



# WM8960 Audio Board

## User Manual

### OVERVIEW

The WM8960 Audio board uses WM8690 which is a Low consumption, Stereo encoder/decoder. Can be used for portable digital audio applications, like recording or drive speaker to play.

### FEATURES

- High quantity MEMS silicon MIC, for recording without earphone.
- 3.5mm 4 segment headphone mic, allows external headphone for recording or playing.
- Dual-channel Speaker interface, for external speaker
- Supports audio sample rate: 8/11.025/22.05/44.1/48KHz
- Supports Stereo and 3D Surround Sound and so on.
- Come with User Manual and examples (Play and record examples for STM32F429 and STM32F746 can be downloaded from Wiki).

### SPECIFICATION

- Audio Encoder/Decoder: WM8960

- Operating voltage: 3.3V
- Control Interface: I2C
- Audio Interface: I2S
- Audio Format: WAV
- DAC signal-noise ratio: 98dB
- ADC signal-noise ratio: 94dB
- Headphone controller: 16Ω 40mW
- Speaker controller: 8Ω 1W

## PINS

PIN	Descriptions
VCC	3.3V
GND	Ground
SDA	I2C Data input
SCL	I2C Clock input
CLK	I2S Bit clock input
WS	I2S Frame clock input
TXSDA	I2S Data output
RXSDA	I2S Data input
TXMCLK	I2S System Clock (Sending)
RXMCLK	I2SSystem Clock (Receive)

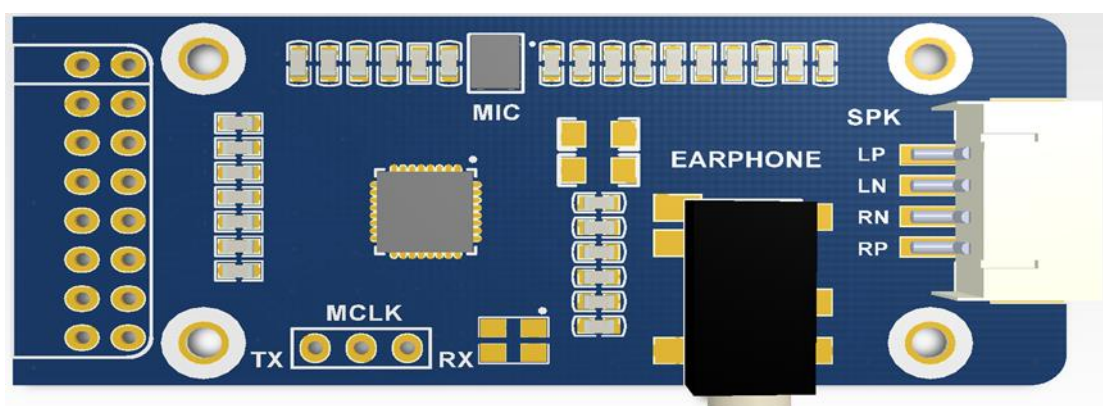
## HARDWARE

### HARDWARE CONNECTION

This WM8960 use I2C for controlling, I2S and SAI for Audio communicating.

There are 3P pins for choosing MCLK signal, left one is MCLK signal transmitted, and the right one is MCLK signal received.

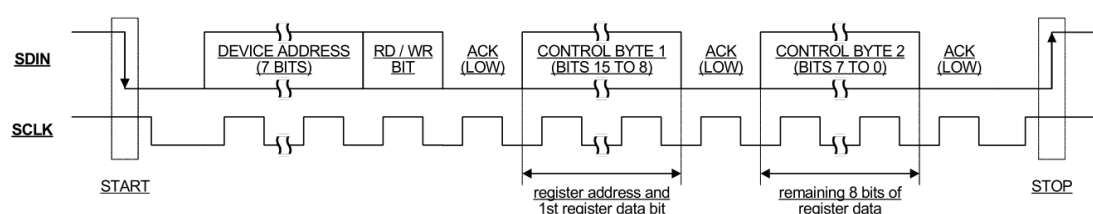
You can connect 3 segment headphone or 4 segment headphone mic to EARPHONE port. Right one is the speaker interface for  $8\Omega$  speaker, recommend you to purchase one more [8Ω 5W Speaker](#) from us.



## WORKING PROTOCOL

This module use WM8960 for audio encode/decode. WM8960 use I2C bus to control signal and configures internal registers, I2S bus used to transmit/receive audio signals.

## I2C BUS

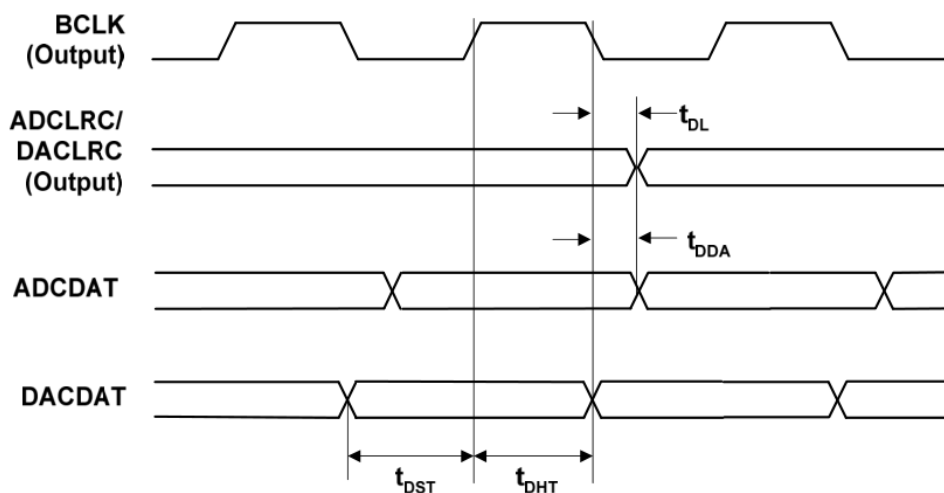


In I2C Bus, master device will first send an address frame for searching slave device and setting communication mode. High 7 bits are address, followed a control bit and finally the response signal. If slave device receives the response signal, it will return a response to master device. Then master device could begin to send data to slave device, which is 8 bits and the high 7 bits are address and the lowest one is response signal. MSB first.

According to Datasheet, registers of WM8960 are 9-bit. Thus, when we send data to it, should split data to two bytes and add the ID of register to recognized before transmitting. The ID of register flagged by 7-bit.

For more details about I2C, please refer to Page 15 and Page 63 of WM8960\_v4.2.

## I2S BUS



I2S has four signal lines, they are: SCLK, LRCK, SDATA and MCLK. And the first three are most important. For better synchronize with system clock, you can mater device clock, or external clock circuit.

Serial clock SCLK is also called as bit clock BCLK, which related to every bit of digital audio.  $SCLK \text{ Frequency} = 2 \times \text{Sample rate} \times \text{Sample bits}$ .

Frame clock LRCK (WS) is used to switch data of LEFT and RIGHT channels. If LRCK is "1", it means that data of RIGHT channel are being transmitted, and LEFT channel is active if LRCK is "0". The rate of LRCK is same as sample rate.

Serial data SDATA are audio data, they are binary complement.

Main clock (MCLK) is also called as System clock (Sys Clock), its frequency is 256 times or 384 times of sample rate. In order to support more function, we reserved the MCLK interface of this module for more audio.

## HOW TO USE

We provide examples for this module, which are based on our Open429I-C and Open746I-C. For every board, there are three examples: play internal audio data, play WAV file from SD card, record WAV audio file to SD card.

### EXAMPLES FOR OPEN429I-C

#### Example 1: Play audio data internal

##### 1. Hardware connection

Board: Open429I-C

Module required: WM8960 Audio Board

You should connect WM8960 module to I2S interface of the Open board

PIN	Open429I-C
VCC	3.3V
GND	GND
SDA	I2C1_SDA (PB9)
SCL	I2C1_SCL (PB8)
CLK	I2S2CLK (PB13)
WS	I2S2WS (PB12)
TXSDA	I2S2SDA (PB15)
TXMCLK	I2S2_MCLK (PC6)

Note: Pins which doesn't listed on table are not connected

## 2. Description of files

Examples are compiled on MDK-ARM V4, generated by STM32CubeMX

../Src:

WM8960.c: Bottom driver of WM8960, mainly provide functions that sending data to chip, initializes chip and Use I2S to play internal audio data

../Inc:

wave\_data.h: file used to store audio data (the internal audio)

## 3. Expected result:

Shorted MCLK and TX on board with jumper, connect WM8960 audio board to Open429 as table above. Connect an earphone or speaker to audio board, then download the example to development board. Audio will be outputted to earphone/speaker.

### Example 2: Play WAV audio from SD card

#### 1. Hardware connection

Board: Open429I-C

Modules required: Micro SD Storage Board, SD card, WM8960 Audio Board

You should insert SD card to Micro SD Storage Board, then connect the SD board to SDIO interface of Open429. Finally insert Audio board to SAI interface of Open429.

PIN	Open429I-C
VCC	3.3V

GND	GND
SDA	I2C1_SDA (PB9)
SCL	I2C1_SCL (PB8)
CLK	SAI1_SCK_B (PF8)
WS	SAI1_FS_B (PF9)
TXSDA	SAI1_SD_B (PF6)
TXMCLK	SAI1_MCLK_B (PF7)

Note: Pins which doesn't listed on table are not connected

## 2. Description of files

Examples are compiled on MDK-ARM V4, generated by STM32CubeMX

../Src:

WM8960.c: Bottom driver of WM8960, mainly provide functions that sending data to chip, initializes chip

Play\_WAV.c: Provide function that play WAV file from SD card, include read list of WAV files, read audio information of files, play WAV files, handle keys events and so on.

## 3. Expected result

After connecting all module to Open429I-C, insert an earphone or speaker to

Audio board, connect USART1 interface of Open429I to PC , and then open serial assistance software on PC.

Download example to Open429 board, module will begin to play audio file



automatically, and print WAV files list and the information of current WAV file to USART port at the same time.

You can use Joystick to control the play: Press to pause/play, left (C) to previous and right (B) to next.

### Example 3: Record WAV files to SD card

#### 1. Hardware connection

Board: Open429I-C

Modules required: Micro SD Storage Board, SD card, WM8960 Audio Board

You should insert SD card to Micro SD Storage Board, then connect the SD board to SDIO interface of Open429. Finally insert Audio board to SAI interface of Open429.

<b>PIN</b>	<b>Open429I-C</b>
VCC	3.3V
GND	GND
SDA	I2C1_SDA (PB9)
SCL	I2C1_SCL (PB8)
CLK	SAI1_SCK_A (PE5)
WS	SAI1_FS_A (PE4)
RXSDA	SAI1_SD_A (PE6)
RXMCLK	SAI1_MCLK_A (PE2)

Note: Pins which doesn' t listed on table are not connected

## 2. Description of files

Examples are compiled on MDK-ARM V4, generated by STM32CubeMX

../Src:

WM8960.c: Bottom driver of WM8960, mainly provide functions that sending data to chip, initializes chip. In the top of this file, macros are used to choose record devices (On board mic or earphone mic), in the function of WM8960 initialization, you can uncomment codes to enable functions of bypass output

Record\_WAV.c: Provide function that record audio and stores to SD card, include create WAV files, record audio, handle keys events and so on.

## 3. Expected result

Connecting all the modules to Open429I-C, then inset an earphone or speaker to Audio board. Connect UASRT1 interface of Open429I-C to PC and open the serial assistance software.

Download example to Open429I-C, MCU will prints the recording file name via UASRT1, and prompt that press Joystick to begin recording.

After pressing joystick, you can speak to mic, and you can see your voice are bypass outputted from speaker or earphone, You can press Joystick to pause/restore during recording. Long press Joystick for 1~2s to stop recording. After recording, power off Open429I-C, inset the SD card to PC, you can find the WAV files recorded and play; You can also use the play example to play the audio you record.

## EXAMPLES FOR OPEN746I-C

**Example 1: Play audio data internal**

## 4. Hardware connection

Board: Open746I-C

Module required: WM8960 Audio Board

You should connect WM8960 module to I2S interface of the Open board

PIN	Open746I-C
VCC	3.3V
GND	GND
SDA	I2C1_SDA (PB9)
SCL	I2C1_SCL (PB8)
CLK	I2S2_CLK (PB13)
WS	I2S2_WS (PB12)
TXSDA	I2S2_SDA (PB13)
TXMCLK	I2S2_MCLK (PC6)

Note: Pins which doesn't listed on table are not connected

## 5. Description of files

Examples are compiled on MDK-ARM V4, generated by STM32CubeMX

../Src:

WM8960.c: Bottom driver of WM8960, mainly provide functions that sending data

to chip, initializes chip and Use I2S to play internal audio data

../Inc:

wave\_data.h: file used to store audio data (the internal audio)

#### 6. Expected result:

Shorted MCLK and TX on board with jumper, connect WM8960 audio board to Open746I-C as table above. Connect an earphone or speaker to audio board, then download the example to development board. Audio will be outputted to earphone/speaker.

### Example 2: Play WAV audio from SD card

#### 1. Hardware connection

Board: Open746I-C

Modules required: Micro SD Storage Board, SD card, WM8960 Audio Board

You should insert SD card to Micro SD Storage Board, then connect the SD board to SDMMC interface of Open429. Finally insert Audio board to SAI interface of Open429.

<b>PIN</b>	<b>Open429I-C</b>
VCC	3.3V
GND	GND
SDA	I2C1_SDA (PB9)
SCL	I2C1_SCL (PB8)

CLK	SAI1_SCK_B (PF8)
WS	SAI1_FS_B (PF9)
TXSDA	SAI1_SD_B (PF6)
TXMCLK	SAI1_MCLK_B (PF7)

Note: Pins which doesn't listed on table are not connected

## 2. Description of files

Examples are compiled on MDK-ARM V4, generated by STM32CubeMX

../Src:

WM8960.c: Bottom driver of WM8960, mainly provide functions that sending data to chip, initializes chip

Play\_WAV.c: Provide function that play WAV file from SD card, include read list of WAV files, read audio information of files, play WAV files, handle keys events and so on.

## 3. Expected result

After connecting all module to Open7461-C, insert an earphone or speaker to Audio board, connect USART1 interface of Open7461-C to PC , and then open serial assistance software on PC.

Download example to Open7461-C board, module will begin to play audio file automatically, and print WAV files list and the information of current WAV file to USART port at the same time.

You can use Joystick to control the play: Press to pause/play, left (C) to previous and right (B) to next.

### Example 3: Record WAV files to SD card

#### 1. Hardware connection

Board: Open746I-C

Modules required: Micro SD Storage Board, SD card, WM8960 Audio Board

You should insert SD card to Micro SD Storage Board, then connect the SD board to SDIO interface of Open746I-C. Finally insert Audio board to SAI interface of Open429.

PIN	Open746I-C
VCC	3.3V
GND	GND
SDA	I2C1_SDA (PB9)
SCL	I2C1_SCL (PB8)
CLK	SAI1_SCK_A (PE5)
WS	SAI1_FS_A (PE4)
RXSDA	SAI1_SD_A (PE6)
RXMCLK	SAI1_MCLK_A (PE2)

Note: Pins which doesn't listed on table are not connected

## 2. Description of files

Examples are compiled on MDK-ARM V4, generated by STM32CubeMX

../Src:

WM8960.c: Bottom driver of WM8960, mainly provide functions that sending data to chip, initializes chip. In the top of this file, macros are used to choose record devices (On board mic or earphone mic), in the function of WM8960 initialization, you can uncomment codes to enable functions of bypass output

Record\_WAV.c: Provide function that record audio and stores to SD card, include create WAV files, record audio, handle keys events and so on.

## 3. Expected result

Connecting all the modules to Open746I-C, then inset an earphone or speaker to Audio board. Connect UASRT1 interface of Open746I-C to PC and open the serial assistance software.

Download example to Open746I-C, MCU will prints the recording file name via UASRT1, and prompt that press Joystick to begin recording.

After pressing joystick, you can speak to mic, and you can see your voice are bypass outputted from speaker or earphone, You can press Joystick to pause/restore during recording. Long press Joystick for 1~2s to stop recording. After recording, power off Open746I-C, inset the SD card to PC, you can find the WAV files recorded and play; You can also use the play example to play the audio you record.