USBFS AUDIO PSoC3/5LP Code Example

3.0

Features

- Simple USB audio streaming
- Transferring USB audio data to VDAC by DMA

General Description

This USB example project implements a USB Audio Device that connects to the PC via the USB interface. The USB Audio Device does not require a special USB driver, because the USB Audio support is already built into Windows. The device appears in the system as a mono speaker with 8-bit resolution and a sample rate of 32 kHz.

Development Kit Configuration

This example project is designed to run on the CY8CKIT-030 or CY8CKIT-050 or CY8CKIT-001 kit from Cypress Semiconductor.

The project requires only the device change to run on the selected kit. Table 1 provides the relationship between the development kit and device. To change the device use Device Selector called from the project's context menu.

Table 1. Development Kits vs Parts

Development Kit	Device
CY8CKIT-030	CY8C3866AXI-040
CY8CKIT-050	CY8C5868AXI_LP035
CY8CKIT-001	CY8C3866AXI-040/ CY8C5868AXI_LP035

Project Configuration

The example project consists of the component USBFS, VDAC8, DMA, interrupt, and LCD. The project schematic is in Figure 1.

The USBFS component implements a limited USB Audio Device which appears in the system as a speaker. It means that audio can be streamed only from the PC to the device and not in the opposite direction. The USB device has VID = 0x4B4 (this is Cypress Semiconductor vendor ID) and PID = 0x2001 (arbitrarily chosen). The appropriate string descriptors are also provided with the company's name (Cypress Semiconductor) and appropriate audio device information. The device is powered through the USB connection, so the device configuration is bus-powered. The

device has a single OUT ISOC endpoint with the maximum packet of 192 bytes to receive an audio stream for the host.

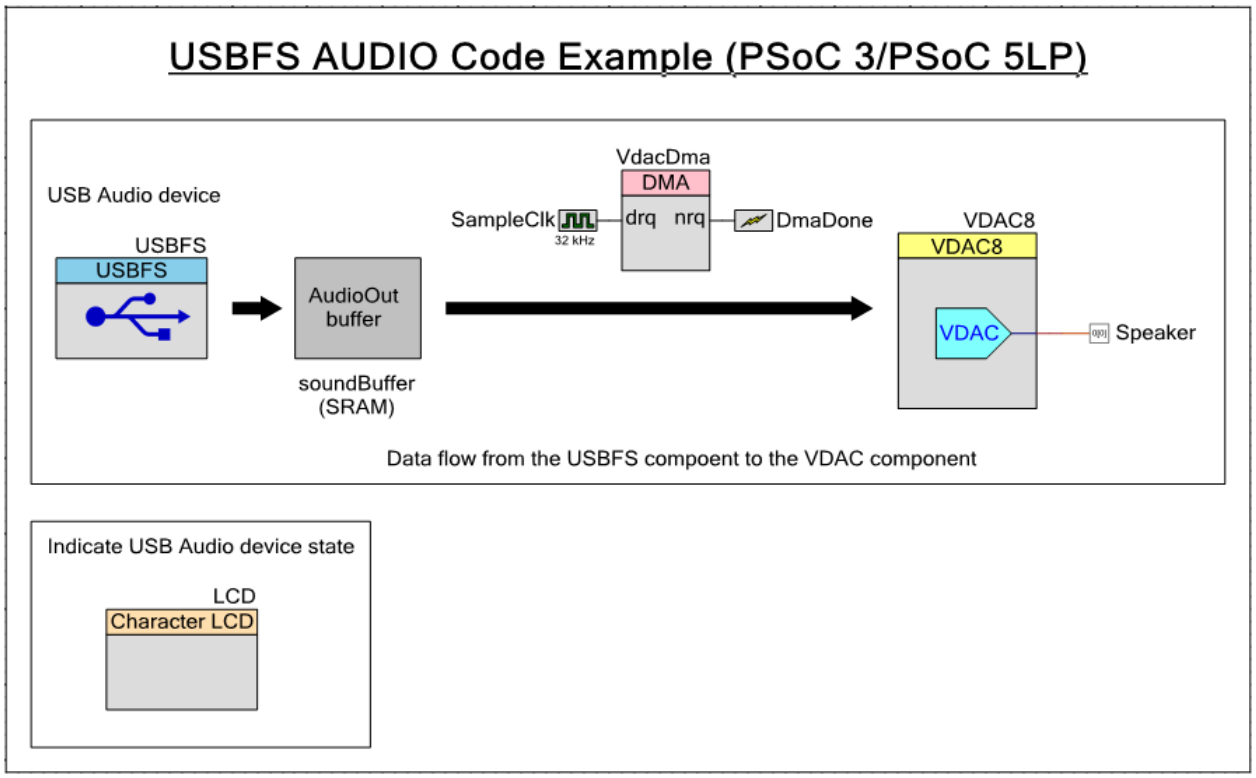
The important option of the USBFS component is the endpoint buffer management that defines the way how the endpoint buffers are serviced. This option is set to a DMA with Manual Buffer Management (Static Allocation). It means that data transfer between the endpoint memory and SRAM buffer is executed by DMA.

The DMA component is used to transfer audio data, received from the host, to the VDAC. The data bytes are supplied to the VDAC with a sample rate of 32 kHz. Therefore, the 32 kHz clock component is connected to the DMA request input. The DMA is configured to transfer 1 byte per request but the total transfer size is 32 bytes. The interrupt is connected to the DMA component to trigger when DMA transfer is done (each time when 32 bytes are transferred).

The VDAC8 component is an 8-bit voltage output Digital-to-Analog Converter (DAC) with the output range from 0 to 4.08 V (16 mV/bit). Its output is controlled by the data register written by DMA.

The LCD component is used to provide information about the data transfer direction in the 1st row (USB -> DMA -> VDAC) and whether audio is streamed to the device from the PC in the 2nd row (Audio On/Off).

Figure 1. Example Project Design Schematic



The important USBFS component configuration Tabs are shown below.

Figure 2. USBFS Descriptor Root

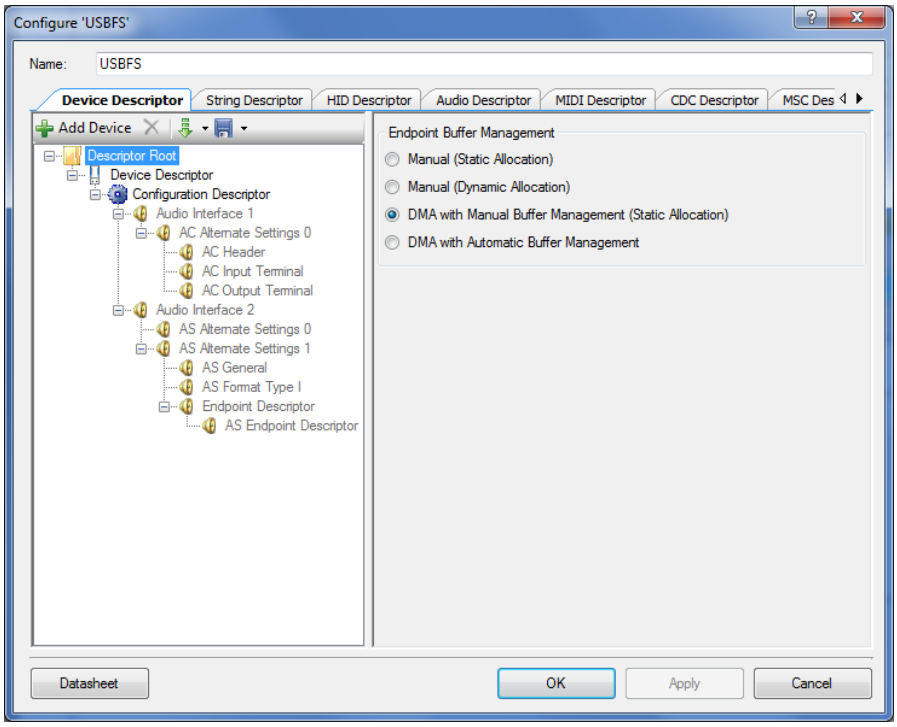


Figure 3. USBFS Audio Descriptor Alternate Settings 0

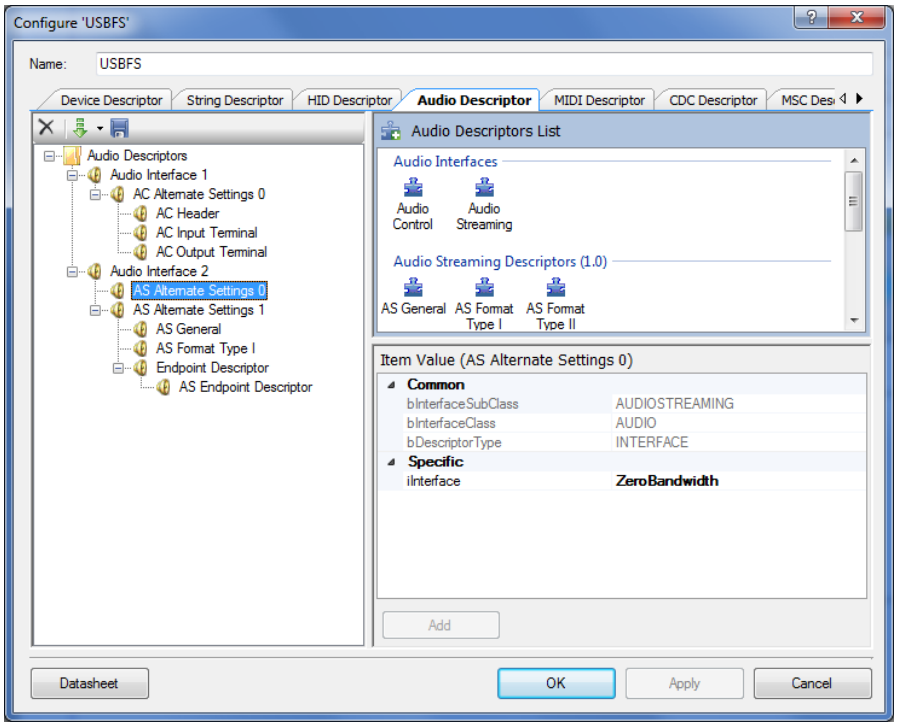


Figure 4. USBFS Audio Descriptor Alternate Settings 1

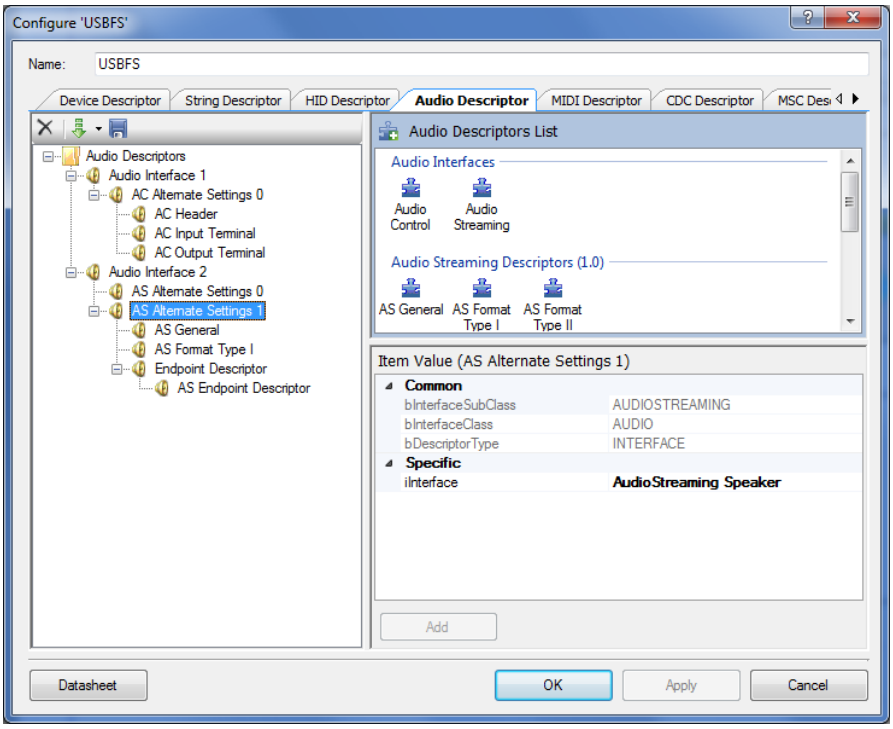


Figure 5. USBFS Audio Descriptor AS Format Type I

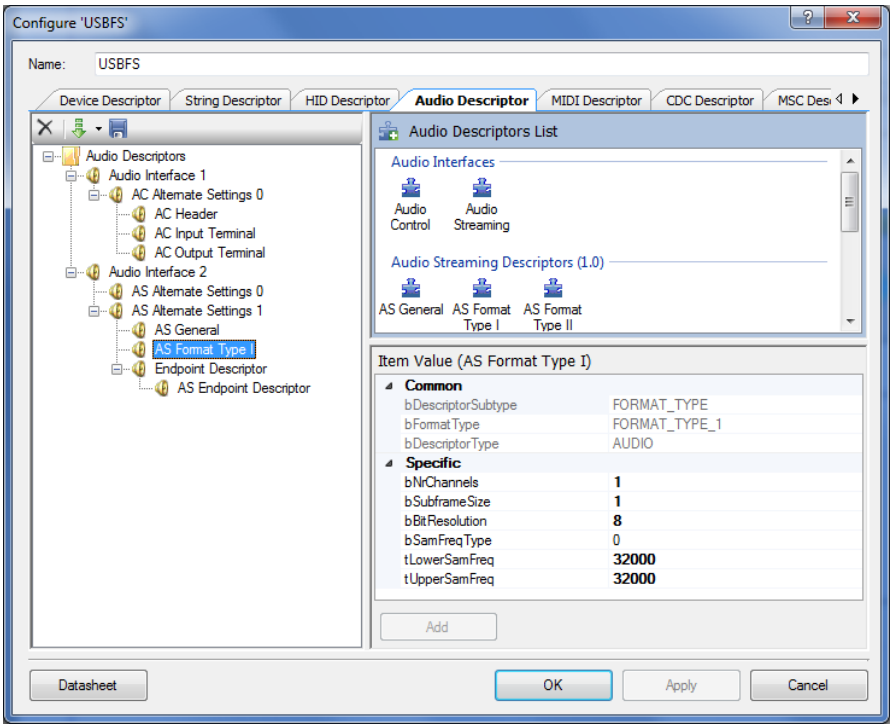
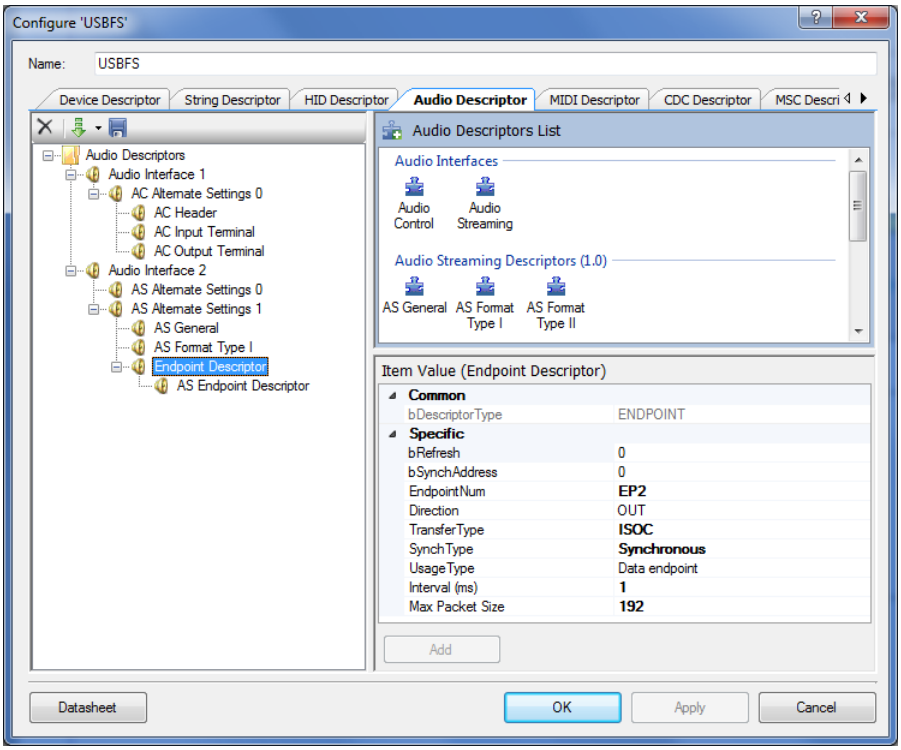


Figure 6. USBFS Audio Descriptor Endpoint



Project Description

The initialization part of the main firmware routine consists of two major steps:

- Step 1 sets up the infrastructure to transfer data received via USB to VDAC by DMA. The 10 transfer descriptors are allocated to transfer 32 bytes from the data buffer to the VDAC data register. Each transfer descriptor transfers a chunk from the buffer (buffer size is 32 * 10 bytes): the 1st transfer descriptor transfers 1 – 32 buffer elements, the 2nd – 33 – 64 buffer elements and so on. The descriptors are successively chained and the last one is chained to the 1st to create a circle. The interrupt handler of the DMA done is registered to disable the DMA when underflow occurs. It triggers every time when 32 bytes have been transferred by DMA to VDAC.

  Note PSoC does not support DMA direct transactions between the USBFS endpoints and other peripherals. All DMA transactions involving the USBFS endpoints (IN and OUT) must terminate or originate with the main system memory.

- Step 2 is configuration and start of the USBFS component operation. The global interrupts are enabled as they are mandatory. The code waits for completion of the enumeration process before entering a forever loop. This process starts by the host when the USB cable is connected to the PC.

After the USB Audio device was enumerated, the device waits for audio streaming. When audio streaming starts, the Interface 1 alternate settings are changed from 0 to 1 and the OUT

endpoint is enabled. The OUT endpoint state is polling to identify whether data has been written. When data is available, it is read from the endpoint memory buffer into the SRAM buffer. Then DMA starts transferring data to VDAC when the buffer is half-full.

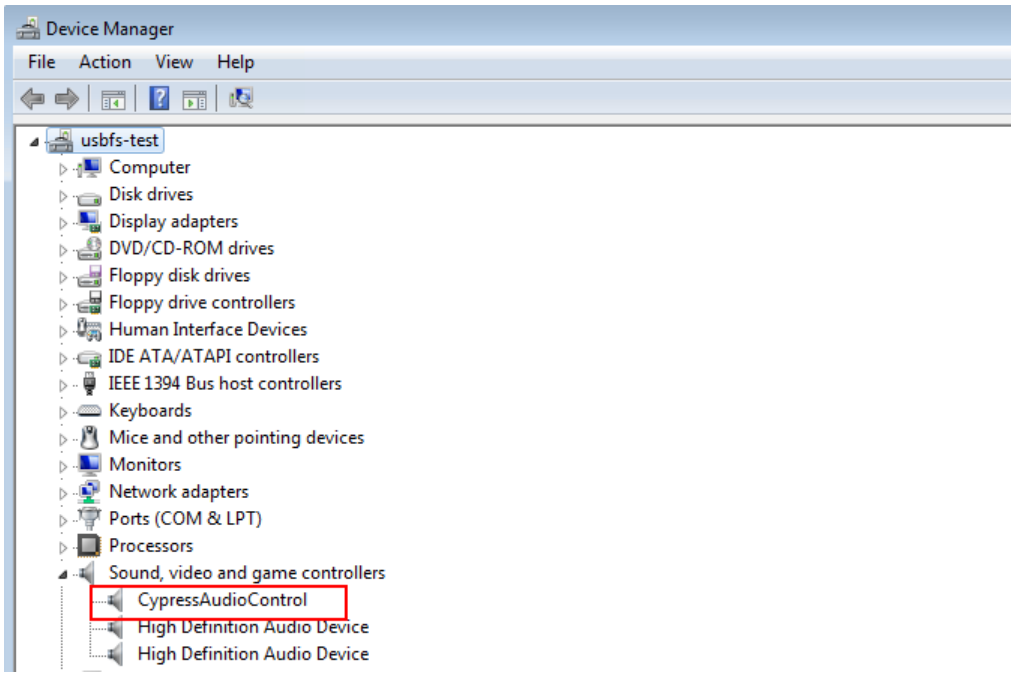
Note The internal 32 kHz clock of PSoC can be faster or slower than the PC. But none of synchronization schemes is implemented. Therefore, when underflow occurs, the DMA is stopped and enabled again after the buffer is half-full. When overflow occurs, the currently received data chunk (32 bytes) is skipped.

Example Project Execution Flow

To execute the USBFS component code example, follow the procedure:

1. Connect the PSoC kit to the PC through the USB connector for programming.
2. Build the USBFS_AUDIO_PSoC3_5LP example project and program into the device. The USB cable can be disconnected from the programming connector at this point.
3. Connect the speaker or oscilloscope to the Speaker pin to listen audio or observe the signal output.
4. Connect the kit to the PC through the USB connector for communication. The USB audio device does not require a driver and is automatically recognized by the system as CypressAudioControl.

Figure 7. CypressAudioControl Is Enumerated



5. Change the default speaker to the CypressAudioControl device. Follow the link to get instructions how to change the audio device in the Windows Media Player.

6. Play an audio file and listen or observe the speaker output. The example project contains audio file 1kHz_sine_wave.wav which generates a 1-kHz sine wave with 8-bit resolution and 32-kHz sample rate. It is recommended to use the audio file attached to this code example.

Expected Results

If you follow the instructions above, the USB Audio device is enumerated by the PC and then you can play audio on the PC and observe it on the VDAC output.