerequisites

1.1.1 Hardware

- XENSIV™ Audio Shield
- PSOC™ 62S2 evaluation kit
- XENSIV™ MEMS microphone flex evaluation kit

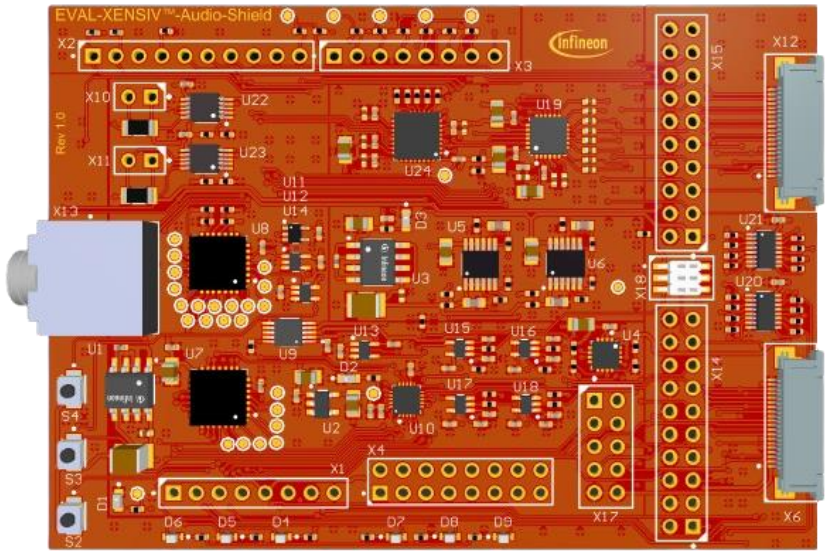


Figure 1 XENSIV™ Audio Shield

1.1.2 Software

- Software examples via ModusToolbox™

2 XENSIV™ Audio Shield

2.1 Key features

- Connect up to 8 digital or 4 analog XENSIV™ MEMS microphones
- Audio streaming over USB interface
- Audio monitoring via headphone
- 48 kHz sampling rate
- 24 bit audio data up to 4 channels or 16-bit audio up to 8 channels via USB
- 24 bit audio internally up to 8 channels
- Flexible connectivity to build multi-microphone demos
- 3 push buttons
- Stereo LED VU meter

2.2 Block diagram

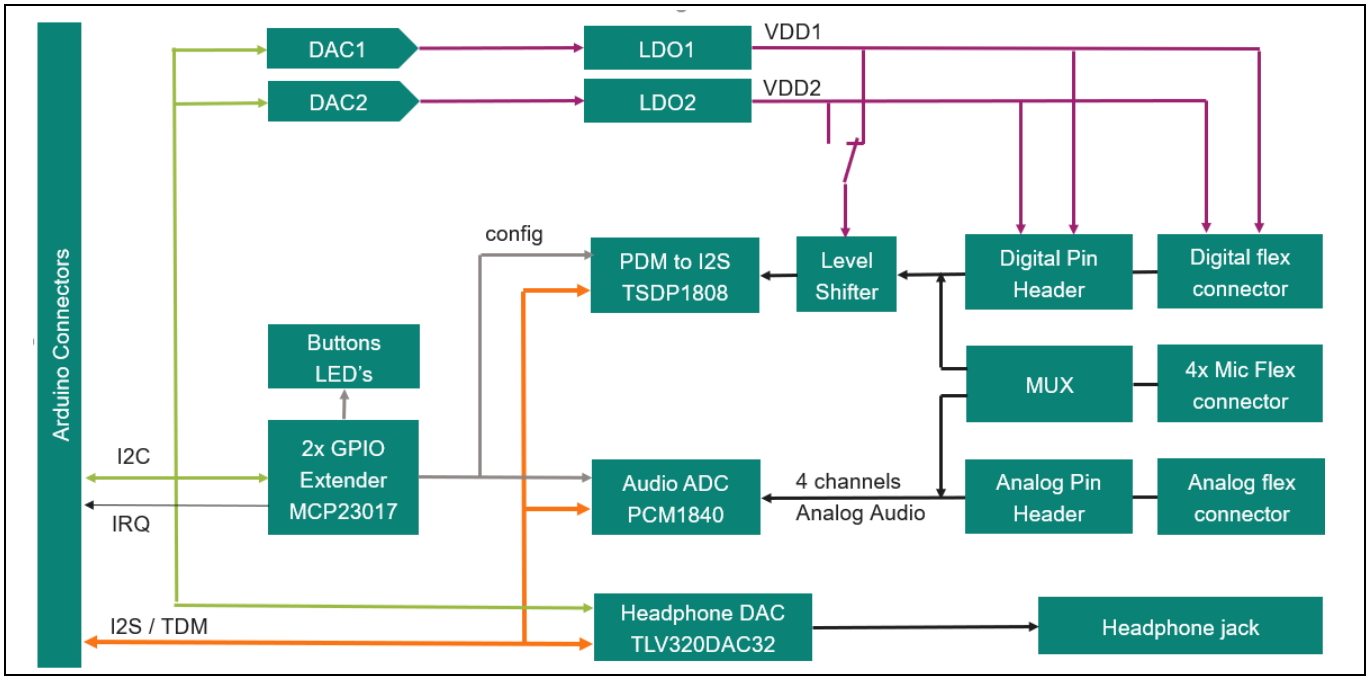


Figure 2 XENSIV™ Audio Shield block diagram

2.3 Block description

Table 2 Block descriptions

Device	Description
DAC 1,2	DAC provides control voltage for LDO
LDO 1,2	LDOs supply microphones with adjustable voltages
Buttons	For user interaction
LEDs	Simple stereo VU meter with 3x2 LEDs
PDM to I2S/TDM TSDP1808	Codec that converts PDM stream from the digital microphone into I2S/TDM audio stream, up to 8 channels
Level shifter	Shifts the digital level of PDM interface from 1.8 V to 3.3 V between digital microphones and TSDP1808
Audio ADC PCM1840	ADC converts analog audio signals from microphone to I2S/TDM audio stream, up to 4 channels
Headphone DAC TLC320DAC	DAC with headphone amplifier to provide audio out and audio monitoring
GPIO extender MCP23017	Configures the audio mode of PCM1840 and TSDP1808, controls LED VU meter and reads push buttons
Mic flex	Flex connector for Infineon microphone flexes
MUX	Multiplexer to switch microphone flexes to the analog or digital path
Analog flex connectors	20 pin ZIF connector for flex boards; up to 4 analog microphones can be connected, it also provides 3.3 V, GND, VDD1, VDD2, and I^2C (SCL, SDA)
Analog pin header	Up to 4 analog microphones can be connected, it also provides GND, VDD1, and VDD2
Digital flex connectors	20 pin ZIF connector for flex boards. Up to 8 digital microphones via PDM can be connected; it also provides 3.3 V, GND, VDD1, VDD2, I^2C, and SPI
Digital pin header	Up to 8 digital microphones via PDM can be connected. It also provides GND, VDD1, and VDD2

2.3.1 Supply Voltages for microphones

XENSIV™ Audio Shield provides two microphone supply voltages. A single supply voltage is typically sufficient for most applications. However, certain microphones may use a secondary voltage to control their internal logic level, for instance.

2.3.2 I²C addresses of components

Table 3 1²C addresses of the components

Component	Vendor	I²C Address	Description
AD5697	Analog devices	0Ch	Dual DAC provides control voltage for LDOs
TLC320DAC	Texas Instruments	18h	DAC for headphone
MCP23017	Microchip	20h	GPIO extender for LEDs, Pushbuttons and board config
MCP23017	Microchip	21h	GPIO extender to config TSDP1808 and PCM1840
INA226	Texas Instruments	40h	Current measurement von VMIC1 on MIC1 flex
INA226	Texas Instruments	41h	Current measurement von VMIC1 on MIC1 flex
24AA64T	Microchip		EEPROM to store individual board information

2.3.3 Signals GPIO extender

Table 4 Signals of MCP23017 GPIO extender 1 for LEDs, push buttons, and board configurations

Port	GPIO	DIR	Signal	Description
A	0	out	LED_LEFT_GN	VU meter LED green left
	1	out	LED_LEFT_YE	VU meter LED yellow left
	2	out	LED_LEFT_RD	VU meter LED red left
	3	out	LED_RIGHT_GN	VU meter LED green right
	4	out	LED_RIGHT_YE	VU meter LED yellow right
	5	out	LED_RIGHT_RD	VU meter LED red right
	6	in	BUTTON1	Push button 1
	7	in	BUTTON2	Push button 2
B	0	in	BUTTON3	Push button 3
	1	out	FREE_GPIO	Not used
	2	out	DAC_CLR	Sets DAC for VMIC1 and VMIC2 to 0 V
	3	out	DAC_LDAC	Loads voltage value for DAC after I²C transfer
	4	out	MIC_TYPE_SEL	Selects microphone type for mic flex 1...4 (0: analog, 1:digital)
	5	out	MIC_FLEX_EN	Enables mic flex 1...4 (0: disabled, 1: enabled)
	6	out	VMIC_IO_SEL	Selects the Vmic to be used for the logic level
	7	out	PDM-SHD_N	Shuts down I2S/TDM of TSDP1808

Table 5 Signals of MCP23017 GPIO extender 2 to config TSDP1808 and PCM1840

PORT	GPIO	DIR	Signal	Description
A	0	out	MODE1	TSDP1808: Oversampling Mode
	1	out	MODE2	TSDP1808: Oversampling Mode
	2	out	MODE3	TSDP1808: Oversampling Mode
	3	out	SCK_PL	TSDP1808: Bitclock rising or falling
	4	out	2CH_TDM1	TSDP1808: I2S/TDM Mode
	5	out	2CH_TDM2	TSDP1808: I2S/TDM Mode
	6	out	WL_MSB	TSDP1808: PCM word length
	7	out	WL_LSB	TSDP1808: PCM word length
B	0	out	ADC_SHD_N	PCM1840: Shut down
	1	out	ADC_MSZ	PCM1840: Mode select
	2	out	ADC_FMT0	PCM1840: I2S/TDM Format
	3	out	ADC_FMT1	PCM1840: I2S/TDM Format
	4	out	ADC_MD0	PCM1840: System Clock select
	5	out	ADC_MD1	PCM1840: DRE selection
	6	out	HEAD_RST_N	TLC320DAC: Reset
	7	out	LR_CTRL	Can switch Digital microphones from left to right. Default = 0

2.4 Audio modes

XENSIV™ Audio Shield supports up to 8 microphones and offers several preconfigured audio modes. Each mode is tailored to a specific application or use case. These modes enable developers to quickly evaluate the performance of the XENSIV™ MEMS microphones in various scenarios.

Table 6 Available audio modes

Mode	Microphones	USB > PC	Headphones
2 channel analog	2x analog	48 kHz 24 bit	Mic data routed through PSOC™ to the headphones
2 channel digital	2x digital		
4 channel analog	4x analog		Mic data of mic 1 and 2 routed through PSOC™ to the headphones
4 channel digital	4x digital		
8 channel digital	8x digital	48 kHz 16 bit	

2.4.1 Audio mode configuration

For the configuration of the different audio mode, see the firmware examples in ModusToolbox™.

For digital modes, Tempo Semiconductor's TDSP1808 needs to be configured either to I²S or TDM mode. This is done via the GPIO extender MCP23017. See the TDSP18xx datasheet from Tempo Semiconductor.

For analog modes, PCM1840 from Texas Instruments needs to be configured either to I²S or TDM mode. This is done via the GPIO extender MCP23017.

2.4.2 GPIO configuration for the Board

For the audio modes, the GPIO Extender 1 Port B needs to be configured as:

Table 7 GPIO configuration (Extender 1 Port B)

Configuration	Bits								Value
	PDM-SHD_N	VMIC_IO_SEL	MIC_FLEX_EN	MIC_TYPE_SEL	DAC_LDAC	DAC_CLR	FREE_GPIO	BUTTON3	
	D7	D6	D5	D4	D3	D2	D1	D0	
Reset	0	0	1	0	0	0	0	0	20h
Analog	0	0	1	0	0	1	0	0	24h
Digital	1	0	1	1	0	1	0	0	B4h

2.4.3 GPIO configuration of analog audio modes

For digital audio modes, PCM1840 needs to be configured via GPIO Extender 2 Port A as:

Table 8 GPIO (Extender 2 Port A) configuration for PCM1840

Configuration	Bits								Value
	LR_CTRL	HEAD_RST_N	ADC_MD1	ADC_MD0	ADC_FMT1	ADC_FMT0	ADC_MSZ	ADC_SHD_N	
	D7	D6	D5	D4	D3	D2	D1	D0	
Reset	0	0	0	0	0	0	0	0	00h
Stereo 48kHz I2S 24 bit	0	1	0	0	1	1	0	1	4Dh
4 channel 48kHz TDM 24 bit	0	1	1	1	0	0	0	1	71h

To configure Texas Instruments' PCM1840, check the corresponding datasheet [3] .

2.4.4 GPIO configuration of digital audio modes

For digital audio modes, TSDP1808 needs to be configured via GPIO Extender 2 Port B as:

Table 9 GPIO (Extender 2 Port A) configuration for TSDP1808

Configuration	Bits								Value
	WL_LSB	WL_MSB	2CH_TDM2	2CH_TDM1	SCK_PL	MODE3	MODE2	MODE1	
	D7	D6	D5	D4	D3	D2	D1	D0	
Stereo 48kHz I2S 24 bit	0	0	0	0	0	1	0	1	05h
4ch 48kHzTDM 24 bit	0	0	1	1	0	1	0	0	34h
8ch 48kHzTDM 24 bit	0	0	1	1	0	1	0	1	35h

To configure Tempo Semiconductor's TSDP1808, see the corresponding datasheet.

The following block diagrams show the audio routings:

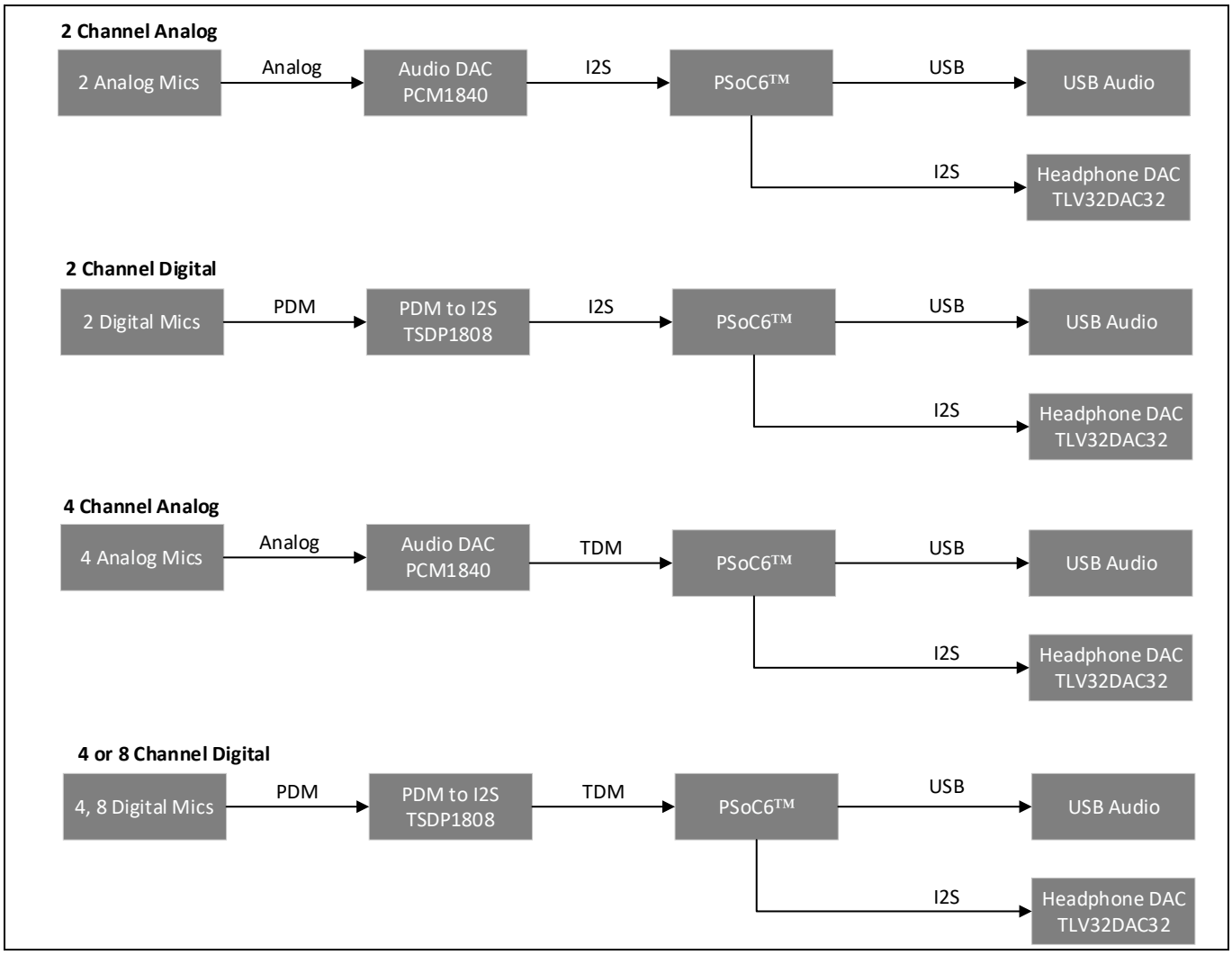


Figure 3 Audio routing block diagrams

2.5 Connectors

2.5.1 Top PCB

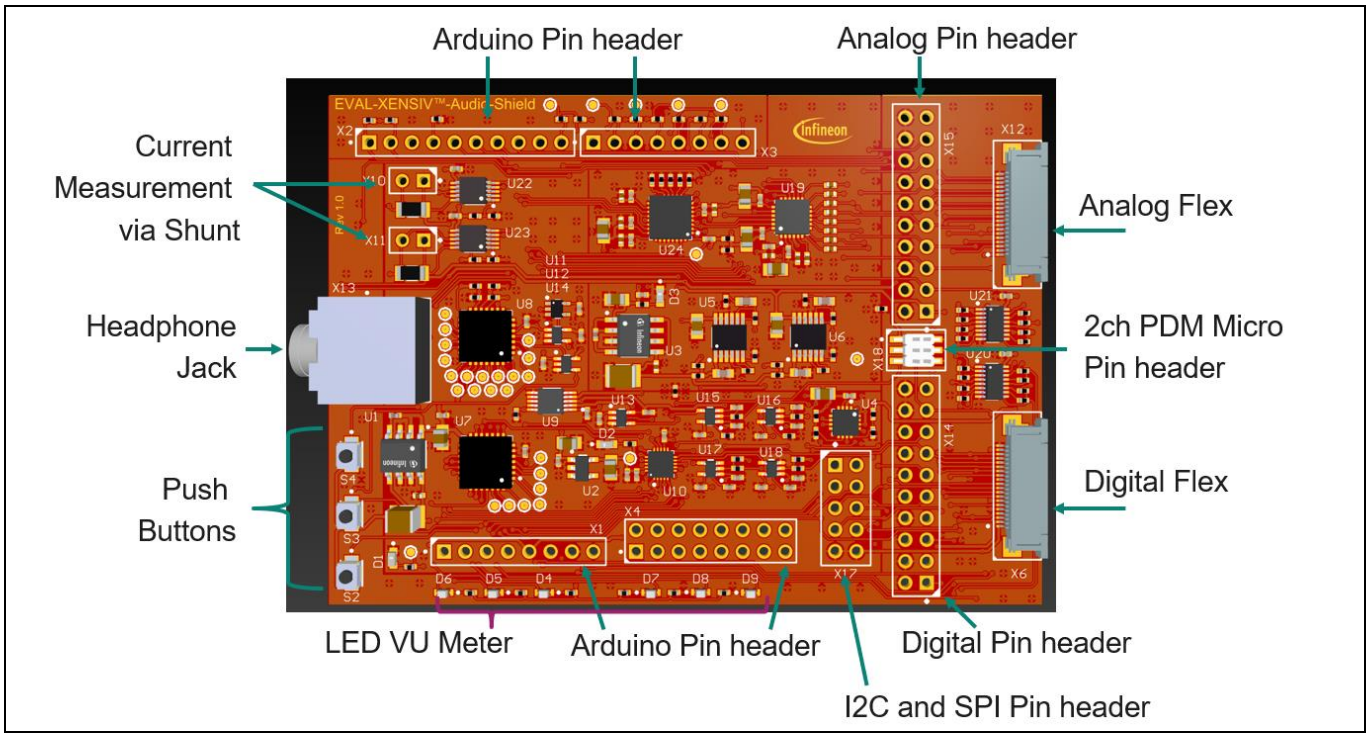


Figure 4 Connectors top PCB

Table 10 Top PCB connector descriptions

Type	Ref	Signals/Interface	Description
Arduino pin header	X1…4	I2S/TDM, SPI, I²C, GPIOs VDD	Connection for the PSOC™ 6 evaluation board
Analog pin header	X15	4x differential Analog In, VMIC1, 2	To evaluate analog microphones
Analog flex	X12	4x differential Analog In, VMIC1, 2 I²C, VDD 3.3 V	Connection to the external analog microphone arrays
Digital pin header	X14	8 channel PDM in, VMIC1, 2	To evaluate the digital microphones
Digital flex	X6	8 channel PDM in, VMIC1, 2, I²C, SPI VDD 3.3 V	Connection to the external analog microphone arrays
2ch PDM micro pin header (1.27 mm)	X18	2 channel PDM in VMIC2	To evaluate and perform demos with two digital microphones
I²C, SPI pin header	X17	I²C, SPI, VDD 3V3	For evaluations and demos

2.5.2 Bottom PCB

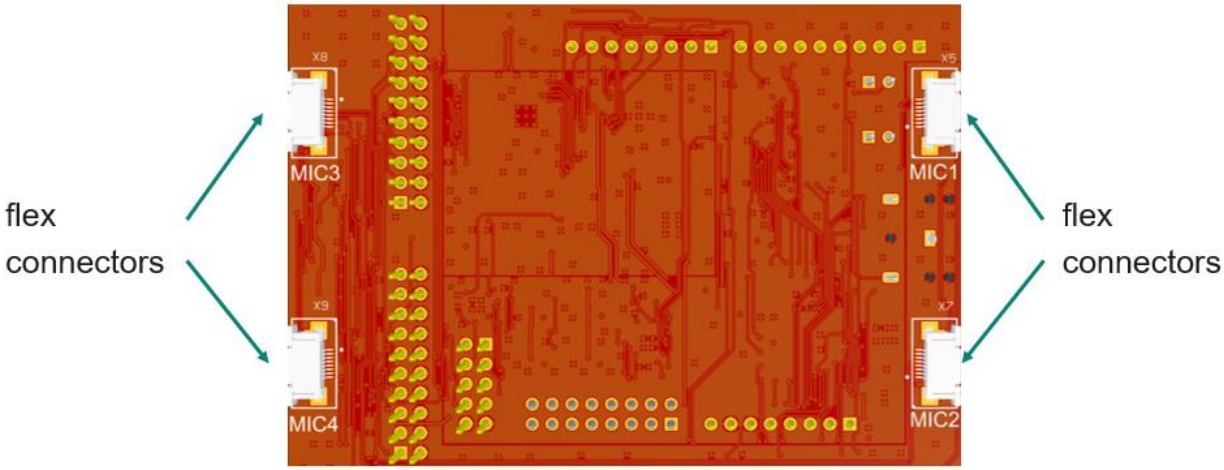


Figure 5 Connector bottom PCB

The bottom side of the PCB has 4 flex connectors for XENSIV™ MEMS microphone flex evaluation kits. They can be used for both analog and digital microphones.

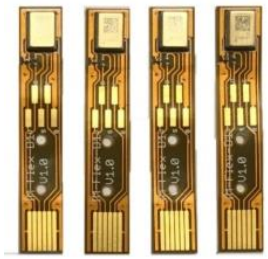


Figure 6 XENSIV™ MEMS microphone flex evaluation kit

3 Getting started

3.1 Hardware setup

Figure 7 shows the hardware setup of the PSOC™ 62S2 evaluation kit with the XENSIV™ Audio Shield connected on top of it.

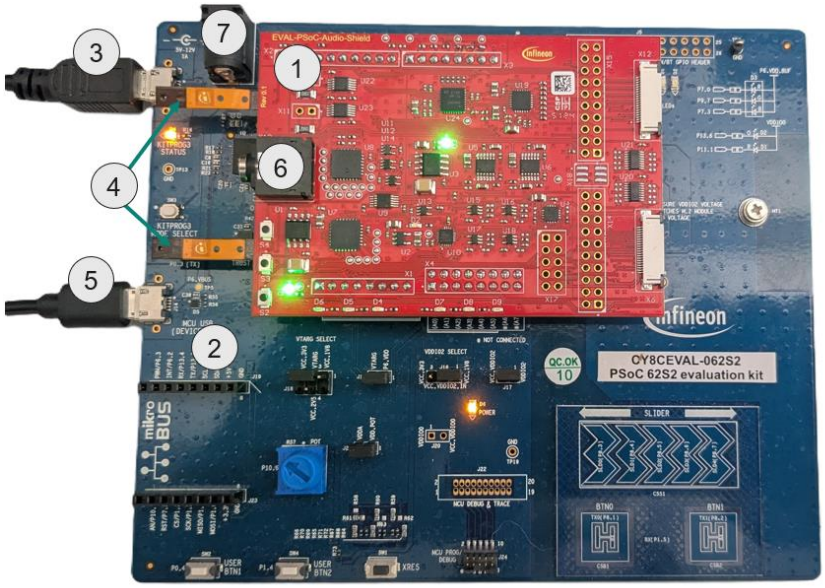


Figure 7 PSOC™ 62S2 evaluation kit with a XENSIV™ Audio Shield

The hardware setup includes:

1. XENSIV™ Audio Shield
2. PSOC™ 6 62S2 evaluation kit
3. USB connection to PC for flashing the firmware and debugging and power supply
4. Two XENSIV™ MEMS microphone flexes
5. USB connection to PC for the USB audio stream
6. 3.5 mm stereo headphone jack to connect a wired headphone to monitor the audio stream
7. DC in 5-12 V can be used alternatively to USB connection 3 in case the firmware is already flashed

XENSIV™ Audio Shield is powered up by either DC (7) or USB (3).

3.2 Loading firmware

The firmware for XENSIV™ Audio Shield was developed using ModusToolbox™, a comprehensive software suite provided by Infineon. This powerful tool enables developers to create, configure, and program PSOC™ devices with ease. You can leverage the available examples [4] within the tool to get started with firmware development.

3.3 Codes examples in ModusToolbox™

Find firmware examples for XENSIV™ Audio Shield demonstrating the different audio modes within the ModusToolbox™ software suite.

3.3.1 PSOC™ 6 MCU: XENSIV™ Audio Shield four-channel microphone

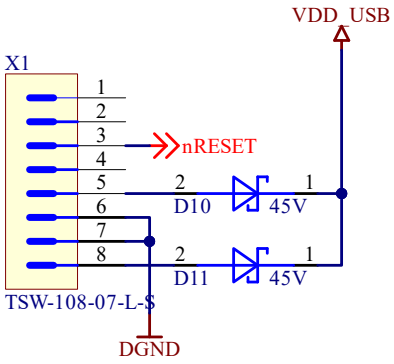
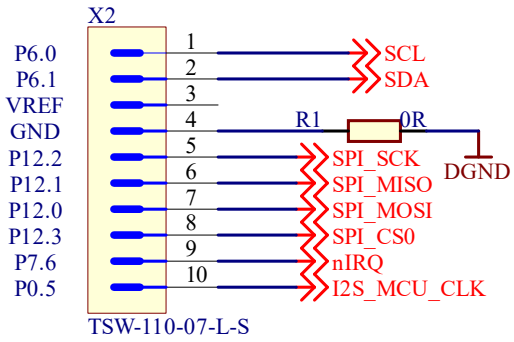
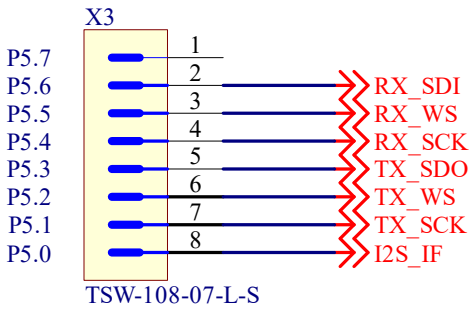
This code example (mtb-example-ce241889-xensiv-audioshield-four-channel-microphone) demonstrates the usage of Infineon's XENSIV™ Audio Shield to connect up to 4 analog or digital microphones to a PC via USB. It is designed to evaluate the performance of XENSIV™ MEMS microphones in array applications and serves as a foundation for advanced audio processing use cases, such as beamforming and direction-of-arrival estimation.

3.3.2 PSOC™ 6 MCU: XENSIV™ microphone Audio Shield Stereo

This code example (mtb-example-ce242117-xensiv-microphone-audioshield-stereo) demonstrates the usage of Infineon's XENSIV™ Audio Shield to connect up to 2 analog or digital microphones to a PC via USB. It is designed to evaluate the performance of XENSIV™ MEMS microphones.

4 Pin assignments of connectors

Table 11 Arduino pin headers

X1, X2, X3	Signal	Description
	VDD_USB	Main voltage supply for the shield
	DGND	Digital ground
	nReset	Reset for the shield, active low
	SCL, SDA	Clock and data of I²C interface
	SPI_SCK, MOSI, MISO, CS0	Clock data and chip select of SPI interface
	DGND	Ground for digital components
	nIRQ	Interrupt request from GPIO extender for the push buttons, active low
	I2S_MCU_CLK	Master clock of I²S/TDM Audio Interface, used by default, can be disabled by removing 0R resistor (see schematics)
	RX_SDI	Receive audio data from codec/ADCs of I²S/TDM
	RX_WS	Word select or sync signal for I2S/TDM for the receive path
	RX_SCK	Audio bit clock for the receive path
	TX_SDO	Send audio data to headphone DAC of I²S/TDM
	TX_WS	Word select or sync signal for I2S/TDM for the transmit path
	TX_SCK	Audio bit clock for the transmit path
	I2S_IF	2nd master clock of I²S/TDM Audio interface, not used by default. It can be enabled by adding 0R resistor (see schematics)

Note: X4 has no connections.

Pin assignments of connectors

Table 12 Microphone flex connector

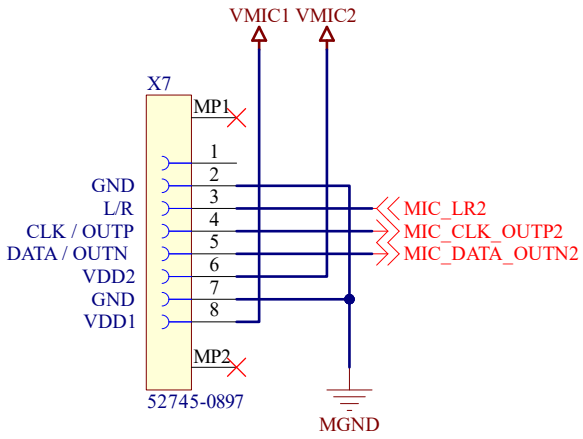
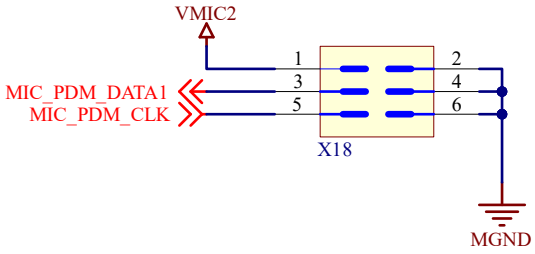
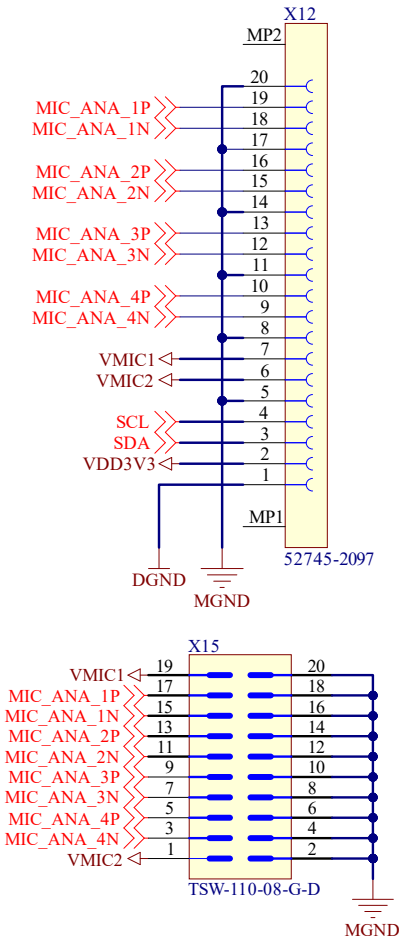
X5, X 7, X8, X9	Signal	Description
	VMIC1	Supply voltage 1 for microphones
	VMIC2	Main supply voltage 2 for microphones
	MIC_CLK_OUTPx x = 1...4	Clock for digital or OUT+ of analog microphones
	MIC_DATA_OUTNx x = 1...4	Data for digital or OUT- of analog microphones
	MIC_LRx	LR signal: by default, odd numbers LR = 1 and even numbers LR = 0
	MGND	Microphone ground

Table 13 1.27 mm pin header for digital stereo microphone demos

X18	Signal	Description
	VMIC2	Main supply voltage 2 for microphones
	MIC_PDM_CLK	Clock for digital microphones
	MIC_PDM_DATAx	Data for digital microphone x [1...4]

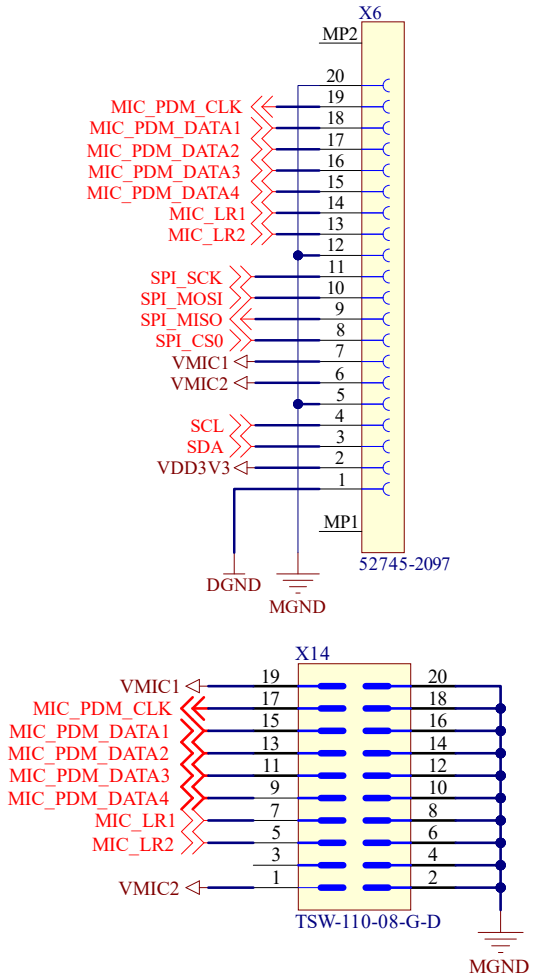
Pin assignments of connectors

Table 14 Analog pin header and flex connector

X12, X15	Signal	Description
	VMIC1	Supply voltage 1 for microphones
	VMIC2	Main supply voltage 2 for microphones
	MIC_ANA_xP	Positive analog out of microphone x [1..4]
	MIC_ANA_xN	Negative analog out of microphone x [1..4]
	MGND	Microphone ground
	SCL	Clock of I^2C interface
	SDA	Data of I^2C Interface
	VDD3V3	Additional 3.3 V supply voltage for digital components
	DGND	Ground for digital components

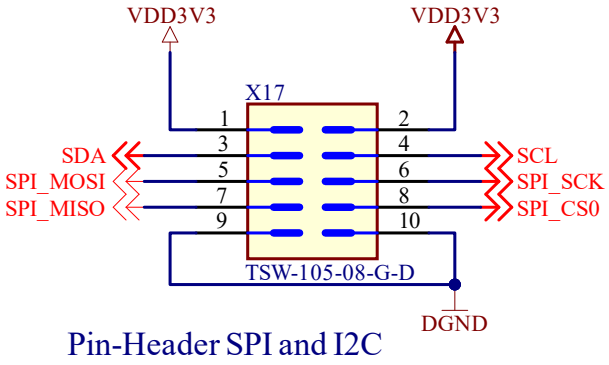
Pin assignments of connectors

Table 15 Digital pin header and flex connector

X6, X14	Signal	Description
	VMIC1	Supply voltage 1 for microphones
	VMIC2	Supply voltage 2 for microphones
	MIC_PDM_CLK	Clock for digital microphones
	MIC_PDM_DATAx	Data for digital microphone x [1..4]
	MIC_LR1	LR signal for left microphones
	MIC_LR2	LR signal for right microphones
	MGND	Microphone ground
	SCL, SDA	Clock and data of I^2C interface
	VDD3V3	Additional 3.3 V supply voltage for digital components

Pin assignments of connectors

Table 16 I²C and SPI pin header

Pin header X17	Signal	Description
	VDD3V3	additional 3.3 V supply voltage for digital components
	DGND	ground for digital components
	SCL, SDA	I²C clock and data
	SCK, MOSI, MISO, CS0	SPI Clock, data, and chip select

5 Related resources

- XENSIV™ MEMS microphones
- PSOC™ 62S2

References

[1] Infineon Technologies AG: *CY8CEVAL-062S2 PSOC™ 62S2 evaluation kit user guide*; Available online

[2] Infineon Technologies AG: *PSOC™ 62S2 Evaluation Kit CY8CEVAL-062S2 quick start guide;* Available online

[3] Texas Instruments: *PCM1840 Quad-channel 32-bit 192-kHz audio analog-to-digital converter (ADC) datasheet*; Available online

[4] Infineon Technologies AG: *ModusToolbox™ Software Training*; Available online

Glossary

DAC

Digital-to-analog converter

LDO

Low dropout regulator

VU

Volume unit

SPI

Serial peripheral interface

TDM

Time division multiplex

GPIO

General-purpose input/output

Revision history

Document revision	Date	Description of changes
Revision 1.00	2025-10-06	Initial release

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Safety & Operating Instructions:

Customer shall check the Evaluation Board for any physical damage which may have occurred during transport. If customer detects any damages or defects in the Evaluation Board, customer shall not connect the Evaluation Board to a power source. Customer shall contact Infineon for further support. If customer observes unusual operating behavior during the evaluation process, customer shall immediately shut off the power supply to the Evaluation Board and consult Infineon for support.

Customer shall not touch the Evaluation Board during operation and keep a safe distance.

Customer shall not touch the Evaluation Board after disconnecting the power supply, several components may still store electrical voltage and can discharge through physical contact. Several parts, like heat sinks and transformers, may still be very hot. Allow the components to cool before touching or servicing.

The electrical installation must be completed in accordance with the appropriate safety requirements..