



Gowin USB Audio Class IP User Guide

IPUG1196-1.0E, 2025-03-07

Copyright © 2025 Guangdong Gowin Semiconductor Corporation. All Rights Reserved.

GOWIN高云, **GOWIN**, , GOWINSEMI, GOWIN, Gowin, 高云, 晨熙, 小蜜蜂, LittleBee, -V, GowinPnR, GoBridge are trademarks of Guangdong Gowin Semiconductor Corporation and are registered in China and/or other countries or regions. All other words and logos identified as trademarks or service marks are the property of their respective holders. No part of this document may be reproduced or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without the prior written consent of GOWINSEMI.

Disclaimer

GOWINSEMI assumes no liability and provides no warranty (either expressed or implied) and is not responsible for any damage incurred to your hardware, software, data, or property resulting from usage of the materials or intellectual property except as outlined in the GOWINSEMI Terms and Conditions of Sale. GOWINSEMI may make changes to this document at any time without prior notice. Anyone relying on this documentation should contact GOWINSEMI for the current documentation and errata.

Revision History

Date	Version	Description
03/07/2025	1.0	Initial version published.

Contents

List of Figures.....	iii
List of Tables.....	iv
1 About This Guide.....	1
1.1 Purpose.....	1
1.2 Related Documents.....	1
1.3 Terminology and Abbreviations.....	2
1.4 Support and Feedback.....	2
2 Function Overview.....	3
2.1 Overview.....	3
2.2 Features.....	4
2.3 Resource Utilization.....	4
3 Functional Description.....	5
3.1 USB Audio Class.....	5
3.2 USB Audio Class Audio TX Interface.....	5
3.3 USB Audio Class Audio RX Interface.....	6
3.4 USB Audio Class Control Interface.....	7
3.4.1 Control Data Interface.....	7
3.4.2 Configuration Data TX Interface.....	8
3.4.3 Configuration Data RX Interface.....	9
3.4.4 Interface Configuration Interface.....	10
4 Signal Definition.....	11
4.1 Signal Definition.....	11
4.2 Parameter Configuration Option.....	18
5 Interface Configuration.....	20
6 Reference Design.....	23
6.1 USB Reference Design.....	23
6.2 USB Driver Installation.....	23
6.3 Audio Loopback Test.....	24
7 File Delivery.....	27

7.1 Document.....	27
7.2 Design Source Code (Encryption).....	27
7.3 Reference Design.....	28

List of Figures

Figure 3-1 Block Diagram for USB Audio Class.....	5
Figure 3-2 Timing Diagram for USB Audio Class Audio TX Interface Data Reception	6
Figure 3-3 Timing Diagram for USB Audio Class Audio RX Interface Data Reception.....	7
Figure 3-4 Timing Diagram for USB Audio Class Control Data Reception.....	8
Figure 3-5 Timing diagram for Get CUR Sample Request Data Transmission on USB Audio Class Control Endpoint.....	9
Figure 3-6 Timing diagram for Data Reception on USB Audio Class Control Endpoint.....	10
Figure 5-1 IP Core Generator.....	20
Figure 5-2 USB Audio Class IP Core.....	21
Figure 5-3 USB Audio Class IP Configuration Interface.....	22
Figure 6-1 USB Audio Class Reference Design Block Diagram.....	23
Figure 6-2 USB Audio Class Device Manager Recognition Result.....	24
Figure 6-3 USB Audio Class Sound Settings Recognition Result.....	25
Figure 6-4 USB Audio Class Audio Loopback Test.....	26

List of Tables

Table 1-1 Terminology and Abbreviations.....	2
Table 2-1 Gowin USB Audio Class IP Overview.....	3
Table 2-2 Resource Utilization 1.....	4
Table 2-3 Resource Utilization 2.....	4
Table 3-1 USB Audio Class Audio TX Interface.....	5
Table 3-2 USB Audio Class Audio RX Interface.....	6
Table 3-3 Control Interface.....	7
Table 3-4 Configuration Data TX Interface.....	8
Table 3-5 Configuration Data RX Interface.....	9
Table 3-6 Interface Configuration Interface.....	10
Table 4-1 Signal Definition.....	12
Table 4-2 Configuration Description.....	18
Table 7-1 Document List.....	27
Table 7-2 Design Source Code List.....	27
Table 7-3 Ref. Design File List.....	28

1 About This Guide

1.1 Purpose

Gowin USB Audio Class IP User Guide is intended to help you learn the features and usage of Gowin USB Audio Class IP by providing descriptions of functions, signals, and interface configuration, etc. The software screenshots and the supported products listed in this manual are based on Gowin Software 1.9.11. As the software is subject to change without notice, some information may not remain relevant and may need to be adjusted according to the software that is in use.

1.2 Related Documents

The latest user guides are available on the GOWINSEMI Website. You can find the related documents at www.gowinsemi.com:

- [DS100, GW1N series of FPGA Products Data Sheet](#)
- [DS117, GW1NR series of FPGA Products Data Sheet](#)
- [DS891, GW1NRF series of FPGA Products Data Sheet](#)
- [DS821, GW1NS series of FPGA Products Data Sheet](#)
- [DS861, GW1NSR series of FPGA Products Data Sheet](#)
- [DS102, GW2A series of FPGA Products Data Sheet](#)
- [DS226, GW2AR series of FPGA Products Data Sheet](#)
- [DS971, GW2AN-18X & 9X Data Sheet](#)
- [DS976, GW2AN-55 Data Sheet](#)
- [DS981, GW5AT series of FPGA Products Data Sheet](#)
- [DS1103, GW5A series of FPGA Products Data Sheet](#)
- [DS1105, GW5AS series of FPGA Products Data Sheet](#)
- [DS1108, GW5AR series of FPGA Products Data Sheet](#)

- [DS1118, GW5ART series of FPGA Products Data Sheet](#)
- [DS1239, GW5AST series of FPGA Products Data Sheet](#)
- [SUG100, Gowin Software User Guide](#)

1.3 Terminology and Abbreviations

The terminology and abbreviations used in this manual are as shown in [Table 1-1](#).

Table 1-1 Terminology and Abbreviations

Terminology and Abbreviations	Meaning
IIS	Inter-IC Sound Bus
IP	Intellectual Property
PCM	Pulse Code Modulation
UAC	USB Audio Class
USB	Universal Serial Bus
UTMI	USB Transceiver Macrocell Interface

1.4 Support and Feedback

Gowin Semiconductor provides customers with comprehensive technical support. If you have any questions, comments, or suggestions, please feel free to contact us directly using the information provided below.

Website: www.gowinsemi.com

E-mail: support@gowinsemi.com

2 Function Overview

2.1 Overview

USB Audio Class (UAC) is an interface defined under the USB specification to implement audio device definition and control function.

Gowin USB Audio Class IP, based on the USB protocol, implements audio device functions. This IP can support up to 3 audio output devices and 3 audio input devices, controlling their sampling frequency, bit depth, and supported audio protocols. One end of the IP is a parallel data interface connected to the USB Device Controller, and the other end is an audio data interface linked to audio devices supporting protocols such as IIS/PCM based on user options.

Table 2-1 Gowin USB Audio Class IP Overview

Gowin USB Audio Class IP	
Logic Resource	Please refer to Table 2-2 and Table 2-3 .
Delivered Doc.	
Design Files	Verilog (encrypted)
Reference Design	Verilog
TestBench	Verilog
Test and Design Flow	
Synthesis Software	GowinSynthesis
Application Software	Gowin Software (V1.9.11 and above)

Note!

For the devices supported, you can click [here](#) to get the information.

2.2 Features

The features of Gowin USB Audio Class IP include:

- Supports high-speed and full-speed modes.
- Supports up to 3 input and 3 output audio devices.
- Supports synchronous data synchronization mode and asynchronous data synchronization mode.
- Selectable bit depth for each device: 16 bits, 24 bits, or 32 bits.
- Selectable sampling frequency for each device: 32kHz, 48kHz, 96kHz, 192kHz, 384kHz, or 768kHz.
- Supports IIS/PCM protocol interfaces and PCM data format.

2.3 Resource Utilization

Gowin USB Audio Class IP can be implemented by Verilog. Its performance and resource utilization may vary when the design is employed in different devices, or at different densities, speeds, or grades. Take Gowin GW2AR-18 device as an instance, its resource utilization is as shown in [Table 2-2](#) and [Table 2-3](#).

Table 2-2 Resource Utilization 1

Device	Speed Grade	Name	Resource Utilization	Note
GW2AR-18	-6	LUT	2541	-1 output device and 1 input device
		REG	1241	
		ALU	291	
		BSRAM	7	

Table 2-3 Resource Utilization 2

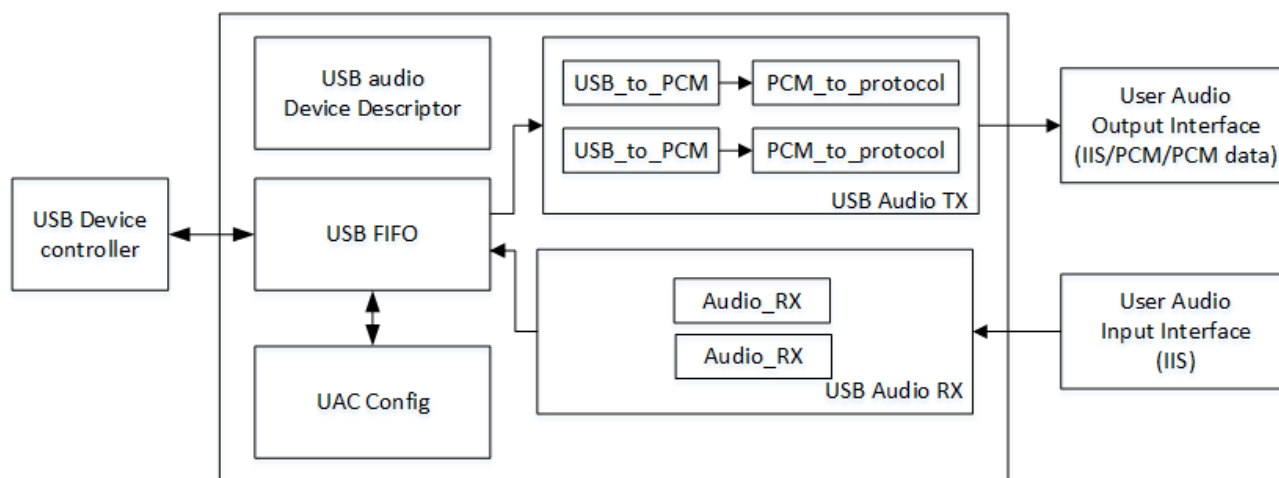
Device	Speed Grade	Name	Resource Utilization	Note
GW2AR-18	-6	LUT	5630	-3 output device and 3 input device
		REG	2859	
		ALU	833	
		BSRAM	16	

3 Functional Description

3.1 USB Audio Class

USB Audio Class is located between the User Design and the USB Device Controller. It receives commands from the USB interface to enable data exchange between the user side and the USB side. The diagram below shows the functional block diagram of the USB Audio Class device controller.

Figure 3-1 Block Diagram for USB Audio Class



3.2 USB Audio Class Audio TX Interface

Table 3-1 USB Audio Class Audio TX Interface

Name	I/O	Bit Width	Description
o_spk_iis_bclk_1	Output	1	BCLK signal in IIS protocol for Speaker
o_spk_iis_lrck_1	Output	1	LRCK signal in IIS protocol for Speaker
o_spk_iis_data_1	Output	1	DATA signal in IIS protocol for Speaker
o_spk_pcm_bclk_1	Output	1	BCLK signal in PCM protocol for Speaker

Name	I/O	Bit Width	Description
o_spk_pcm_lrck_1	Output	1	LRCK signal in PCM protocol for Speaker
o_spk_pcm_data_1	Output	1	DATA signal in PCM protocol for Speaker
o_spk_l_pcm_data_1	Output	32	32-bit PCM data for Speaker (left channel)
o_spk_r_pcm_data_1	Output	32	32-bit PCM data for Speaker (right channel)

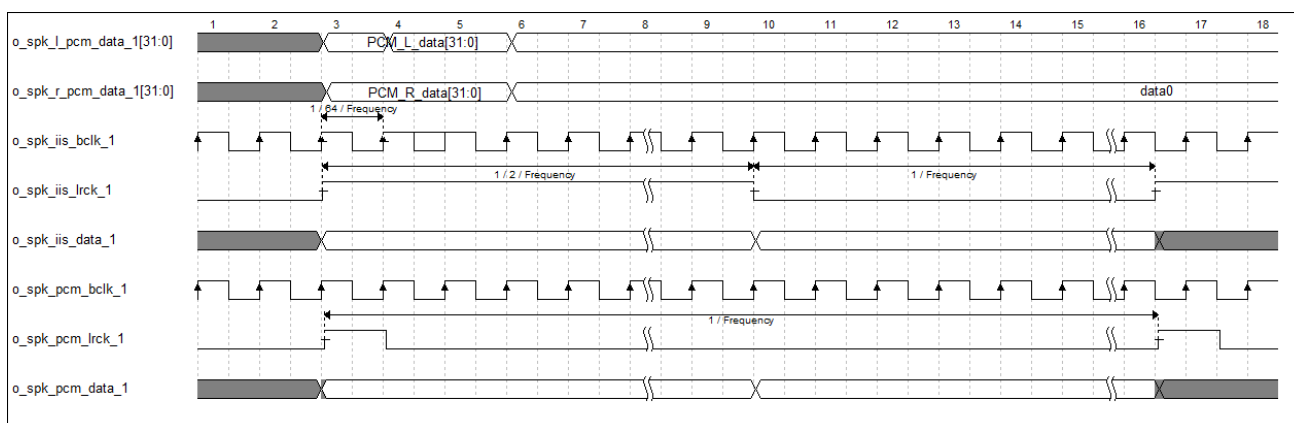
When the Device receives audio data from the Host, the Device will convert the USB data into 32-bit parallel PCM audio data based on the preset sampling frequency, bit depth, and protocol output format of the device. Then it will further convert the data into the required IIS/PCM protocol format serial data as needed.

If the device selects ASYNC data synchronization mode, o_spk_iis_bclk and o_spk_pcm_bclk will have a fixed length, equal to $1s/64/\text{the device's sampling frequency}$.

If the device selects SYNC data synchronization mode, o_spk_iis_bclk and o_spk_pcm_bclk will adjust their length based on the FIFO's empty/full status. Note that if the device's sampling frequency is high, there may be noticeable variations in the sampling frequency of the audio serial signals output from the TX interface. Therefore, it is not recommended to use the SYNC data synchronization mode for devices with a sampling frequency of 192 kHz or higher under this IP.

The following diagram shows the timing for device data reception.

Figure 3-2 Timing Diagram for USB Audio Class Audio TX Interface Data Reception



3.3 USB Audio Class Audio RX Interface

Table 3-2 USB Audio Class Audio RX Interface

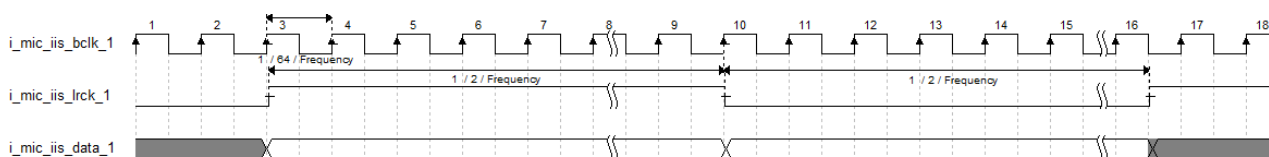
Name	I/O	Bit Width	Description
i_mic_iis_bclk_1	Input/output	1	BCLK signal in IIS protocol for Microphone (externally input/internally generated)
o_mic_iis_bclk_1			

Name	I/O	Bit Width	Description
i_mic_iis_lrck_1 o_mic_iis_lrck_1	Input/output	1	BCLK signal in IIS protocol for Microphone (externally input/internally generated)
i_mic_iis_data_1	Input	1	Transmitting data busy signal; High indicates that it should stop writing data to Flash.

When a USB audio input device is declared, the device will continuously generate or receive IIS protocol clock and continuously receive IIS data signals under this clock. The Device will convert the received IIS protocol signals into 32-bit parallel PCM data and then convert it into USB data to send to the Host.

The following diagram shows the timing diagram for device data transmitting.

Figure 3-3 Timing Diagram for USB Audio Class Audio RX Interface Data Reception



3.4 USB Audio Class Control Interface

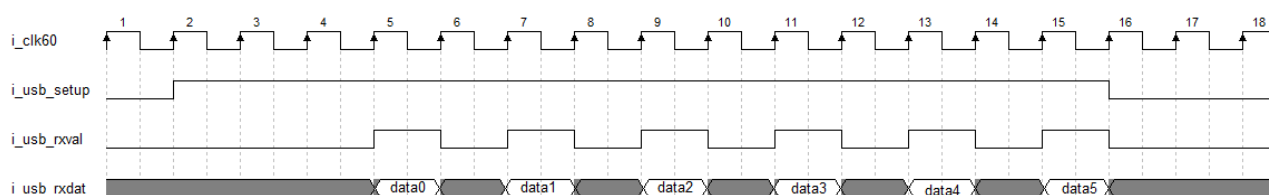
3.4.1 Control Data Interface

Table 3-3 Control Interface

Name	I/O	Bit Width	Description
i_usb_setup	Input	1	Data active indicator signal; high indicates that the UAC configuration data is active.
i_usb_rxval	Input	1	Data valid indicator signal; high indicates that the UAC configuration data is valid.
i_usb_rxdat	Input	8	Receiving data; the configuration data received from the USB interface is input through this port.

During the enumeration and use of the USB Audio Class, after the host issues a standard request, the host will issue special USB class requests, including GET/SET sample, GET/SET volume, GET/SET mute, and other commands.

For these class-specific requests, the control interface receives configuration requests through i_usb_setup, i_usb_rxval, and i_usb_rxdat and processes subsequent data. The following diagram shows the timing diagram for device configuration data reception.

Figure 3-4 Timing Diagram for USB Audio Class Control Data Reception

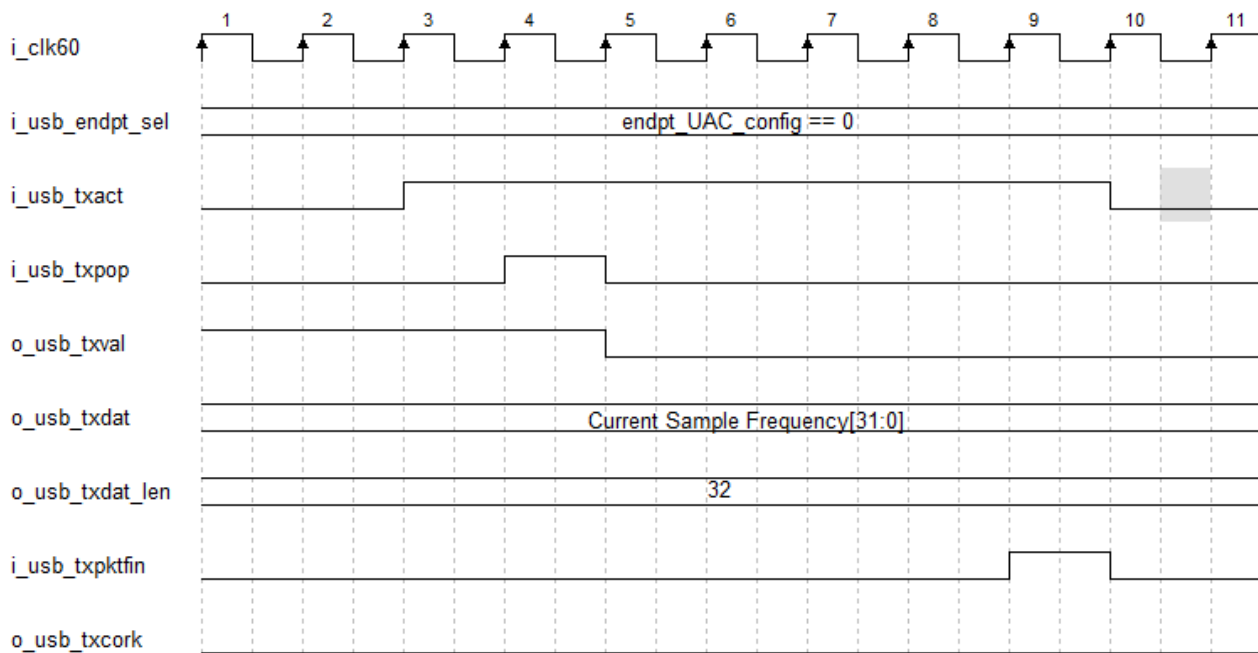
3.4.2 Configuration Data TX Interface

Table 3-4 Configuration Data TX Interface

Name	I/O	Bit Width	Description
i_usb_endpt_sel	Input	4	Endpoint selection indicator signal; it indicates the current communication endpoint of USB.
i_usb_txact	Input	1	Transmit active signal; high indicates that the device enters data transmitting status.
i_usb_txpop	Input	1	Transmitting read signal; high indicates the read of next data.
o_usb_txval	Output	1	TX data valid indicator signal; high indicates the user input data is valid.
o_usb_txdat	Output	8	Transmitting data; IP transmits this data to the USB interface.
o_usb_txdat_len	Output	12	Transmitting data byte count; used to control the number of TX data bytes.
i_usb_txpktfin	Input	1	Transmitting data completion signal; it indicates the completion of this data transmission.
o_usb_tx cork	Output	1	Transmitting data valid signal; low indicates that TXDAT is insufficient.

After the Device receives the class-specific requests from the Host, during the subsequent Host IN command, the Device sends the corresponding configuration data through the TX interface.

Figure 3-5 Timing diagram for Get CUR Sample Request Data Transmission on USB Audio Class Control Endpoint



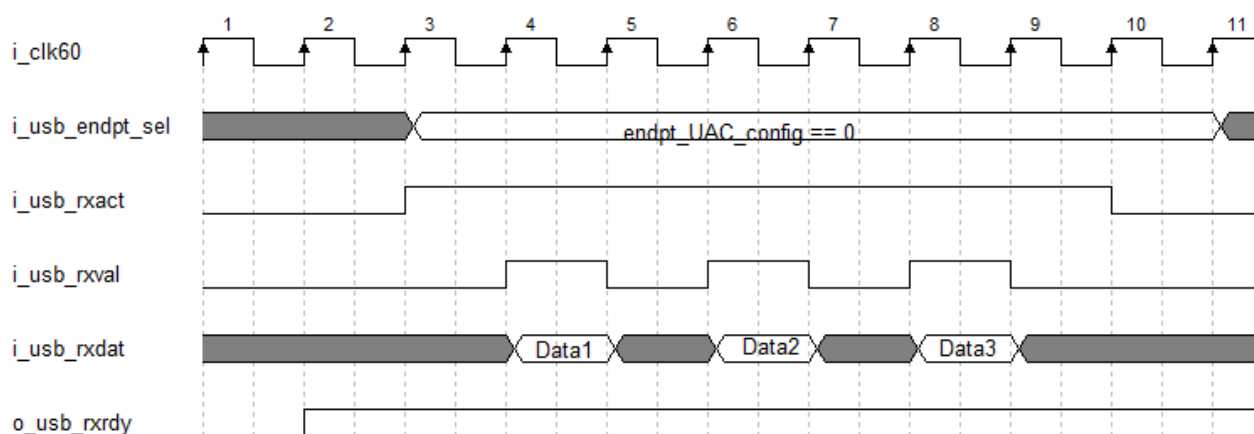
3.4.3 Configuration Data RX Interface

Table 3-5 Configuration Data RX Interface

Name	I/O	Bit Width	Description
i_usb_rxact	Input	1	Receiving active signal; high indicates that the device enters data receiving status.
i_usb_rxval	Input	1	Data valid indicator signal; high indicates that the USB configuration data is valid.
i_usb_rxdat	Input	8	RX Data; IP will output the data received from the USB interface through this port.
o_usb_rxrdy	Output	1	Receive ready signal; high indicates that it can receive RXDAT.
i_usb_endpt_sel	Input	4	Endpoint selection indicator signal; it indicates the current communication endpoint of USB.

After the device receives the class-specific requests from the Host, during the subsequent Host OUT command, the device receives and applies the corresponding configuration data through the RX interface.

Figure 3-6 Timing diagram for Data Reception on USB Audio Class Control Endpoint



3.4.4 Interface Configuration Interface

Table 3-6 Interface Configuration Interface

Name	I/O	Bit Width	Description
i_interface_alter	Input	8	USB interface configuration data input
o_interface_alter	Output	8	USB interface configuration data output
i_interface_sel	Input	8	USB interface configuration selection signal
i_interface_update	Input	1	USB interface configuration update indicator signal; high indicates interface configuration update.

When the device receives the Set Interface command from the Host, and i_interface_update is high, the interface signal to be configured is input through i_interface_update, and the replacement configuration for the interface is input through i_interface_alter.

When the device receives the Get Interface command from the Host, the interface signal to be read is input through i_interface_update, and then the configuration information on o_interface_alter is returned to the Host.

4 Signal Definition

4.1 Signal Definition

The signal description of Gowin USB Audio Class IP is as shown in [Table 4-1](#).

Table 4-1 Signal Definition

Signal Name	I/O	Data Width	Description	Note
i_clk60	I	1	Used to receive the clock signal sent from PHY, and it must be 60MHz.	-
i_clk98304	I	1	Clock signal used for audio protocol processing, and it must be 98.304M.	
i_reset	I	1	Asynchronous reset signal	
i_usb_busreset	I	1	USB reset indicator signal; high indicates the detection of USB bus reset.	
i_desc_raddr	I	16	USB device descriptor address	USB device descriptor
o_desc_rdat	O	8	USB device descriptor data	
i_desc_index	I	8	USB device descriptor index	
i_desc_type	I	8	USB device descriptor type	
o_desc_dev_addr	O	16	Device descriptor start address	
o_desc_dev_len	O	16	Device descriptor byte length	
o_desc_qual_addr	O	16	Device qualifier start address	
o_desc_qual_len	O	16	Device qualifier byte length	
o_desc_fscfg_addr	O	16	Device full speed configuration start address	
o_desc_fscfg_len	O	16	Device full speed configuration byte length	
o_desc_hscfg_addr	O	16	Device high speed configuration start address	
o_desc_hscfg_len	O	16	Device high speed configuration byte length	USB device descriptor
o_desc_hidrpt_addr	O	16	USB device HID descriptor start address	
o_desc_hidrpt_len	O	16	USB device HID descriptor byte length	

Signal Name	I/O	Data Width	Description	Note
o_desc_oscfg_addr	O	16	Device other speed configuration start address	USB device descriptor
o_desc_strlang_addr	O	16	Device string descriptor start address	
o_desc_strvendor_addr	O	16	Device vendor string start address	
o_desc_strvendor_len	O	16	Device vendor string byte length	
o_desc_strproduct_addr	O	16	Device product string start address	
o_desc_strproduct_len	O	16	Device product string byte length	
o_desc_strserial_addr	O	16	Device serial string start address	
o_desc_strserial_len	O	16	Device serial string byte length	
o_desc_have_strings	O	1	High indicates there are string descriptors in the device descriptor.	
i_usb_setup	I	1	Configuration data active indicator signal; high indicates that the USB configuration data is active.	USB device control
i_usb_endpt_sel	I	4	Endpoint selection indicator signal; It indicates the currently selected communication endpoint of USB.	
i_usb_sof	I	1	USB frame synchronization signal	
i_usb_txact	I	1	Transmit operating signal; high indicates that the device enters data transmitting status.	
i_usb_txpop	I	1	Transmit read signal; high indicates the read of next data.	

Signal Name	I/O	Data Width	Description	Note
o_usb_txval	O	1	TX data valid indicator signal; high indicates the user input data is valid (only valid during control endpoint data transmission, otherwise inactive).	USB device control
o_usb_txdat	O	8	TX Data; IP transmits this data through the USB interface.	
o_usb_txdat_len	O	12	TX data byte count; used to control the number of TX data bytes.	USB device control
i_usb_txpktfin	I	1	Transmitting data completion signal; high indicates the current data packet is complete and valid.	
o_usb_txcork	O	1	Transmitting data valid signal; low indicates that TXDAT is insufficient.	
i_usb_rxact	I	1	Reception active signal, high indicates the device is in data reception state.	
i_usb_rxval	I	1	RX data valid signal; High indicates RXDAT is valid.	
i_usb_rxpktval	I	1	Data packet valid signal; high indicates that the RX data packets is valid.	
o_usb_rxdy	O	1	Receive ready signal; high indicates that it can receive RXDAT.	
i_usb_rxdat	I	8	RX Data; IP will output the data received from the USB interface through this port.	
i_interface_alter	I	8	USB interface configuration data input	
o_interface_alter	O	8	USB interface configuration data output	
i_interface_sel	I	8	USB interface selection	

Signal Name	I/O	Data Width	Description	Note
i_interface_update	I	1	USB interface configuration update; high indicates interface configuration update.	USB device control
o_spk_iis_bclk_1	O	1	IIS protocol BCLK signal for Speaker 1	UAC audio output device
o_spk_iis_lrck_1	O	1	IIS protocol LRCK signal for Speaker 1	
o_spk_iis_data_1	O	1	IIS protocol DATA signal for Speaker 1	
o_spk_pcm_bclk_1	O	1	PCM protocol BCLK signal for Speaker 1	
o_spk_pcm_lrck_1	O	1	PCM protocol LRCK signal for Speaker 1	
o_spk_pcm_data_1	O	1	PCM protocol DATA signal for Speaker 1	
o_spk_l_pcm_data_1	O	32	32-bit PCM data for Speaker 1	
o_spk_r_pcm_data_1	O	32	32-bit PCM data for Speaker 1	
o_spk_iis_bclk_2	O	1	IIS protocol BCLK signal for Speaker 2	
o_spk_iis_lrck_2	O	1	IIS protocol LRCK signal for Speaker 2	
o_spk_iis_data_2	O	1	IIS protocol DATA signal for Speaker 2	UAC audio output device
o_spk_pcm_bclk_2	O	1	PCM protocol BCLK signal for Speaker 2	
o_spk_pcm_lrck_2	O	1	PCM protocol LRCK signal for Speaker 2	
o_spk_pcm_data_2	O	1	PCM protocol DATA signal for Speaker 2	
o_spk_l_pcm_data_2	O	32	32-bit PCM data for Speaker 2	
o_spk_r_pcm_data_2	O	32	32-bit PCM data for Speaker 2	
o_spk_iis_bclk_3	O	1	IIS protocol BCLK signal for Speaker 3	
o_spk_iis_lrck_3	O	1	IIS protocol LRCK signal for Speaker 3	
o_spk_iis_data_3	O	1	IIS protocol DATA signal for Speaker 3	

Signal Name	I/O	Data Width	Description	Note
o_spk_pcm_bclk_3	O	1	PCM protocol BCLK signal for Speaker 3	UAC audio output device
o_spk_pcm_lrck_3	O	1	PCM protocol LRCK signal for Speaker 3	
o_spk_pcm_data_3	O	1	PCM protocol DATA signal for Speaker 3	
o_spk_l_pcm_data_3	O	32	32-bit PCM data for Speaker 3	
o_spk_r_pcm_data_3	O	32	32-bit PCM data for Speaker 3	
i_mic_iis_bclk_1	I	1	IIS protocol external input BCLK signal for Microphone 1	UAC audio input device
i_mic_iis_lrck_1	I	1	IIS protocol external input LRCK signal for Microphone 1	
o_mic_iis_bclk_1	O	1	IIS protocol internal output LRCK signal for Microphone 1	
o_mic_iis_lrck_1	O	1	IIS protocol internal output LRCK signal for Microphone 1	
i_mic_iis_data_1	I	1	IIS protocol input DATA signal for Microphone 1	
i_mic_iis_bclk_2	I	1	IIS protocol external input BCLK signal for Microphone 2	
i_mic_iis_lrck_2	I	1	IIS protocol external input LRCK signal for Microphone 2	
o_mic_iis_bclk_2	O	1	IIS protocol internal output LRCK signal for Microphone 2	
o_mic_iis_lrck_2	O	1	IIS protocol internal output LRCK signal for Microphone 2	
i_mic_iis_data_2	I	1	IIS protocol input DATA signal for Microphone 2	

Signal Name	I/O	Data Width	Description	Note
i_mic_iis_bclk_3	I	1	IIS protocol external input BCLK signal for Microphone 3	UAC audio input device
i_mic_iis_lrck_3	I	1	IIS protocol external input LRCK signal for Microphone 3	
o_mic_iis_bclk_3	O	1	IIS protocol internal output LRCK signal for Microphone 3	
o_mic_iis_lrck_3	O	1	IIS protocol internal output LRCK signal for Microphone 3	
i_mic_iis_data_3	I	1	IIS protocol input DATA signal for Microphone 3	

4.2 Parameter Configuration Option

Gowin USB Audio Class IP parameters are described as shown in [Table 4-2](#).

Table 4-2 Configuration Description

Option	Description
UAC Speed Mode	UAC device speed mode selection, including UAC1.0 mode (Full Speed) and UAC2.0 (Fast Speed) mode.
IIS_Outside_clk	Select the clock source of the IIS protocol for the UAC audio input device: externally input or internally generated and output.
Enable_Speaker1	Enable Speaker 1
Speaker1_string	Speaker 1 string
Speaker1_depth	Supported bit depth for Speaker 1, including 16 bits, 24 bits, and 32 bits.
Speaker1_sync_type	Data synchronization mode for Speaker 1, including asynchronous mode (with feedback endpoint) and synchronous mode (without feedback endpoint).
Speaker1_sample	Supported sampling frequency for Speaker 1, including 32kHz, 48kHz, 96kHz, 192kHz, 384kHz, and 768kHz.
Speaker1_output_format	Supported output audio data format for Speaker 1, including IIS protocol, PCM protocol, and 32-bit PCM data.
Enable_Speaker2	Enable Speaker 2
Speaker2_string	Speaker 2 string
Speaker2_depth	Supported bit depth for Speaker 2, including 16 bits, 24 bits, and 32 bits.
Speaker2_sync_type	Data synchronization mode for Speaker 2, including asynchronous mode (with feedback endpoint) and synchronous mode (without feedback endpoint).
Speaker2_sample	Supported sampling frequency for Speaker 2, including 32kHz, 48kHz, 96kHz, 192kHz, 384kHz, and 768kHz.
Speaker2_output_format	Supported output audio data format for Speaker 2, including IIS protocol, PCM protocol, and 32-bit PCM data.
Enable_Speaker3	Enable Speaker 3
Speaker3_string	Speaker 3 string
Speaker3_depth	Supported bit depth for Speaker 3, including 16 bits, 24 bits, and 32 bits.
Speaker3_sync_type	Data synchronization mode for Speaker 3, including asynchronous mode (with feedback endpoint) and synchronous mode (without feedback endpoint).

Option	Description
Speaker3_sample	Supported sampling frequency for Speaker 3, including 32kHz, 48kHz, 96kHz, 192kHz, 384kHz, and 768kHz.
Speaker3_output_format	Supported output audio data format for Speaker 3, including IIS protocol, PCM protocol, and 32-bit PCM data.
Enable_MIC1	Enable Microphone 1
MIC1_String	Microphone 1 string
MIC1_Depth	Supported bit depth for Microphone 1, including 16 bits, 24 bits, and 32 bits.
MIC1_Sample	Supported sampling frequency for Microphone 1, including 32kHz, 48kHz, 96kHz, 192kHz, 384kHz, and 768kHz (only 32kHz, 48kHz, 96kHz, and 192kHz are supported in UAC1.0 mode).
Enable_MIC2	Enable Microphone 2
MIC2_String	Microphone 2 string
MIC2_Depth	Supported bit depth for Microphone 2, including 16 bits, 24 bits, and 32 bits.
MIC2_Sample	Supported sampling frequency for Microphone 2, including 32kHz, 48kHz, 96kHz, 192kHz, 384kHz, and 768kHz (only 32kHz, 48kHz, and 96kHz are supported in UAC1.0 mode).
Enable_MIC3	Enable Microphone 3
MIC3_String	Microphone 3 string
MIC3_Depth	Supported bit depth for Microphone 3, including 16 bits, 24 bits, and 32 bits.
MIC3_Sample	Supported sampling frequency for Microphone 3, including 32kHz, 48kHz, 96kHz, 192kHz, 384kHz, and 768kHz (only 32kHz and 48kHz are supported in UAC1.0 mode).

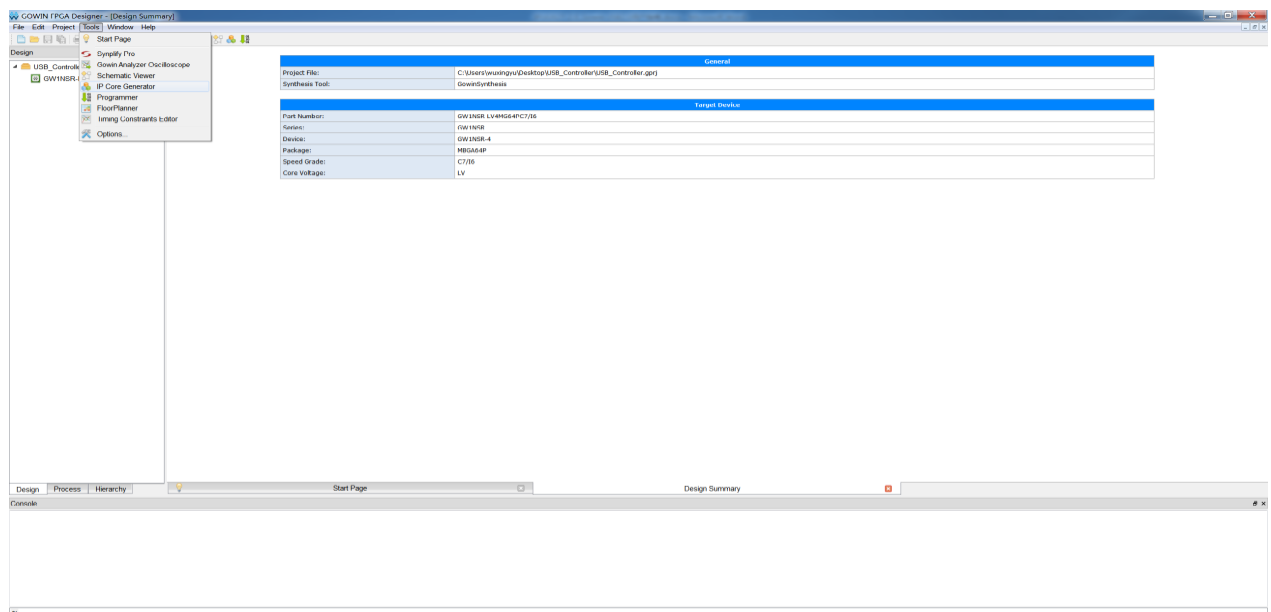
5 Interface Configuration

You can select “Tools” in Gowin Software to start the “IP Core Generator” to call and configure USB Audio Class IP.

1. Open IP Core Generator.

After creating the project, you can click the “Tools” tab in the upper-left corner, then click the “IP Core Generator” via the drop-down list, as shown in [Figure 5-1](#).

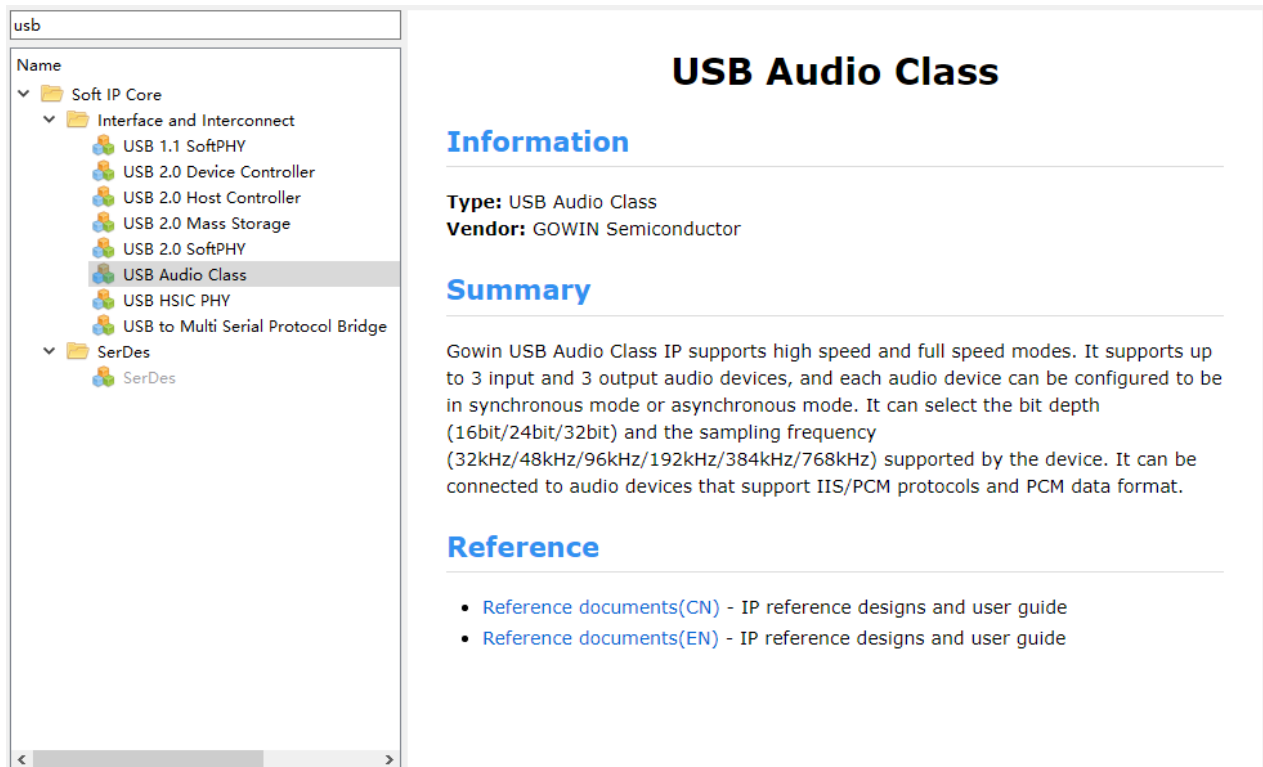
Figure 5-1 IP Core Generator



2. Open USB Audio Class IP core

Select “Soft IP Core > Interface and Interconnect > USB Audio Class”, as shown in [Figure 5-2](#). Double click to open the configuration interface.

Figure 5-2 USB Audio Class IP Core



usb

Name

▼ Soft IP Core

▼ Interface and Interconnect

USB 1.1 SoftPHY

USB 2.0 Device Controller

USB 2.0 Host Controller

USB 2.0 Mass Storage

USB 2.0 SoftPHY

USB Audio Class

USB HSIC PHY

USB to Multi Serial Protocol Bridge

▼ SerDes

SerDes

USB Audio Class

Information

Type: USB Audio Class
Vendor: GOWIN Semiconductor

Summary

Gowin USB Audio Class IP supports high speed and full speed modes. It supports up to 3 input and 3 output audio devices, and each audio device can be configured to be in synchronous mode or asynchronous mode. It can select the bit depth (16bit/24bit/32bit) and the sampling frequency (32kHz/48kHz/96kHz/192kHz/384kHz/768kHz) supported by the device. It can be connected to audio devices that support IIS/PCM protocols and PCM data format.

Reference

- [Reference documents\(CN\)](#) - IP reference designs and user guide
- [Reference documents\(EN\)](#) - IP reference designs and user guide

3. USB Audio Class IP Core Configuration Interface.

Figure 5-3 shows the USB Audio Class IP core configuration interface. The port diagram is on the left, and options are on the right.

- You can configure the generated file name in “File Name” text box.
- You can configure the generated top module name in “Module Name” text box.
- You can configure speed mode, audio device number, the audio sample frequency, bit depth, and more in “Options” tab.

Figure 5-3 USB Audio Class IP Configuration Interface

USB Audio Class

General

Device: GW2AR-18 Device Version: C

Part Number: GW2AR-LV18QN88C8/I7 Language: Verilog

File Name: usb_audio_class Module Name: USB_Audio_Class_Top

创建至: E:\example2024\4.UAC_IP\1.TEST_IP_DEMO\Gowin_UAC_V1_0\src\usb_audio_class

Options

Common

UAC Speed Mode: UAC 2.0

☒ IIS Outside Clock

Speaker1 **Speaker2** **Speaker3** **Microphone1** **Microphone2** **Microphone3**

☒ Enable Speaker1

Name: GOWIN UAC SPEAKER1

Bit Depth: ☐ 16 ☒ 24 ☐ 32

Sample Frequency: ☐ 32k ☒ 48k ☐ 96k

☐ 192k ☐ 384k ☐ 768k

Sync Type: ☐ Asynchronous ☒ Synchronous

Output Format: ☐ PCM Protocol ☒ IIS Protocol

☐ PCM 32bit Data

☒ Enable Microphone1

Name: GOWIN UAC MIC1

Bit Depth: ☐ 16 ☒ 24 ☐ 32

Sample Frequency: ☐ 32k ☒ 48k ☐ 96k

☐ 192k ☐ 384k ☐ 768k

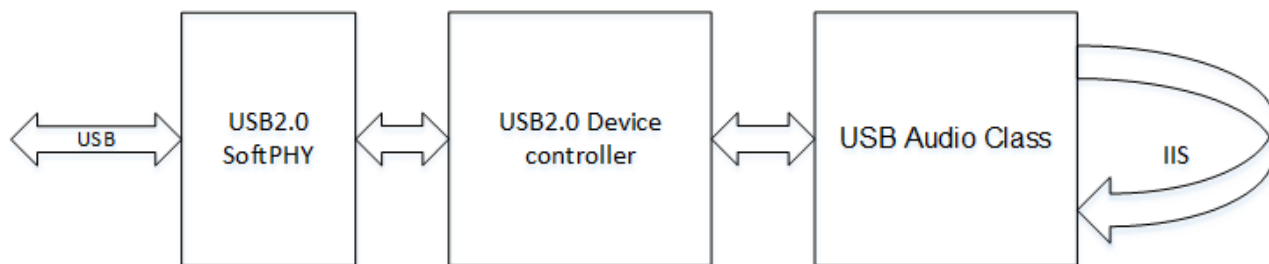
OK Cancel

6 Reference Design

6.1 USB Reference Design

This chapter introduces the structure and usage of Gowin USB Audio Class IP *reference design* instance. This reference design is an example of a UAC 2.0 audio composite device that outputs to three speakers and three microphones based on the IIS protocol. Its basic structure is shown in Figure 6-1

Figure 6-1 USB Audio Class Reference Design Block Diagram



In this design example, USB signals are converted into parallel UTMI signals by Gowin USB 2.0 SoftPHY IP module, and then USB data packet parsing is completed by USB 2.0 Device Controller. The USB Audio Class module contains the descriptor information of the UAC audio composite device.

The USB Audio Class module sends device descriptors and configuration commands to the USB Host, processes commands and data from the USB interface, and outputs IIS protocol audio data through the speaker.

At the same time, the IIS data is looped back into the USB microphone, processed by the USB interface, and then input into the USB Host.

6.2 USB Driver Installation

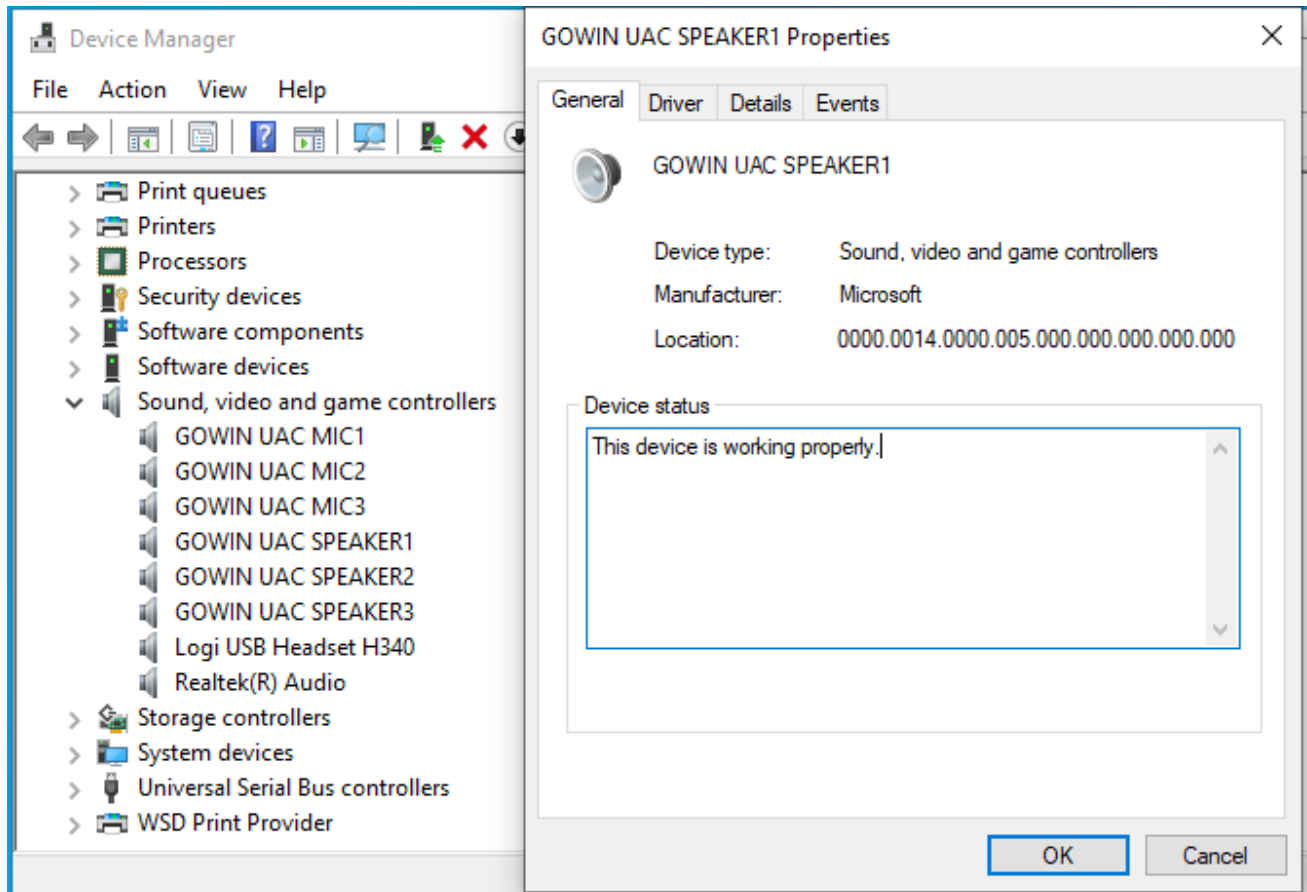
You can install winUSB driver on the device through the Zadig software. The installation steps are as follows:

Open Zadig (Administrator rights required) and select List All Devices in the Options drop-down list.

6.3 Audio Loopback Test

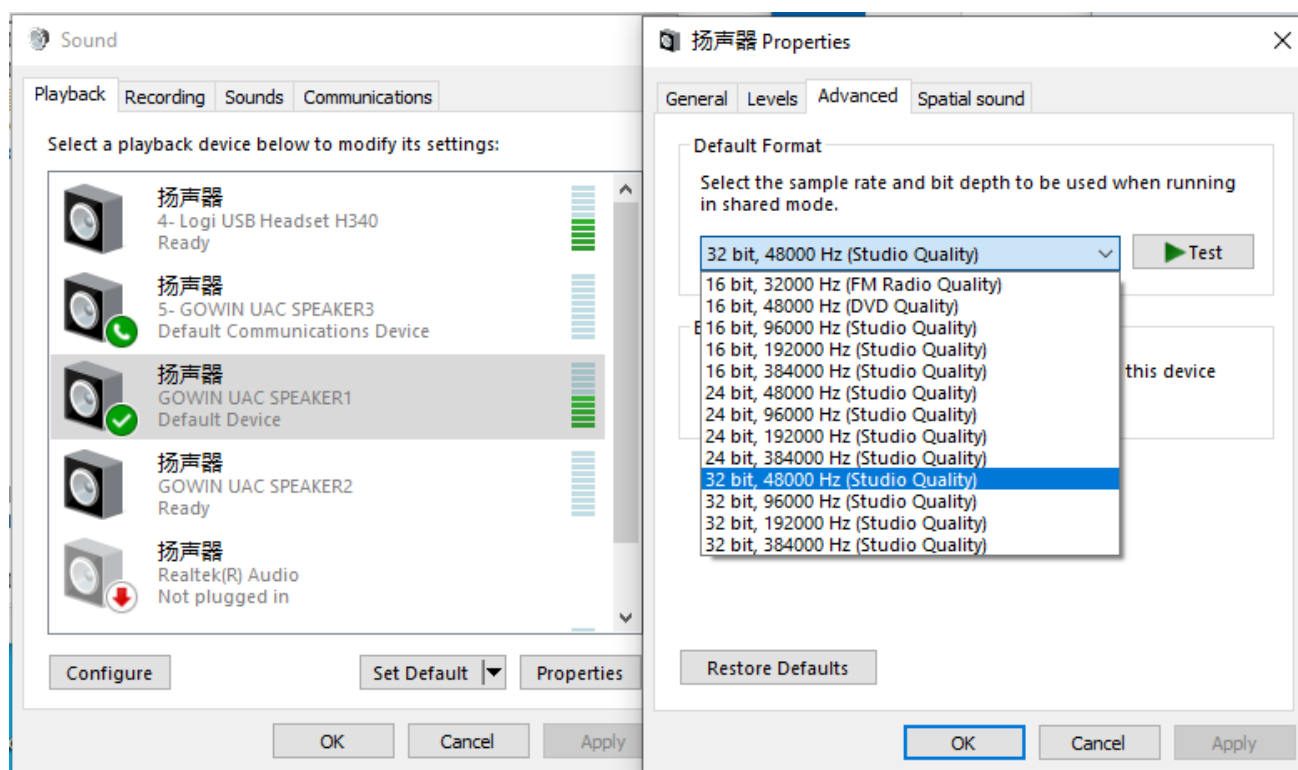
As shown in [Figure 6-2](#), after inserting Gowin USB Audio Class, the computer recognizes this device and displays it in the Device Manager.

Figure 6-2 USB Audio Class Device Manager Recognition Result



As shown in [Figure 6-3](#), you can now select the sample frequency and bit depth for the specific audio device through the "Sound Settings".(To perform the audio loopback operation, the sample frequency of both the speaker and microphone involved in the loopback test should be set to the same value.)

Figure 6-3 USB Audio Class Sound Settings Recognition Result

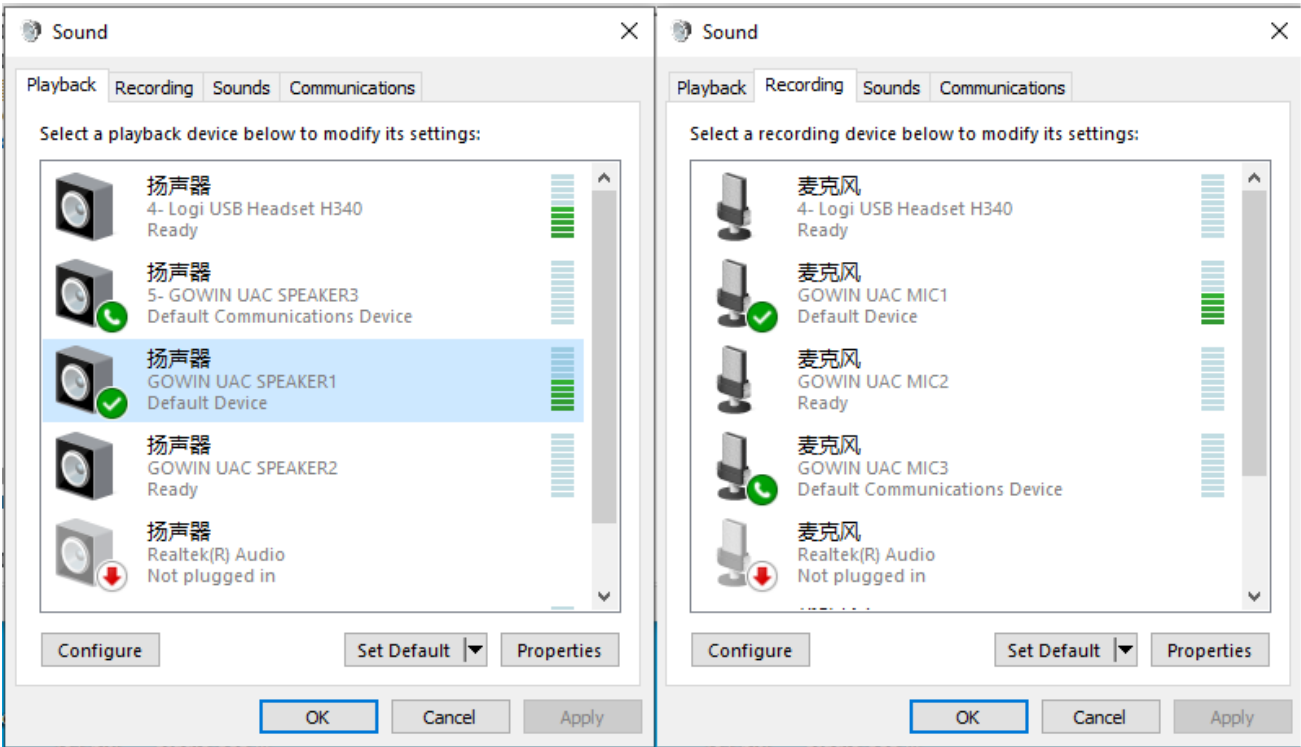


As shown in [Figure 6-4](#), after inserting Gowin USB Audio Class, open the Windows Media Player and set "GOWIN UAC SPEAKER1" as the default device, and set "GOWIN UAC MIC1" as the default device.

At this point, the audio played by the Windows Media Player will be converted and output as an IIS signal from the "GOWIN UAC SPEAKER1" speaker, and looped back to the "GOWIN UAC MIC1" microphone.

Select "GOWIN UAC MIC1 Properties - Listen", check "Listen to this device", and select another speaker as the listening device (an additional headphone "5-Logi USB Headset H340" is used in [Figure 6-4](#)). At this point, you can listen to the loopback audio from the "GOWIN UAC MIC1" microphone through this speaker (the headphone "5-Logi USB Headset H340" in [Figure 6-4](#)).

Figure 6-4 USB Audio Class Audio Loopback Test



7 File Delivery

The file delivery for Gowin USB Audio Class IP includes the documentation, the design source code, and the reference design.

7.1 Document

The folder contains the user guide in PDF version.

Table 7-1 Document List

Name	Description
IPUG1196, Gowin USB Audio Class IP User Guide	Gowin USB Audio Class IP User Guide, namely this one

7.2 Design Source Code (Encryption)

The encryption code folder contains the RTL encryption code of Gowin USB Audio Class IP used for the GUI, in order to work with Gowin Software for generating the IP core required by users.

Table 7-2 Design Source Code List

Name	Description
usb_audio_class_top.v	The top-level file of the IP core, which provides users with interface information, encrypted.
usb_audio_class.v	Gowin USB Audio Class IP IP design RTL source file, encrypted.
uac_define.v	Gowin USB Audio Class IP parameter definition module, generated by user via GUI configuration, unencrypted.
static_macro_define.v	Local static parameter configuration file, not encrypted

7.3 Reference Design

The Ref. Design folder contains the netlist file, the user reference design, the constraints file, the top file, and the project folder, etc.

Table 7-3 Ref. Design File List

Name	Description
Top.v	The top module of reference design
usb_audio_class.vo	Gowin USB Audio Class IP netlist file
Gowin_UAC_V1_0.cst	USB Audio Class physical constraints file
Gowin_UAC_V1_0.sdc	USB Audio Class timing constraint file
Gowin_UAC_V1_0	USB Audio Class IP project folder

