



## USB Interface Audio CODEC

### Features:

- **USB Audio Controller**
  - 12 Mbps bit rate
  - USB Serial Interface Engine (SIE)
  - Audio Class Processing Block
  - 4 Endpoints
  - USB transceiver
- **16bit CODEC**
  - Single-channel A/D Converter
    - Microphone Pre-Amp (Fixed Gain: 20dB)
    - Mute/Volume Control
    - Programmable Gain Control
      - +24dB to -31dB ( 1dB step )
  - D/A Converter
    - 2 channels
  - Mixer
    - Mute/Attenuation Control
      - +0dB to -47dB ( 1dB step )
    - Analog Bass Boost
- **HID Support**
  - remote control of playback volume/mute
  - recording mute/status function
- **Power Management**
  - control of external headphone amplifier
  - low power at suspend mode (< 1uA)
- **EEPROM Interface (Microwire Interface)**
  - can read Device/String Descriptor from EEPROM
  - 1K/2K/4K bit EEPROM
- **On-chip PLL**
  - 7 sampling frequencies:
    - 8kHz, 11.025kHz, 16kHz, 22.05kHz, 32kHz,
    - 44.1kHz, 48kHz
- **Single Power Supply, Low Power**
  - +3.3Volts±0.3V
- **Package**
  - 48pin LQFP

### General Description:

The AK4571 is a USB Interface audio CODEC. The AK4571 incorporates a 16-bit CODEC, PLLs, USB transceiver, SIE (serial interface engine), audio class processing unit, FIFO and other required signals into a single chip. The AK4571 can simultaneously transmit and receive audio stream data through USB bus. In addition to this, the single-channel ADC and 2-channel DAC can operate at different sampling rates.

The AK4571 has a programmable gain amplifier for analog input (IPGA). The gain range is from -31dB to +24dB with 1dB steps. In addition to the IPGA, the AK4571 also has a fixed +20dB pre-amplifier. Analog input signals can be mixed directly with the D/A signal and sent to the LINEOUT pins of the chip.

The analog outputs of the AK4571 can be attenuated up to -47dB in 1dB steps. The AK4571 also has an analog bass boost circuit. Bass Boost response can be modified by changing the values of external resistors and capacitors.

The AK4571 has a Human Interface Device function that allows a user to control the playback volume at the device side. The playback volume on mixer applet moves up or down automatically by the operation of HID buttons. The AK4571 also can mute analog input signal locally in addition to mixer applet control.

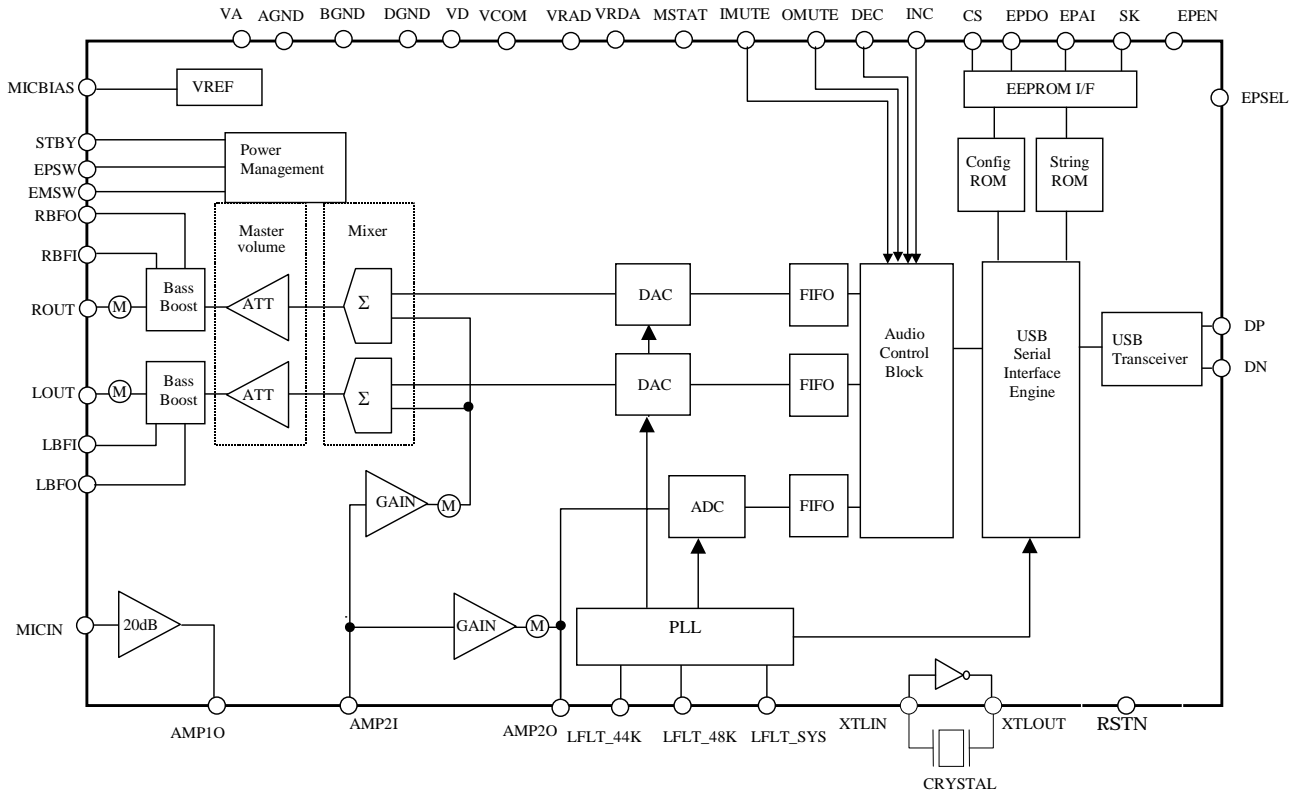
The AK4571 has advanced power management capabilities. Suspend current is less than 1uA. The AK4571 can also control the power of an external headphone amplifier to conform to the USB suspend current requirement of 500uA maximum.

The AK4571 has a Microwire interface for an external EEPROM, allowing customization of Vendor ID and product ID.

The high integration of the AK4571 reduces both the number of external components required and the PCB area required to build USB devices, including small format products such as USB headsets.



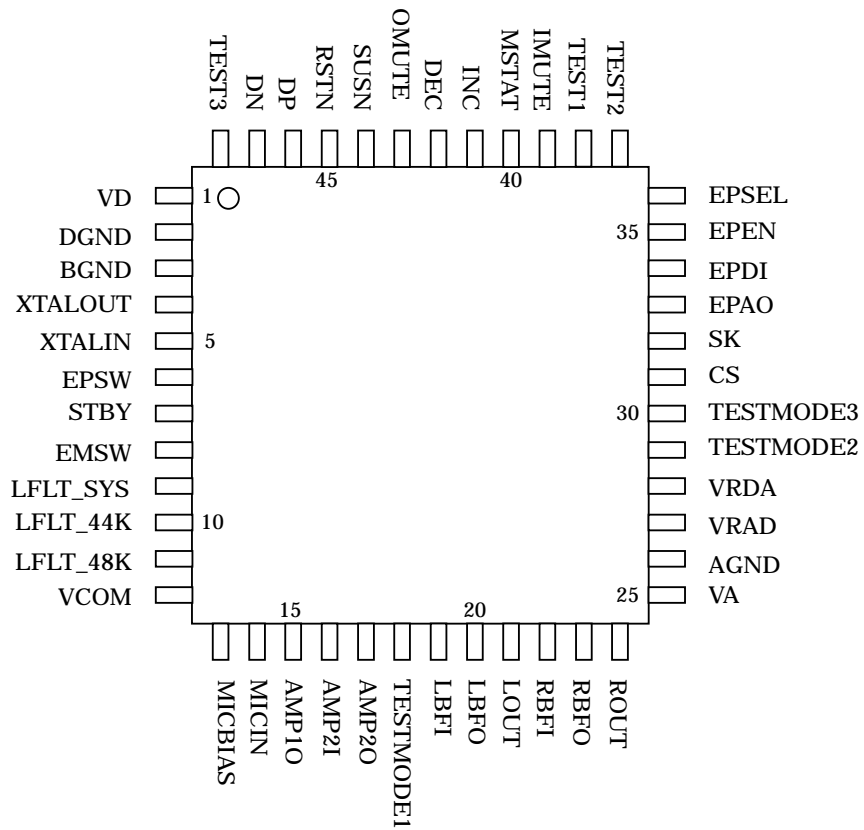
**Block Diagram**



**Ordering Guide**

AK4571VQ      0 ~ +70°C      48pinLQFP(0.5mm pitch)  
 AKD4571      Evaluation Board for AK4571

**Pin Layout**



| Pin/Function                         |             |     |           |  |
|--------------------------------------|-------------|-----|-----------|--|
| No.                                  | Signal Name | I/O | Ana / Dig | Description  |
| USB Interface                        |             |     |           |  |
| 46                                   | DP          | I/O | D         | USB bus Non-Inverting pin.<br>Since the AK4571 is a full-speed device, a 1.5kΩ resistor must be connected between D+ node to VD. |
| 47                                   | DN          | I/O | D         | USB bus Inverting Pin.   |
| Reset, Crystal, PLL                  |             |     |           |  |
| 45                                   | RSTN        | I   | D         | Reset Pin. Low input resets the chip.<br>Schmitt Trigger input.  |
| 44                                   | SUSN        | O   | D         | Suspend Pin<br>"L": Suspend Mode<br>"H": Normal Mode   |
| 4                                    | XTALOUT     | O   | A         | Crystal Oscillator Output, Connect Crystal Resonator. Connect capacitor  |
| 5                                    | XTALIN      | I   | A         | Crystal Oscillator Input, Connect Crystal Resonator. Connect capacitor   |
| 9                                    | LFLT_SYS    | O   | A         | System PLL loop filter Pin. Connect 2.7kΩ resistor and 22nF capacitor in series externally.                                      |
| 10                                   | LFLT_44K    | O   | A         | Codec PLL loop filter Pin. Connect 120kΩ resistor and 6.8nF capacitor in series externally.                                      |
| 11                                   | LFLT_48K    | O   | A         | Codec PLL loop filter Pin. Connect 120kΩ resistor and 6.8nF capacitor in series externally.                                      |
| Analog Input/Output                  |             |     |           |  |
| 12                                   | VCOM        | O   | A         | Analog Common Voltage Reference Pin  |
| 27                                   | VRAD        | O   | A         | ADC Common Voltage Reference Pin.  |
| 28                                   | VRDA        | O   | A         | ADC Common Voltage Reference Pin.  |
| 14                                   | MICIN       | I   | A         | Mono Channel Microphone Input  |
| 15                                   | AMP1O       | O   | A         | Mono Channel 1 <sup>st</sup> Amplifier Output Pin  |
| 16                                   | AMP2I       | I   | A         | Mono Channel 2 <sup>nd</sup> Amplifier Input Pin   |
| 17                                   | AMP2O       | O   | A         | Mono Channel 2 <sup>nd</sup> Amplifier Output Pin<br>Please Connect 1nF capacitor.   |
| 21                                   | LOUT        | O   | A         | Left Channel D/A Out   |
| 24                                   | ROUT        | O   | A         | Right Channel D/A Out  |
| 19                                   | LBFI        | I   | A         | Left Channel Bass Boost Filter Input Pin   |
| 20                                   | LBFO        | O   | A         | Left Channel Bass Boost Filter Output Pin  |
| 22                                   | RBFI        | I   | A         | Right Channel Bass Boost Filter Input Pin  |
| 23                                   | RBFO        | O   | A         | Right Channel Bass Boost Filter Input Pin  |
| 13                                   | MICBIAS     | O   | A         | Voltage Reference Output for the Microphone's bias voltage<br>When the chip goes into Suspend mode, this pin goes to Hi-Z.       |
| External Headphone Amplifier Control |             |     |           |  |
| 6                                    | EPSW        | O   |           | External Headphone Amplifier Power Switch Control Pin 1<br>"H": Normal Operation<br>"L": Suspend Mode                            |
| 7                                    | STBY        | O   |           | External Headphone Amplifier Power Switch Control Pin 2<br>"L": Normal Operation<br>"H": Suspend Mode                            |
| 8                                    | EMSW        | O   |           | External Headphone Amplifier Mute Control Pin<br>"H": MUTE ON<br>"L": MUTE OFF   |

| No.           | Signal Name | I/O | Ana / Dig | Description  |
|---------------|-------------|-----|-----------|--|
| EEPROM I/F    |             |     |           |  |
| 31            | CS          | O   | D         | EEPROM I/F Chip Select Pin   |
| 32            | SK          | O   | D         | Read Clock Pin   |
| 34            | EPDI        | I   | D         | EEPROM Data Input Pin  |
| 33            | EPAO        | O   | D         | EEPROM Address Output Pin  |
| 35            | EPEN        | I   | D         | EEPROM Enable Pin<br>"H": Read Device/String Descriptor from external EEPROM<br>"L": Read Device/String Descriptor from internal ROM.<br>CS,SK,EPDI,EPAO are Hi-Z        |
| 36            | EPSEL       | I   | D         | EEPROM Select<br>"L": 1Kbit Type EEPROM is connected.<br>"H": 2Kbit/4Kbit EEPROM is connected  |
| HID Interface |             |     |           |  |
| 39            | IMUTE       | I   | D         | A/D Mute<br>Toggles mute status at the rising edge. If this pin is not used, please connect this pin to DGND.  |
| 43            | OMUTE       | I   | D         | D/A Mute<br>Sets "1" to internal register at the rising edge, and reset to "0" at the falling edge. If this pin is not used, please connect this pin to DGND.            |
| 41            | INC         | I   | D         | D/A Volume Up Pin<br>Sets "1" to internal register at the rising edge, and reset to "0" at the falling edge. If this pin is not used, please connect this pin to DGND.   |
| 42            | DEC         | I   | D         | D/A Volume Down Pin<br>Sets "1" to internal register at the rising edge, and reset to "0" at the falling edge. If this pin is not used, please connect this pin to DGND. |
| 40            | MSTAT       | O   | D         | Recording Mute Status Pin.<br>"H": Mute ON<br>"L": Mute OFF<br>In suspend mode, this pin is "L".   |
| Power Supply  |             |     |           |  |
| 25            | VA          | P   | A         | Analog Power Supply, 3.3V  |
| 26            | AGND        | P   | A         | Analog Ground  |
| 1             | VD          | P   | D         | Digital Power Supply, 3.3V   |
| 2             | DGND        | P   | D         | Digital Ground   |
| 3             | BGND        | P   | D         | Bulk Ground, 0V  |
| Test Mode     |             |     |           |  |
| 18            | TESTMODE1   | I   |           | Please tie down to AGND for normal operation.  |
| 29            | TESTMODE2   | I   |           | Please tie down to AGND for normal operation.  |
| 30            | TESTMODE3   | I   |           | Please tie down to AGND for normal operation.  |
| 38            | TEST1       | I   |           | Please tie down to DGND for normal operation.  |
| 37            | TEST2       | O   |           | Please open state  |
| 48            | TEST3       | I   |           | Please tie down to DGND for normal operation.  |

|                                |
|--------------------------------|
| <b>Absolute Maximum Rating</b> |
|--------------------------------|

AGND, DGND=0V

| Parameter                                    | Symbol                     | min  | Max      | Units |
|--|----------------------------|------|----------|-------|
| Power Supplies                               | Analog<br>VA               | -0.3 | 4.5      | V     |
|  | Digital<br>VD              | -0.3 | 4.5      | V     |
|  | DGND-AGND <br>$\Delta$ GND |      | 0.3      | V     |
| Input Current (any pins except for supplies) | IIN                        | -    | $\pm$ 10 | mA    |
| Analog Input Voltage                         | VINA                       | -0.3 | VA+0.3   | V     |
| Digital Input Voltage                        | VIND                       | -0.3 | VD+0.3   | V     |
| Ambient Temperature                          | Ta                         | 0    | 70       | °C    |
| Storage Temperature                          | Tstg                       | -40  | 125      | °C    |

Note 1. All voltages with respect to ground

Warning: Operation at or beyond these limits may result in permanent damage to the device. Normal operation is not guaranteed at these extremes.

|  |
|--|
| <b>Recommended Operating Condition</b> |
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AGND, DGND=0V

| Parameter      | Symbol        | min | typ | Max | Units |
|----------------|---------------|-----|-----|-----|-------|
| Power Supplies | Analog<br>VA  | 3.0 | 3.3 | 3.6 | V     |
|                | Digital<br>VD | 3.0 | 3.3 | 3.6 | V     |

All voltages with respect to ground.

\* AKM assumes no responsibility for usage beyond the conditions set forth in this datasheet.



**Filter Characteristics**

Ta=25°C, VA=VD=3.3V, fs=44.1kHz

| Parameter                                  | min  | typ       | max   | Units |
|--|------|-----------|-------|-------|
| <b>ADC Digital Filter (Decimation LPF)</b> |      |           |       |       |
| Pass band ( $\pm 0.2$ dB)                  | 0    |           | 17.64 | kHz   |
| Stop band                                  | 26.5 |           |       | kHz   |
| Stop band Attenuation                      | 70   |           |       | dB    |
| Group Delay                                |      | 0.363     |       | ms    |
| <b>ADC Digital Filter (HPF)</b>            |      |           |       |       |
| Frequency Response: -3dB                   |      | 6.89      |       | Hz    |
| -0.5dB                                     |      | 19.3      |       |       |
| -0.1dB                                     |      | 44.9      |       |       |
| <b>DAC Digital Filter</b>                  |      |           |       |       |
| Pass band ( $\pm 0.2$ dB)                  | 0    |           | 17.64 | kHz   |
| Stop band                                  | 26.5 |           |       | kHz   |
| Stop band Attenuation                      | 70   |           |       | dB    |
| Group Delay                                |      | 0.312     |       | ms    |
| <b>DAC Analog Post filter</b>              |      |           |       |       |
| Pass band Frequency Response               | -    | $\pm 0.1$ | -     | dB    |



|                                   |
|-----------------------------------|
| <b>Digital DC Characteristics</b> |
|-----------------------------------|

Ta=0 - 70°C; VD=3.0 - 3.6V; DGND=0V Measurement under static state

All digital pins except DP, DN. Schmitt hysteresis level of RSTN pin and levels of all test pins will not be tested.

| Parameter  | Symbol | Min   | Typ | Max   | Units |
|--|--------|-------|-----|-------|-------|
| EPDI,EPEN, EPSEL, pin "H" level input voltage                        | VIH    | 70%VD |     |       | V     |
| EPDI, EPEN, EPSEL pin "L" level input voltage                        | VIL    |       |     | 30%VD | V     |
| RSTN pin "H" level voltage   | VIHR   | 2.4   |     |       | V     |
| RSTN pin "L" level voltage   | VILR   |       |     | 0.8   | V     |
| IMUTE, OMUTE, INC, DEC pin "H" level voltage                         | VIHR   | 2.4   |     |       | V     |
| IMUTE, OMUTE, INC, DEC pin "L" level voltage                         | VILR   |       |     | 0.8   | V     |
| SUSN, EPSW, STBY, EMSW, MSTAT pin "H" level output voltage IOH= 2mA  | VOH    | 2.4   |     |       | V     |
| SUSN, EPSW, STBY, EMSW, MSTAT pin "L" level output voltage IOL= -2mA | VOL    |       |     | 0.6   | V     |
| CS, SK, EPAO pin "H" level output voltage IOH= 2mA                   | VOH    | 2.4   |     |       | V     |
| CS, SK, EPAO pin "L" level output voltage IOL= -2mA                  | VOL    |       |     | 0.6   | V     |
| DP, DN Single Ended Receiver Threshold for "H" level                 | VIHR   | 2.0   |     |       | V     |
| DP, DN Single Ended Receiver Threshold for pin "L" level             | VILR   |       |     | 0.8   | V     |
| Input Leakage Current  | Iin    |       |     | ±10   | μA    |
| Pull down Resistance (only EPDI pin)@3.3V Ta=25°C                    | Rpd    |       | 100 |       | kΩ    |

|                                  |
|----------------------------------|
| <b>Switching Characteristics</b> |
|----------------------------------|

Ta=25°C, VA=VD=3.3V

| Parameter   | Symbol   | Min    | Typ    | Max | Units |
|---|----------|--------|--------|-----|-------|
| Master Clock Frequency  | MCLK     | -      | 12.000 | -   | MHz   |
| Reset input width @RSTN pin(low active)   | Wrst     | 1.0    |        |     | us    |
| Time Width for USB Reset Signal Recognition<br>DP<VseL & DN< VseL to USB Reset mode                           | Trst_rec | 3.0    |        |     | μs    |
| Device Ready Time from USB Reset<br>After releasing from USB Reset to Device Ready<br>(Transaction can start) | Tdrr     |        |        | 10  | ms    |
| Time Width for Suspend Recognition<br>Idle state ( DP > VseL & DN < VseL )<br>to Suspend mode                 | Tsus_rec | 4.36   |        |     | ms    |
| Resume Time from Suspend<br>First flip of DP/DN from Idle state<br>To Device Ready*)                          | Tresm    |        |        | 30  | ms    |
| Imute input width with @IMUTE pin(High active)  | Wimute   | 10.005 |        |     | ms    |
| Omute,Dec,Inc input width with @OMUTE,DEC,INC<br>pin (High active)  | Wodi     | 2.001  |        |     | ms    |

Device Ready: VREF, X'tal oscillator and PLL are stable and standard bus transactions can proceed

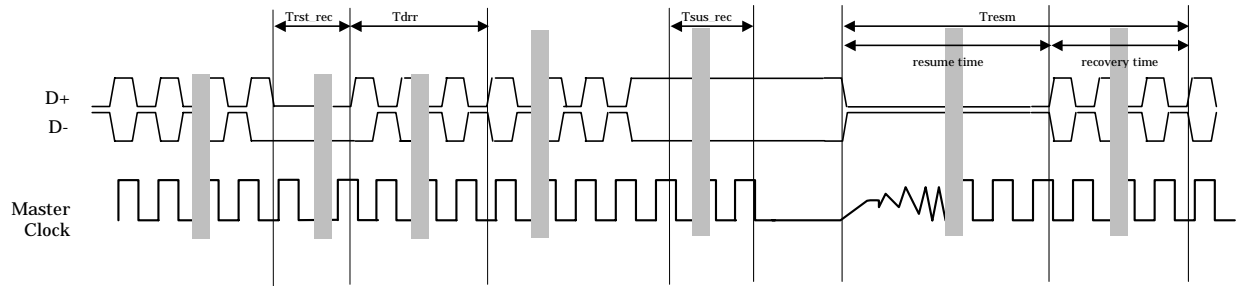


Figure 1. Mode Change with respect to Bus States

| Transmitter/Receiver Characteristics |         |        |                               |       |      |       |       |
|--------------------------------------|---------|--------|-------------------------------|-------|------|-------|-------|
| Ta=25°C; VD=3.3V; DGND=0V; CL=50pF   |         |        |                               |       |      |       |       |
| Parameter                            | Symbol  | Pins   | Conditions                    | Min   | Typ  | Max   | Units |
| Transmitter                          |         |        |                               |       |      |       |       |
| Data Rate                            | DR      | DP, DN |                               | 11.97 | 12   | 12.03 | MHz   |
| Output Impedance (Hi)                | Roh     | DP, DN | DP, DN="H"<br>at Iout = -10mA |       | 36   |       | Ω     |
| Output Impedance (Lo)                | Rol     | DP, DP | DP, DN="L"<br>at Iout = 10mA  |       | 36   |       | Ω     |
| "H" level Output Voltage             | Vohd    | DP, DN | at Iout = -200uA              | 2.8   |      |       | V     |
| "L" level Output Voltage             | Vold    | DP, DN | at Iout = 2.2mA               |       |      | 0.3   | V     |
| Tri-state Leakage Current            | Iolk    | DP, DN | 0 < DP, DN < 3.3V             | -10   |      | 10    | μA    |
| Rise/Fall Time                       | Trf/Tff | DP, DN |                               | 4     | 10   | 20    | ns    |
| Rise/Fall Time Matching              | Trfm    | DP, DN |                               |       | 100  |       | %     |
| Crossover Point                      | Vcrs    | DP, DN |                               |       | 1.65 |       | V     |
| Receiver                             |         |        |                               |       |      |       |       |
| Input Common Mode range              | CMR     | DP, DN |                               | 0.8   |      | 2.5   | V     |
| Differential Input Level             | Vdiff   | DP, DN | DP - DN                       | 0.2   |      |       | V     |

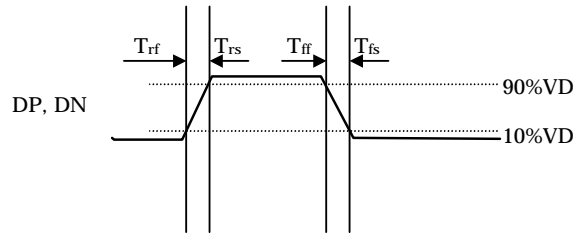


Figure 2. Rise/Fall Time

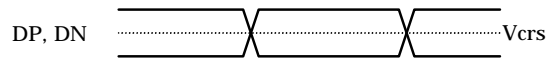


Figure 3. Crossover Point

## 1 Device Overview

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### 1.1 PLL and Sampling Rates

The AK4571 has three PLLs in addition to a crystal oscillation circuit. The first PLL generates a system clock at 48MHz, the second PLL generates the clock for 44.1kHz sample rates (including derivatives of this sample rate) and third PLL generates the clock for 48kHz sample rates (including derivatives).

The CODEC clocks are generated from the USB SOF, so they are synchronized with USB SOF. The ADC and DAC operate at one of seven sampling rates, 8kHz, 11.025kHz, 16kHz, 22.05kHz, 32kHz, 44.1kHz, and 48kHz. The ADC and DAC can operate at different sampling rates.

### 1.2 A/D Converter & D/A Converter

The AK4571 has a 16-bit single-channel A/D converter, and a 16-bit two-channel D/A converter. The AK4571 has a programmable gain amplifier for the analog input (IPGA) with a range from  $-31\text{dB}$  to  $+24\text{dB}$  in 1dB steps. In addition to the IPGA, the AK4571 has a fixed 20dB gain pre-amplifier. Therefore the total gain of the analog input is  $+44\text{dB}$  maximum. Analog output can be attenuated from 0dB to 47dB in 1dB steps. Analog input and the D/A signal can be mixed in the chip and sent to the Line outputs. The Lineout volume, the microphone playback volume, and the microphone recording volume can be controlled directly from the PC

### 1.3 Bass Boost Control

The AK4571 has an analog bass boost circuit, and can boost the bass frequencies of the lineout signal by up to 20dB. Frequency response and DC gain are adjusted by external resistors and capacitors. The Bass boost effect is controlled via the HID application.

### 1.4 Serial Interface Engine (SIE) & Audio Class Processing Block

The AK4571 has a Serial Interface Engine that processes lower-level protocols like CRC checking, bit stuffing, NRZI encoding/decoding, in addition to higher-level protocol like USB standard requests. SIE also notifies the backend that it has received an Audio Class Request, and passes the request to the backend. The backend decodes and processes Audio Class Request like mute requests, volume requests and sampling frequency control requests. Therefore, the AK4571 does not require a micro-controller for this processing.

### 1.5 HID (Human Interface Device)

Since the AK4571 supports HID function, mute and volume can be controlled remotely. The host knows whether the playback volume/mute button has been pressed or not by issuing an Interrupt Request periodically, and notifies the application that the status has changed. The software application issues the volume/mute request in order to synchronize the software with the AK4571. Input/Recording signals can be also muted independently of the software application.

### 1.6 EEPROM I/F

The AK4571 has all of its descriptors in its internal ROM, so it does not require external an EEPROM. However vendor ID, vendor name, product ID, and product name can be also customized by using an external Microwire interface EEPROM. A Microwire™ type, 1K, 2K, or 4K EEPROM can be used.

### 1.7 Power Management

The AK4571 starts its transition to suspend mode when the idle state of USB bus continues more than 3ms. The AK4571 suppresses the power-supply current (typ.1uA) while in suspend mode because all blocks, including PLLs, are placed in power-down mode. Under normal operation the AK4571 supplies a bias voltage via the output buffer to the microphone. In suspend mode, the MICBIAS pin goes to a Hi-Z state, and the AK4571 does not supply this current to the microphone.

The AK4571 also has 3 pins for control of an external headphone amplifier. These pins are used to suppress the power-supply current during suspend mode in addition to suppressing “pop noise” during the transition of suspend/resume. The AK4571 has two pins for power-control because there are “active high” types and “active low” types of external headphone amplifiers. Third pin is for the mute control to suppress transitional pop noise.

The USB bus consumes 200uA current even in suspend mode. A regulator also consumes current in standby mode. Even with these devices consuming power the system can still conform to the 500uA USB specification because of the AK4571 low-power consumption and its control of the microphone and headphone power circuits.

The AK4571 is ready for operation 30ms after transitioning from suspend mode to normal operating mode.

### 1.8 USB Transceiver

The AK4571 includes a USB transceiver.

## 2 Functional Description

### 2.1 Synchronization of the host and the AK4571

The ADC and DAC in the AK4571 operate synchronously with the SOF (Start of frame) of the USB bus. USB's Isochronous transfer guarantees that audio stream data is transferred once per frame. However, USB does not specify the start point of the transfer in a frame. The worst-case period between two transfers is about 2ms, therefore the AK4571 has a FIFO that stores 2ms audio stream data.

If the CODEC operates at 44.1kHz sampling frequency, the AK4571 expects that 45 samples are transferred once per 10 frames. (Please see Figure 4)

The average sampling frequency in Figure 4 is 44.1kHz.

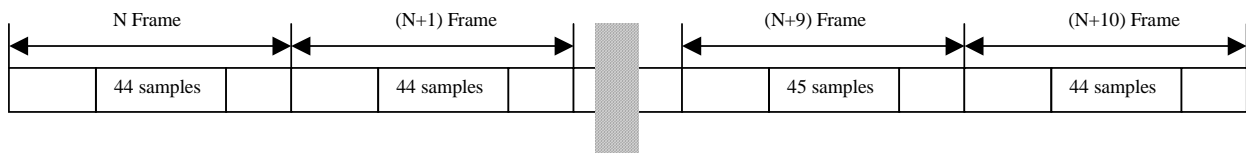


Figure 4 Synchronization Scheme

The AK4571 transmits all A/D data stored to FIFO in the previous frame while updating the A/D data to FIFO in the current frame. The sample count of 48kHz series D/A data per frame is fixed in all frames. For 44.1kHz, the appearance of 45 samples should be just one time per 10 frames. If the D/A clock and SOF clock operated asynchronously, the FIFO would overrun or underrun, and an audible pop noise would occur periodically. Therefore, CODEC clocks are synchronized with SOF clock. In order to achieve this synchronization, the AK4571 has built-in two PLLs for CODEC clocks and generates clocks for both of 48kHz sample rate series and 44.1 sample rate series.

### 2.2 Power Management

USB devices fall into one of three power categories: 1) Low-power Bus-powered Devices (<100mA) 2) High-power Bus-powered Devices (>100mA, <500mA) 3) Self-powered Devices.

As the AK4571 is a low-power consumption device, it can be defined as a Low-power Bus-powered Device and can be connected to a bus-powered Hub. (High-power Bus-powered Devices can't be connected to a Bus-powered Hub)

USB specifications require a maximum of 500µA in suspend mode. This includes the current drawn between Vbus and ground through the 1.5 k ohm resistor tied to D+ line and Vbus. This current is about 200µA.

Two points should be considered in order to observe the USB suspend mode specification.

- a) Suppression of the AK4571 current
  - All blocks including ADC, DAC, PLL go to power-down mode when the idle state continues for more than 3ms. Values like volume and mute status are preserved in suspend mode.
- b) Control of External Circuits
  - The USB specification does not permit more than 500µA of current in suspend mode. Therefore, the AK4571 must control the power dissipation of the external headphone amplifier and microphone. Since the MICBIAS pin is in a Hi-Z state in suspend mode, the AK4571 does not supply current to the microphone.

Headphone Amplifiers commonly have power-down pin and can be controlled externally. There are two types of power-control logic; active-low and active-high. Some headphone amplifiers have a mute pin for suppressing pop noise. The AK4571 supports all of these headphone amplifiers.

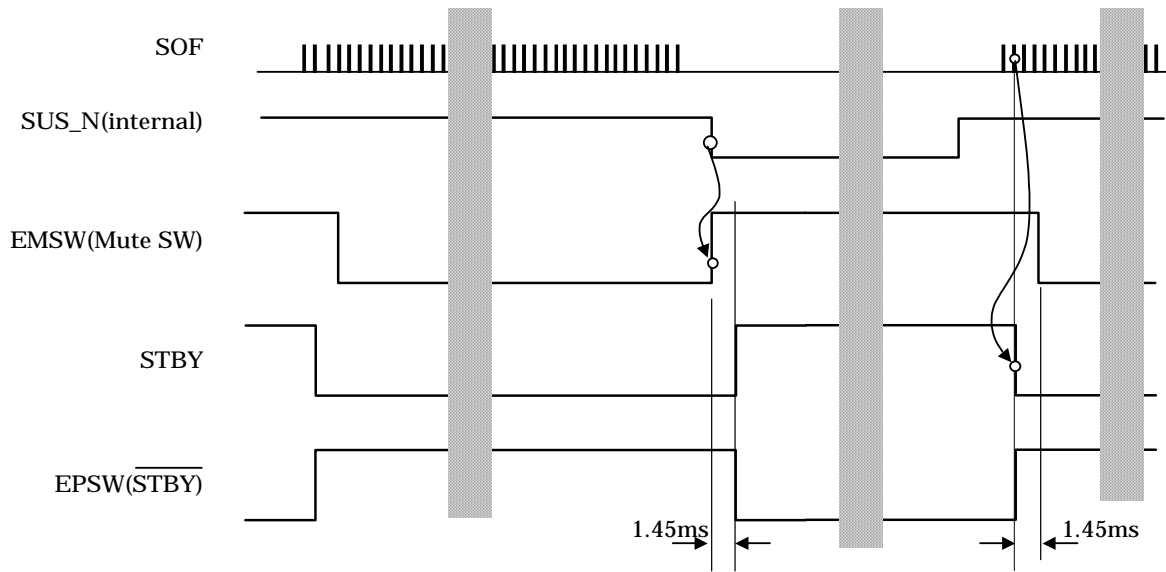


Figure 5 Suspend and Resume Sequence

**2.3 Bias Circuit for Microphone**

The AK4571 supplies a bias voltage to the microphone through the MICBIAS pin. The output voltage is about 2.2 volts and output current is 2mA maximum. Since the microphone's output signal level is very low, the noise level of the bias voltage should also be low. USB bus transactions typically cause variation of the regulator's output. However, the AK4571 has a built-in voltage reference for mic bias, and suppresses the bias noise caused by the regulator.

Coupling capacitors should be connected in parallel between the two resistors (i.e. Ra=300Ω, and Rb=4.7kΩ/2.2kΩ) in order to make the bias circuit stable. The appropriate value, Rb, depends on the microphone 's characteristics.

The output is placed in a Hi-Z state in suspend mode.

**2.4 EEPROM Interface**

The AK4571 has all descriptors, including String Descriptors, in its internal ROM so it does not require an external EEPROM. The AK4571 also has an EEPROM interface so that an external EEPROM can be attached for customizing Vendor ID, Product ID, vendor name and product name.

The EPEN pin should be "L" if the EEPROM is not used. CS, SK, EPAO pins are at a Hi-Z state in this configuration. Please see "Descriptors in Detail" section for internal ROM information.

The EPEN pin should be "H" if an external EEPROM is used. The AK4571 reads the Device Descriptor from the EEPROM after a USB Reset. The AK4571 starts to read String Descriptor just after receiving "GET Descriptor (String)" request.

With the AK4571 you can customize the following fields:

- 1) Device Descriptor (18 bytes)
- 2) String Descriptor (Language ID, Manufacturer Name, Product Name)

Microwire type (4 wire) , 1K/2K/4K bit EEPROM can be used (for example, AK93C45A/55A/65A)

If a 1Kbit EEPROM is selected, the length of Manufacturer name or Product name should be just 50 bytes. As each String Descriptor requires 2-bytes of length information, the total length of each String Descriptor is 52 bytes. If a 2K/4K bit EEPROM is selected, the length of Manufacturer name or Product name should be just 100 bytes. As each String Descriptor requires 2-bytes of length information, the total length of each String Descriptor is 102 bytes. If a 1K bit EEPROM is used, EPSEL pin should be "L" while EPSEL pin should be "H" for a 2K/4K EEPROM.

The length in both cases should be exactly 52 bytes or 102 bytes, no longer, no shorter.

Table 1 shows the relationship between EEPROM address and Descriptor.

|   | 1K bit EEPROM<br>(AK93C45A) | 2K/4K bit EEPROM<br>(AK93C55A/65A) |
|---|-----------------------------|------------------------------------|
| Device Descriptor (18 bytes)                                | 00h -08h                    | 00h-08h                            |
| String Descriptor Lang ID (4 bytes index = 0)               | 09h -0Ah                    | 09h-0Ah                            |
| String Descriptor iManufacturer (52 or 102 bytes: index =1) | 0Bh-24h-                    | 0Bh-3Dh                            |
| String Descriptor iProduct (52 or 102 bytes: index = 2)     | 25h-3Eh                     | 3Eh-71h                            |

**Table 1 Relationship between EEPROM Address and Descriptor**

Since the AK4571 cannot write data to the EEPROM, the EEPROM should be mounted on the PCB after it has been programmed with the necessary data. Please refer to the AKM EEPROM datasheet for the write sequence. If EEPROM is not used (EPEN = "L"), an EEPROM should not be mounted on the PCB because the CS, CK and EPAO outputs are Hi-Z when EPEN = "L".



2.5 Bass Boost

The AK4571 has an analog bass boost that is activated by mounting a resistor and a capacitor between LBFO-LBFI, and RBFO-RBFI respectively as Figure 6 shows. Bass frequencies can be amplified up to 20dB by selecting an appropriate resistor. Cut-off frequency shifts as the capacitor value varies.

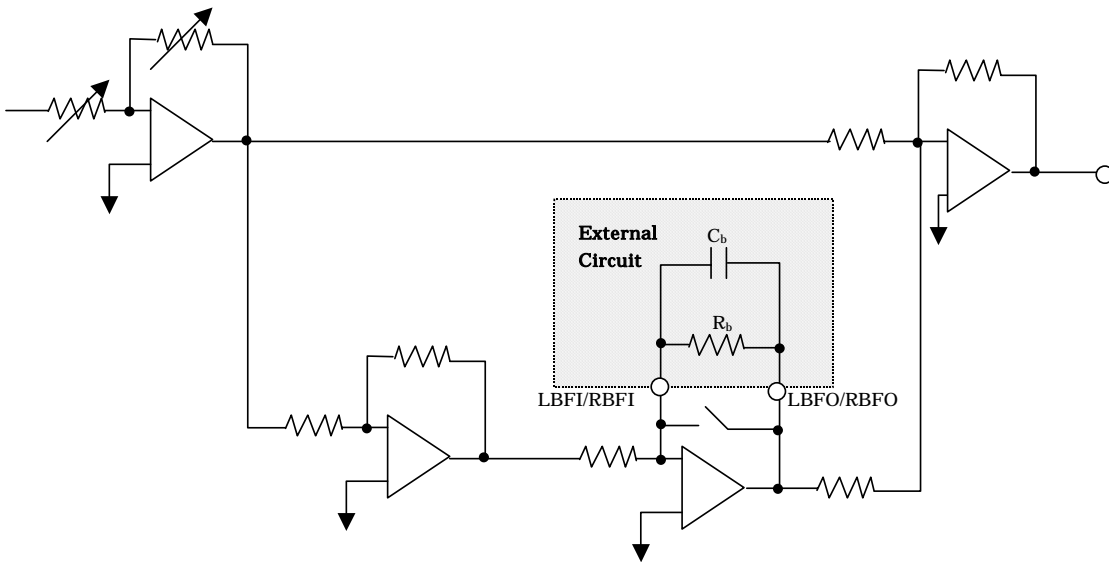


Figure 6 Analog Bass Boost Circuit

Bass Boost

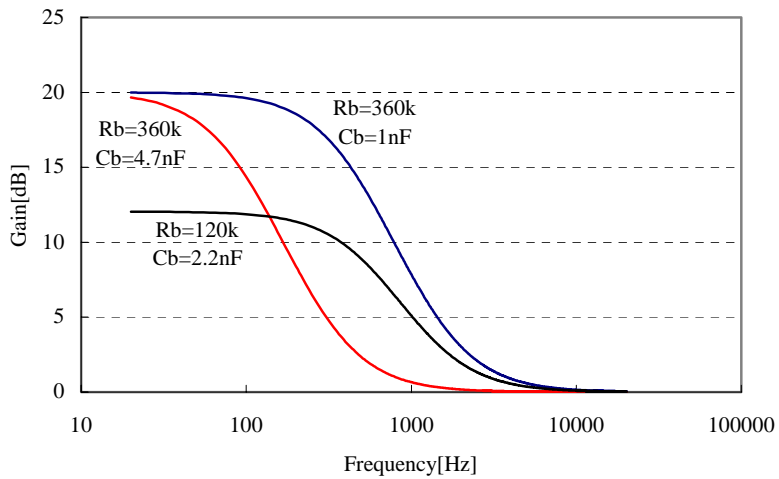


Figure 7 Bass Boost Characteristics

**2.6 HID (Human Interface Device)**

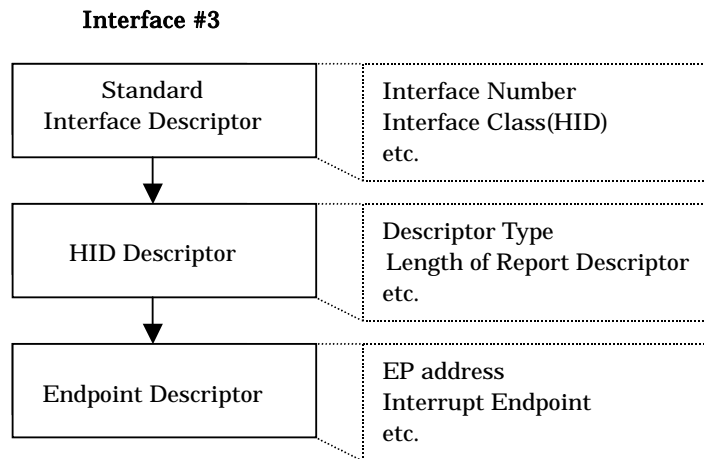
**2.6.1 HID Overview**

The AK4571 has two pins for incrementing or decrementing the lineout volume (INC pin and DEC pin), and has a pin for the control of mute (OMUTE pin). For example, the lineout volume slider in a Windows application automatically moves up at the rising edge of INC pin. This means that the value in the Windows program is synchronized with the device's hardware value.

If a button is pressed, the internal bit assigned to it is set to "1". Based on the USB spec for HID, the host knows whether the INC button and/or DEC button and/or OMUTE buttons are pressed or not by periodically issuing an Interrupt transfer request. The AK4571 notifies the host of the status change, but does not change the value itself. The application program changes the value by issuing a SET FEATURE REQUEST.

**2.6.2 HID Details**

The AK4571 has Interface (#3) and Interrupt Endpoint (#4: 1 byte) commands for HID. Figure 8 shows hierarchy of HID Interface.

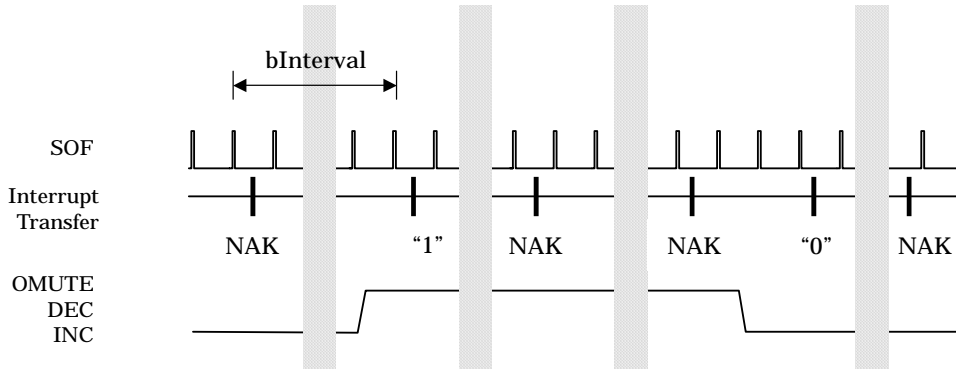


**Figure 8 Hierarchy of HID Interface**

Interrupt Endpoint is 1 byte, and lower 3 bits are valid.

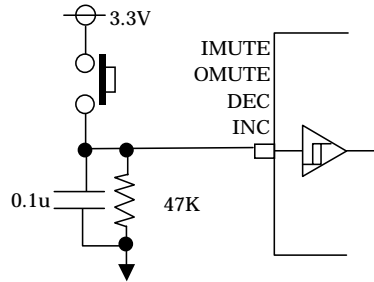
| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|-------|-------|-------|-------|-------|-------|-------|-------|
| "0"   | "0"   | "0"   | "0"   | "0"   | OMUTE | DEC   | INC   |

Internal bits[2:0] are set to "1" at the rising edge of OMUTE, INC or DEC pins, and are cleared to "0" at the falling edge of these respective pins. The AK4571 transmits 1 byte of data through the Interrupt Pipe. If none of the buttons are pressed or if a button is continually pressed, the AK4571 sends NAK to the host.



**Figure 9 Interrupt Transfer Timing**

illustrates a switch de-bounce circuit (highly recommended)



**Figure 10 Switch De-Bounce Circuit**

Figure 10 illustrates a switch de-bounce circuit (highly recommended)

If HID function is not used, please connect OMUTE pin, DEC pin, INC pin, to DGND.

**2.6.3 IMUTE pin and MSTAT pin**

The AK4571 has an IMUTE pin for mute control of the recording path. Mute status toggles on the rising edge of the IMUTE pin. Note that pressing a physical button connected to IMUTE changes the internal state. This may cause an inconsistent mute state between the device and the Windows application. MSTAT pin reflects the actual mute status of the device. This limitation comes from the fact that the Windows OS does not support HID audio for recording. The MSTAT pin is forced to “L” in suspend mode regardless of previous state.

MSTAT = (Internal IMUTE status) & SUS\_N;  
 Normal Operation: “H” -> Mute ON  
 “L” -> Mute OFF  
 Suspend State: “L”

Figure 10 illustrates a switch de-bounce circuit (highly recommended)

If IMUTE pin is not used, please connect it to DGND.

**2.7 Audio Format**

The AK4571 supports only the 16-bit, 2's compliment audio format, and outputs LSB first.

1) 16bit mono data format on the USB (A/D data)

| Sample #     | #1             |                | #2            |                | #3             |                | ... |
|--------------|----------------|----------------|---------------|----------------|----------------|----------------|-----|
|              | mono           |                | mono          |                | mono           |                | ... |
|              | Lower<br>8 bit | Upper<br>8 bit | Lower<br>8bit | Upper<br>8 bit | Lower<br>8 bit | Upper<br>8 bit | ... |
| bit position | 0-7            | 8-15           | 0-7           | 8-15           | 8-15           | 8-15           | ... |

2) 16bit stereo data format on the USB (D/A data)

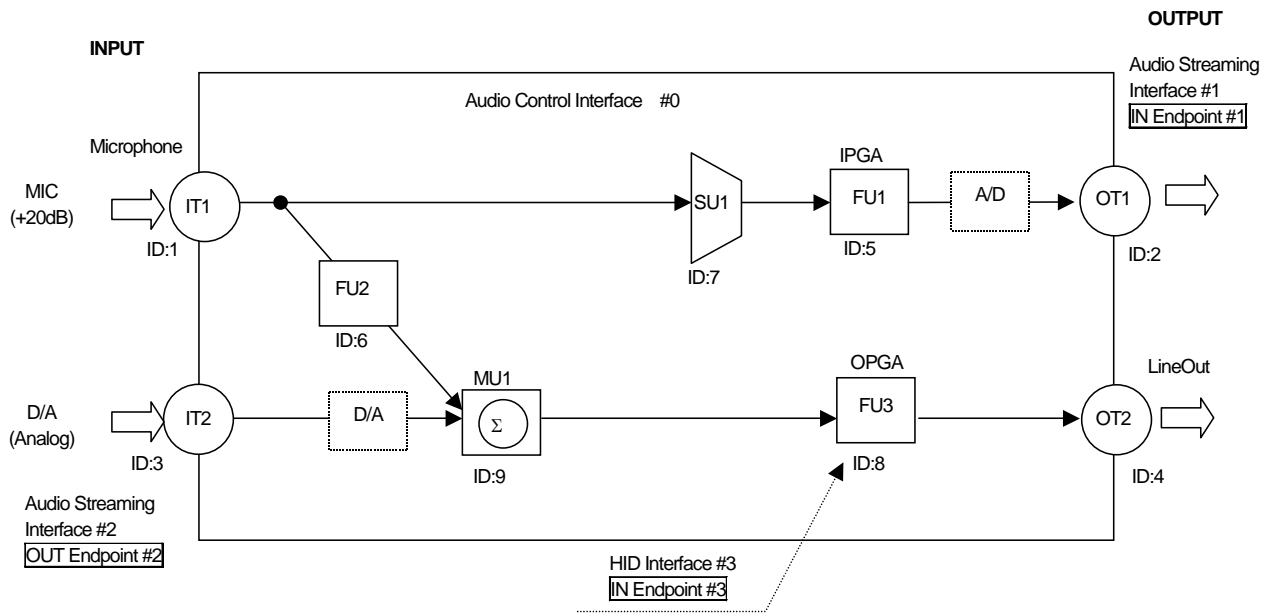
| Sample #     | #1                |                |                    |                | #2                |                |                    |                | ... |
|--------------|-------------------|----------------|--------------------|----------------|-------------------|----------------|--------------------|----------------|-----|
|              | Left channel data |                | Right channel data |                | Left channel data |                | Right channel data |                | ... |
|              | Lower<br>8 bit    | Upper<br>8 bit | Lower<br>8 bit     | Upper<br>8 bit | Lower<br>8 bit    | Upper<br>8 bit | Lower<br>8bit      | Upper<br>8 bit | ... |
| bit position | 0-7               | 8-15           | 0-7                | 8-15           | 0-7               | 8-15           | 0-7                | 8-15           | ... |

**2.8 Device topology and function**

USB audio devices must report their capabilities to the host and must report the topology that describes the connections between blocks. Figure 11 shows the topology of the AK4571.

The host obtains the capabilities and connection diagram from the device by reading the Audio Control (AC) Interface Descriptor. The volume, mute, and sampling rate are controlled via Audio Class Specific Requests.

- 1) IN Endpoint#1 for A/D data is related to the MIC signal that is described as [OT1]. The MIC signal is amplified via FU1 and is digitized by the A/D converter and transmitted to the host.
- 2) OUT Endpoint#2 for D/A data is related to the Lineout. The D/A analog signal is mixed with the MIC analog signal that is amplified through FU2. The mixed analog signal can be attenuated/boosted by FU3, and is output via Lineout.
- 3) Endpoint#3 for HID is related to playback mute and volume up/down.



**Figure 11 AK4571 Topology**

**2.8.1 Terminal/Units**

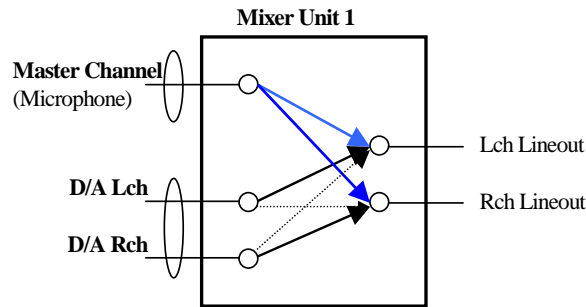
- a) Input Terminal (IT)  
IT is abbreviation of Input Terminal: IT1 (Microphone Input ID:1), IT2 (D/A Input ID:3)
- b) Output Terminal (OT)  
OT is abbreviation of Output Terminal: OT1(A/D Output ID:2), OT2 (Lineout ID:4)
- c) FU (Feature Unit)

The FU (Feature Unit) describes that the AK4571 has volume/mute/bass-boost functions by setting the **bmaControls(0)**, **bmaControls(1)** , **bmaControls(2)** to “1”. The bit position assigned to the bass-boost function is D8, the length of **bcontrolSize** for FU3 is 0x02, and others are 0x01.

**bmaControl(0)** means master channel. The AK4571 controls DAC mute or bass-boost via the master channel, and controls DAC volume via channel 1 and channel 2 controls. Since the AK4571 input is a single-channel, it controls both ADC mute and volume via the master channel.

- e) MU (Mixer Unit)

The MU (Mixer Unit) describes mixing and volume control functions. Each input channel is connected to all output channels per the USB Audio Class specification shown in Figure 12. Only mixing function is available in the AK4571 because the volume is controlled via Feature Unit. Therefore, bitmap of **bmControl** in Mixer Unit Descriptor is all “0”.



**Figure 12 Channel Connection**

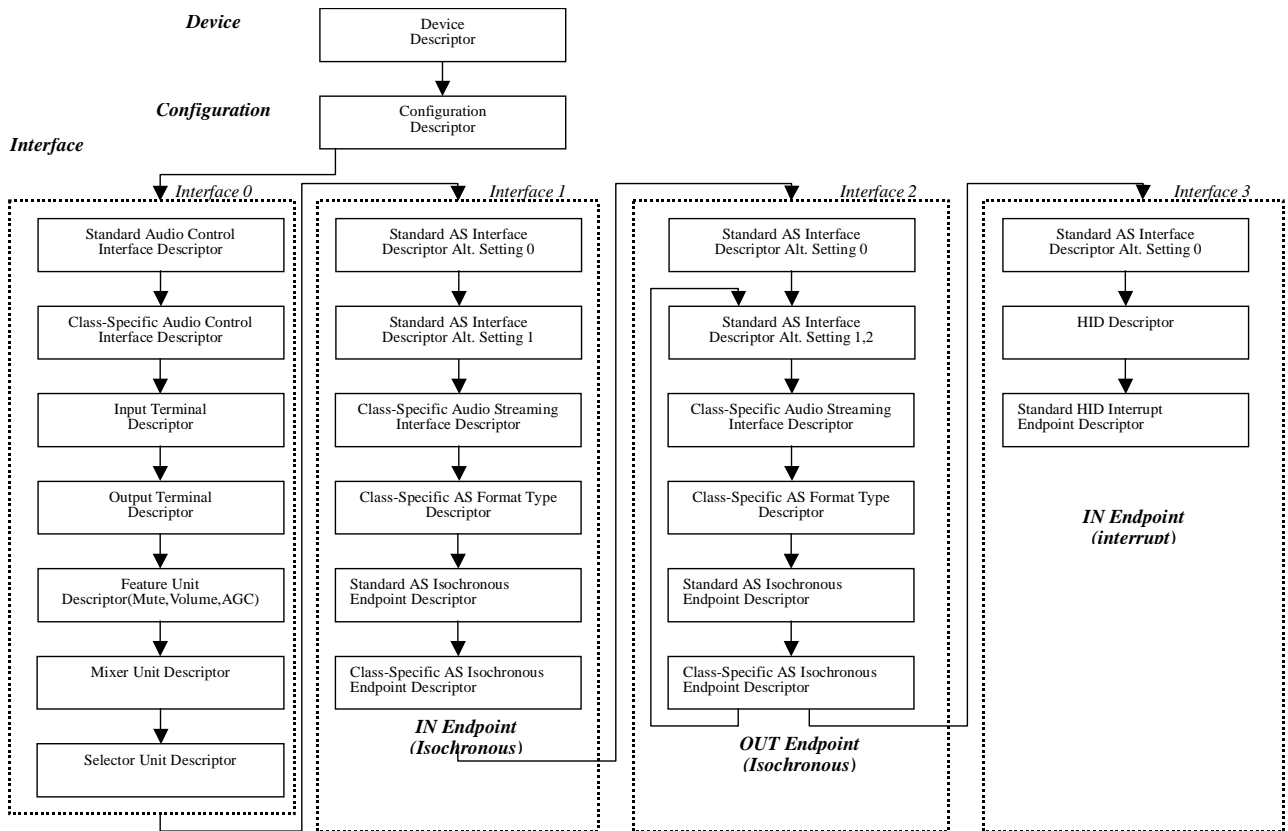
- f) SU (Selector Unit)

Selector Unit is unnecessary for the AK4571's topology. Windows application does not display playback MIC volume slider if the AK4571 does not define Selector Unit.

**2.8.2 Descriptor Overview**

When the AK4571 is connected to the USB bus, the host assigns unique address to the device first, and starts reading of the device’s information via a default pipe. Descriptors consist of (1) Device Descriptor, (2) Configuration Descriptor, (3) Interface Descriptor, (4) Endpoint Descriptor.

The AK4571 is defined as a device with one configuration and four interfaces. It has one Endpoint (EP) for Interface#0, one EP for Interface#1 (ADC), one for Interface#2 (DAC), and one for Interface#3 (HID)



**Figure 13 Descriptor Hierarchy**

**■ Device Descriptor**

Device Descriptor includes product name, manufacturer name, product revision, etc. And it also includes the number of configurations (The AK4571 is a one configuration device).

**■ Configuration Descriptor**

Configuration Descriptor includes the device type, which is described as bus-powered device or self-powered device, power consumption, number of interfaces, etc. The AK4571 is defined as a low-power bus-powered device with four interfaces.

**■ Interface Descriptor**

The AK4571 has four interfaces as follows.

- a) Audio Control (AC) Interface
- b) Audio Streaming (AS) Interface1 for A/D converter
- c) Audio Streaming (AS) Interface2 for D/A converter
- d) HID Interface for Mute & Volume Control

AC Interface includes topology information, Input/Output Terminal information, and Function information in addition to the standard Class Interface Descriptor.

AS Interface also includes audio format and sampling frequencies.

The AK4571 has two alternates for Interface#1 (ADC), and Interface#2 (DAC). The default state is Alt0, and Alt 0 does not occupy USB bandwidth.

Alt 1 is used as the interface for audio streaming data. The bandwidth occupied by A/D data and D/A data are 100 bytes and 200 bytes respectively, and each value is described in the **wMaxPacketSize** field in the Standard Endpoint Descriptor in each interface.

**■ Endpoint Descriptor**

Endpoint 0 (EP0: default pipe) is used for AC Interface. The EP for the AS interface includes IN/OUT, synchronization type, maximum packet length, etc.

The AK4571 also has one Interrupt Endpoint for the HID Interface. The AK4571 returns one byte of information at the Interrupt transfer just after the playback volume or mute buttons are pressed. If no buttons are pressed, the AK4571 returns NAK.



### 3 Descriptors in Detail

---

#### 3.1 Device Descriptor

| Offset | Field              | Size | Value  | Description   |
|--------|--------------------|------|--------|---|
| 0      | bLength            | 1    | 0x12   | Size of this descriptor in bytes                              |
| 1      | bDescriptorType    | 1    | 0x01   | DEVICE descriptor   |
| 2      | BcdUSB             | 2    | 0x0110 | 1.10 - current revision of USB spec.                          |
| 4      | bDeviceClass       | 1    | 0x00   | Device defined at Interface level                             |
| 5      | bDeviceSubClass    | 1    | 0x00   | Unused  |
| 6      | bDeviceProtocol    | 1    | 0x00   | Unused  |
| 7      | bMaxPacketSize0    | 1    | 0x08   | 8 bytes   |
| 8      | IdVendor           | 2    | 0x0556 | AKM's Vendor ID   |
| 10     | IdProduct          | 2    | 0x0004 | Upper 00 means Audio Product<br>Lower 03 means AKM product ID |
| 12     | bcdDevice          | 2    | 0x0100 | Device release code   |
| 14     | IManufacturer      | 1    | 0x01   | “ AKM ”   |
| 15     | Iproduct           | 1    | 0x02   | “ AK4571”   |
| 16     | ISerialNumber      | 1    | 0x00   | Unused  |
| 17     | bNumConfigurations | 1    | 0x01   | One configuration   |

Table Device Descriptor

#### 3.2 Configuration Descriptor

| Offset | Field               | Size | Value  | Description   |
|--------|---------------------|------|--------|---|
| 0      | Blength             | 1    | 0x09   | Size of this descriptor   |
| 1      | bDescriptorType     | 1    | 0x02   | CONFIGURATION descriptor  |
| 2      | WTotalLength        | 2    | 0x011C | length of entire configuration block<br>total 284 bytes including this interface<br>descriptor. |
| 4      | BnumInterfaces      | 1    | 0x04   | Four interfaces   |
| 5      | bConfigurationValue | 1    | 0x01   | index of this configuration   |
| 6      | IConfiguration      | 1    | 0x00   | null string   |
| 7      | BmAttributes        | 1    | 0x80   | supports Bus Powered Device   |
| 8      | MaxPower            | 1    | 0x31   | 98mA  |

### 3.3 Interface Descriptor # 0

#### 3.3.1 Standard Audio Control Interface Descriptor

| Offset | Field              | Size | Value | Description                  |
|--------|--------------------|------|-------|------------------------------|
| 0      | bLength            | 1    | 0x09  | Size of this descriptor      |
| 1      | bDescriptorType    | 1    | 0x04  | INTERFACE descriptor         |
| 2      | bInterfaceNumber   | 1    | 0x00  | Index of this interface      |
| 3      | bAlternateSetting  | 1    | 0x00  | Index of this setting        |
| 4      | bNumEndpoints      | 1    | 0x00  | only uses Endpoint 0         |
| 5      | bInterfaceClass    | 1    | 0x01  | AUDIO                        |
| 6      | bInterfaceSubclass | 1    | 0x01  | AUDIO_CONTROL                |
| 7      | bInterfaceProtocol | 1    | 0x00  | not vendor or class specific |
| 8      | IInterface         | 1    | 0x00  | null string                  |

Table Standard Interface Descriptor

#### 3.3.2 Class-Specific Audio Control Interface Descriptor

| Offset | Field              | Size | Value  | Description   |
|--------|--------------------|------|--------|---|
| 0      | BLength            | 1    | 0x0A   | Size of this descriptor   |
| 1      | bDescriptorType    | 1    | 0x24   | CS_INTERFACE  |
| 2      | bDescriptorSubtype | 1    | 0x01   | HEADER subtype  |
| 3      | BcdADC             | 2    | 0x0100 | Revision of class specification – 1.00  |
| 5      | wTotalLength       | 2    | 0x0065 | Total size of class-specific Audio Control Interface descriptors 101 bytes (includes this descriptor) |
| 7      | binCollection      | 1    | 0x02   | The number of streaming interfaces  |
| 8      | baInterfaceNr(0)   | 1    | 0x01   | Streaming interface number 1 belongs to this audio control interface. IN Interface                    |
| 9      | baInterfaceNr(1)   | 1    | 0x02   | Streaming interface number 2 belongs to this audio control interface. OUT Interface                   |

**3.3.3 Terminal Descriptor(ID=3)**

D/A Input Terminal

| Offset | Field              | Size | Value  | Description                             |
|--------|--------------------|------|--------|---|
| 0      | Blength            | 1    | 0x0C   | Size of this descriptor                 |
| 1      | BDescriptorType    | 1    | 0x24   | CS_INTERFACE                            |
| 2      | bDescriptorSubtype | 1    | 0x02   | INPUT_TERMINAL subtype                  |
| 3      | BterminalID        | 1    | 0x03   | ID of this terminal                     |
| 4      | WterminalType      | 2    | 0x0101 | Terminal is USB streaming OUT           |
| 6      | BassocTerminal     | 1    | 0x04   | Associated with Output Terminal is 0x04 |
| 7      | BnrChannels        | 1    | 0x02   | Two channel                             |
| 8      | WChannelConfig     | 2    | 0x0003 | Left/Right Front                        |
| 10     | IchannelNames      | 1    | 0x00   | Unused                                  |
| 11     | Iterminal          | 1    | 0x00   | Unused                                  |

**3.3.4 Terminal Descriptor(ID=4)**

Lineout Terminal

| Offset | Field              | Size | Value  | Description                        |
|--------|--------------------|------|--------|------------------------------------|
| 0      | Blength            | 1    | 0x09   | Size of this descriptor            |
| 1      | BdescriptorType    | 1    | 0x24   | CS_INTERFACE                       |
| 2      | bdescriptorSubtype | 1    | 0x03   | OUTPUT_TERMINAL subtype            |
| 3      | BterminalID        | 1    | 0x04   | ID of this terminal                |
| 4      | WterminalType      | 2    | 0x0301 | Terminal is Speaker                |
| 6      | BassocTerminal     | 1    | 0x03   | Associate with Input Terminal 0x03 |
| 7      | BsourceID          | 1    | 0x08   | From Feature Unit (ID8)            |
| 8      | Iterminal          | 1    | 0x00   | Unused                             |

**3.3.5 Terminal Descriptor(ID=1)**

## Analog Microphone Input Terminal

| Offset | Field              | Size | Value  | Description                          |
|--------|--------------------|------|--------|--------------------------------------|
| 0      | Blength            | 1    | 0x0C   | Size of this descriptor              |
| 1      | bDescriptorType    | 1    | 0x24   | CS_INTERFACE                         |
| 2      | bDescriptorSubtype | 1    | 0x02   | INPUT_TERMINAL subtype               |
| 3      | BterminalID        | 1    | 0x01   | ID of this terminal                  |
| 4      | WterminalType      | 2    | 0x0201 | Terminal is Microphone               |
| 6      | BAssocTerminal     | 1    | 0x02   | Associated with Output Terminal 0x02 |
| 7      | BNrChannels        | 1    | 0x01   | One channel                          |
| 8      | WChannelConfig     | 2    | 0x0000 | Mono sets no position bit            |
| 10     | IChannelNames      | 1    | 0x00   | Unused                               |
| 11     | Iterminal          | 1    | 0x00   | Unused                               |

**3.3.6 Terminal Descriptor (ID=2)**

## A/D Output Terminal

| Offset | Field              | Size | Value  | Description                           |
|--------|--------------------|------|--------|---------------------------------------|
| 0      | Blength            | 1    | 0x09   | Size of this descriptor               |
| 1      | BdescriptorType    | 1    | 0x24   | CS_INTERFACE                          |
| 2      | bdescriptorSubtype | 1    | 0x03   | OUTPUT_TERMINAL subtype               |
| 3      | BterminalID        | 1    | 0x02   | ID of this terminal                   |
| 4      | WterminalType      | 2    | 0x0101 | Terminal is USB streaming             |
| 6      | BassocTerminal     | 1    | 0x01   | Associate with Input Terminal is 0x01 |
| 7      | BsourceID          | 1    | 0x05   | From Feature Unit (ID5)               |
| 8      | Iterminal          | 1    | 0x00   | Unused                                |

**3.3.7 Feature Unit Descriptor(ID=5)**

## Microphone Recording Volume Unit

| Offset | Field              | Size | Value | Description                     |
|--------|--------------------|------|-------|---------------------------------|
| 0      | Blength            | 1    | 0x08  | Size of this descriptor         |
| 1      | BdescriptorType    | 1    | 0x24  | CS_INTERFACE                    |
| 2      | BdescriptorSubtype | 1    | 0x06  | FEATURE_UNIT descriptor subtype |
| 3      | BunitID            | 1    | 0x05  | ID of this feature Unit         |
| 4      | BsourceID          | 1    | 0x07  | From Selector Unit              |
| 5      | BcontrolSize       | 1    | 0x01  | One byte Control Array          |
| 6      | bmaControls(0)     | 1    | 0x03  | D0(Mute), D1(Volume) supported  |
| 7      | Ifeature           | 1    | 0x00  | Unused                          |

**3.3.8 Feature Unit Descriptor(ID=6)**

## Microphone Playback Volume Unit

| Offset | Field              | Size | Value | Description                      |
|--------|--------------------|------|-------|----------------------------------|
| 0      | Blength            | 1    | 0x08  | Size of this descriptor          |
| 1      | BdescriptorType    | 1    | 0x24  | CS_INTERFACE                     |
| 2      | BdescriptorSubtype | 1    | 0x06  | FEATURE_UNIT descriptor subtype  |
| 3      | BunitID            | 1    | 0x06  | ID of this feature Unit          |
| 4      | BsourceID          | 1    | 0x01  | From Input Terminal (Microphone) |
| 5      | BcontrolSize       | 1    | 0x01  | One byte Control Array           |
| 6      | bmaControls(0)     | 1    | 0x03  | D0(Mute) D1(Volume) supported    |
| 7      | Ifeature           | 1    | 0x00  | Unused                           |

**3.3.9 Feature Unit Descriptor(ID=8)**

## Lineout Volume/Bass Boost Unit

| Offset | Field              | Size | Value  | Description                                     |
|--------|--------------------|------|--------|---|
| 0      | blength            | 1    | 0x0D   | Size of this descriptor                         |
| 1      | bdescriptorType    | 1    | 0x24   | CS_INTERFACE                                    |
| 2      | bdescriptorSubtype | 1    | 0x06   | FEATURE_UNIT descriptor subtype                 |
| 3      | bunitID            | 1    | 0x08   | ID of this feature Unit                         |
| 4      | BsourceID          | 1    | 0x09   | From Mixer Unit(ID9)                            |
| 5      | BcontrolSize       | 1    | 0x02   | Two byte Control Array                          |
| 6      | bmaControls(0)     | 1    | 0x0101 | D0(Mute) , D8(Bass Boost)is enable for channel0 |
| 8      | bmaControls(1)     | 1    | 0x0002 | D1(Volume) control is enable for channel 1      |
| 10     | bmaControls(2)     | 1    | 0x0002 | D1(Volume) control is enable for channel 2      |
| 12     | IFeature           | 1    | 0x00   | Unused  |

**3.3.10 Mixer Unit Descriptor(ID=9)**

Mixer Unit (D/A and Microphone)

| Offset | Field              | Size | Value  | Description   |
|--------|--------------------|------|--------|---|
| 0      | blength            | 1    | 0x0D   | Size of this descriptor   |
| 1      | bdescriptorType    | 1    | 0x24   | CS_INTERFACE  |
| 2      | bdescriptorSubtype | 1    | 0x04   | MIXER_UNIT subtype  |
| 3      | bunitID            | 1    | 0x09   | ID of this terminal   |
| 4      | bnrInPins          | 1    | 0x02   | Number of Input Pin   |
| 5      | baSourceID(1)      | 1    | 0x06   | From Feature Unit 2(ID6)  |
| 6      | baSourceID(2)      | 1    | 0x03   | From IT(ID3)  |
| 7      | bnrChannels        | 1    | 0x02   | Number of logical output channels in the Mixer's output audio channel cluster |
| 8      | wChannnelConfig    | 2    | 0x0003 | describes the spatial location L/R front                                      |
| 10     | iChannelNames      | 1    | 0x00   | Index of String descriptor  |
| 11     | bmControl          | 1    | 0x00   | bit map no control  |
| 12     | Imixer             | 1    | 0x00   | Index of String descriptor  |

**3.3.11 Selector Unit Descriptor(ID=7)**

| Offset | Field              | Size | Value | Description                      |
|--------|--------------------|------|-------|----------------------------------|
| 0      | blength            | 1    | 0x07  | Size of this descriptor          |
| 1      | bdescriptorType    | 1    | 0x24  | CS_INTERFACE                     |
| 2      | bdescriptorSubtype | 1    | 0x05  | Selector_UNIT descriptor subtype |
| 3      | bunitID            | 1    | 0x07  | ID of this feature Unit          |
| 4      | bNrInPins          | 1    | 0x01  | Inputs Pins                      |
| 5      | bSourceID(1)       | 1    | 0x01  | From Input Terminal              |
| 6      | IFeature           | 1    | 0x00  | Unused                           |

### 3.4 Interface Descriptor #1

#### 3.4.1 Standard Interface descriptor <Alternate Setting 0> (A/D Audio Streaming Data)

Zero Bandwidth

| Offset | Field              | Size | Value | Description               |
|--------|--------------------|------|-------|---------------------------|
| 0      | bLength            | 1    | 0x09  | Length of this descriptor |
| 1      | bDescriptorType    | 1    | 0x04  | INTERFACE descriptor      |
| 2      | bInterfaceNumber   | 1    | 0x01  | Index of this interface   |
| 3      | bAlternateSetting  | 1    | 0x00  | Index of this setting     |
| 4      | bNumEndpoints      | 1    | 0x00  | 0 Endpoint                |
| 5      | bInterfaceClass    | 1    | 0x01  | AUDIO                     |
| 6      | bInterfaceSubclass | 1    | 0x02  | AUDIO_STREAMING           |
| 7      | bInterfaceProtocol | 1    | 0x00  | Unused                    |
| 8      | iInterface         | 1    | 0x00  | null string               |

### 3.4.2 Standard Interface descriptor <Alternate Setting 1> (A/D Audio Streaming Data)

| Offset | Field              | Size | Value | Description               |
|--------|--------------------|------|-------|---------------------------|
| 0      | bLength            | 1    | 0x09  | Length of this descriptor |
| 1      | bDescriptorType    | 1    | 0x04  | INTERFACE descriptor      |
| 2      | bInterfaceNumber   | 1    | 0x01  | Index of this interface   |
| 3      | bAlternateSetting  | 1    | 0x01  | Index of this setting     |
| 4      | bNumEndpoints      | 1    | 0x01  | 1 Endpoint                |
| 5      | bInterfaceClass    | 1    | 0x01  | AUDIO                     |
| 6      | bInterfaceSubclass | 1    | 0x02  | AUDIO_STREAMING           |
| 7      | bInterfaceProtocol | 1    | 0x00  | Unused                    |
| 8      | iInterface         | 1    | 0x00  | null string               |

### 3.4.3 Class-specific audio streaming interface descriptor <Alt 1>

| Offset | Field              | Size | Value  | Description                             |
|--------|--------------------|------|--------|---|
| 0      | bLength            | 1    | 0x07   | Length of this descriptor               |
| 1      | bDescriptorType    | 1    | 0x24   | CS_INTERFACE descriptor                 |
| 2      | bDescriptorSubtype | 1    | 0x01   | AS_GENERAL                              |
| 3      | bTerminalLink      | 1    | 0x02   | Unit ID of terminal(Output Terminal ID) |
| 4      | bDelay             | 1    | 0x00   | Interface delay                         |
| 5      | wFormatTag         | 2    | 0x0001 | PCM                                     |

### 3.4.4 Type I format type descriptor

| Offset | Field              | Size | Value    | Description             |
|--------|--------------------|------|----------|-------------------------|
| 0      | bLength            | 1    | 0x1D     | Size of this descriptor |
| 1      | bDescriptorType    | 1    | 0x24     | CS_INTERFACE            |
| 2      | bDescriptorSubtype | 1    | 0x02     | FORMAT_TYPE             |
| 3      | bFormatType        | 1    | 0x01     | FORMAT_TYPE_I           |
| 4      | bNrChannels        | 1    | 0x01     | One channel             |
| 5      | bSubFrameSize      | 1    | 0x02     | Two bytes per slot      |
| 6      | bBitResolution     | 1    | 0x10     | 16 bits                 |
| 7      | bSamFreqType       | 1    | 0x07     | Seven frequencies       |
| 8      | tSamFreq[0]        | 3    | 0x001F40 | 8000Hz                  |
| 11     | tSamFreq[1]        | 3    | 0x002B11 | 11025Hz                 |
| 14     | tSamFreq[2]        | 3    | 0x003E80 | 16000Hz                 |
| 17     | tSamFreq[3]        | 3    | 0x005622 | 22050Hz                 |
| 20     | tSamFreq[4]        | 3    | 0x007D00 | 32000Hz                 |
| 23     | tSamFreq[5]        | 3    | 0x00AC44 | 44100Hz                 |
| 26     | tSamFreq[6]        | 3    | 0x00BB80 | 48000Hz                 |



**3.4.5 Standard Endpoint descriptor**

| Offset | Field            | Size | Value  | Description                               |
|--------|------------------|------|--------|---|
| 0      | bLength          | 1    | 0x09   | Length of this descriptor                 |
| 1      | bDescriptorType  | 1    | 0x05   | ENDPOINT descriptor                       |
| 2      | bendpointAddress | 1    | 0x81   | Endpoint 1, IN direction                  |
| 3      | bmAttributes     | 1    | 0x05   | Isochronous, asynchronous                 |
| 4      | wMaxPacketSize   | 2    | 0x0064 | 2byte*50sample*1ch=100 byte/frame         |
| 6      | bInterval        | 1    | 0x01   | One packet every frame (Must be set to 1) |
| 7      | bRefresh         | 1    | 0x00   | Unused                                    |
| 8      | bSynchAddress    | 1    | 0x00   | Unused                                    |

**3.4.6 Class-specific isochronous audio data endpoint descriptor**

| Offset | Field              | Size | Value  | Description             |
|--------|--------------------|------|--------|-------------------------|
| 0      | bLength            | 1    | 0x07   | Size of this descriptor |
| 1      | bDescriptorType    | 1    | 0x25   | CS_ENDPOINT             |
| 2      | bDescriptorSubtype | 1    | 0x01   | EP_GENERAL              |
| 3      | bmAttributes       | 1    | 0x01   | sample rate control     |
| 4      | bLockDelayUnits    | 1    | 0x00   | Unused                  |
| 5      | wLockDelay         | 2    | 0x0000 |                         |

### 3.5 Interface Descriptor #2

#### 3.5.1 Standard Audio Streaming Interface descriptor <Alternate Setting 0> (D/A Audio Streaming Data) Zero Bandwidth

| Offset | Field              | Size | Value | Description               |
|--------|--------------------|------|-------|---------------------------|
| 0      | bLength            | 1    | 0x09  | Length of this descriptor |
| 1      | bDescriptorType    | 1    | 0x04  | INTERFACE descriptor      |
| 2      | bInterfaceNumber   | 1    | 0x02  | Index of this interface   |
| 3      | bAlternateSetting  | 1    | 0x00  | Index of this setting     |
| 4      | bNumEndpoints      | 1    | 0x00  | endpoints 0               |
| 5      | bInterfaceClass    | 1    | 0x01  | AUDIO                     |
| 6      | bInterfaceSubclass | 1    | 0x02  | AUDIO_STREAMING           |
| 7      | bInterfaceProtocol | 1    | 0x00  | Unused                    |
| 10     | iInterface         | 1    | 0x00  | null string               |

#### 3.5.2 Operational Interface descriptor <Alternate Setting 1> (D/A Audio Streaming Data)

| Offset | Field              | Size | Value | Description               |
|--------|--------------------|------|-------|---------------------------|
| 0      | BLength            | 1    | 0x09  | Length of this descriptor |
| 1      | bDescriptorType    | 1    | 0x04  | INTERFACE descriptor      |
| 2      | bInterfaceNumber   | 1    | 0x02  | Index of this interface   |
| 3      | bAlternateSetting  | 1    | 0x01  | Index of this setting     |
| 4      | bNumEndpoints      | 1    | 0x01  | Streaming Endpoint        |
| 5      | bInterfaceClass    | 1    | 0x01  | AUDIO                     |
| 6      | bInterfaceSubclass | 1    | 0x02  | AUDIO_STREAMING           |
| 7      | bInterfaceProtocol | 1    | 0x00  | Unused                    |
| 8      | iInterface         | 1    | 0x00  | null string               |

#### 3.5.3 Class-specific audio streaming interface descriptor<Alternate Setting 1>

| Offset | Field              | Size | Value  | Description                         |
|--------|--------------------|------|--------|-------------------------------------|
| 0      | bLength            | 1    | 0x07   | Length of this descriptor           |
| 1      | bDescriptorType    | 1    | 0x24   | CS_INTERFACE descriptor             |
| 2      | bDescriptorSubtype | 1    | 0x01   | AS_GENERAL                          |
| 3      | bTerminalLink      | 1    | 0x03   | Unit ID of Terminal(Input Terminal) |
| 4      | bDelay             | 1    | 0x00   | Interface delay                     |
| 5      | wFormatTag         | 2    | 0x0001 | PCM                                 |

**3.5.4 Type I format type descriptor<Alternate Setting 1>**

| Offset | Field              | Size | Value    | Description             |
|--------|--------------------|------|----------|-------------------------|
| 0      | bLength            | 1    | 0x1D     | Size of this descriptor |
| 1      | bDescriptorType    | 1    | 0x24     | CS_INTERFACE            |
| 2      | bDescriptorSubtype | 1    | 0x02     | FORMAT_TYPE             |
| 3      | bFormatType        | 1    | 0x01     | FORMAT_TYPE_I           |
| 4      | bNrChannels        | 1    | 0x02     | Two channels            |
| 5      | bSubFrameSize      | 1    | 0x02     | Two bytes per slot      |
| 6      | bBitResolution     | 1    | 0x10     | 16 bits                 |
| 7      | bSamFreqType       | 1    | 0x07     | Six frequencies         |
| 8      | tSamFreq[0]        | 3    | 0x001F40 | 8000Hz                  |
| 11     | tSamFreq[1]        | 3    | 0x002B11 | 11025Hz                 |
| 14     | tSamFreq[2]        | 3    | 0x003E80 | 16000Hz                 |
| 17     | tSamFreq[3]        | 3    | 0x005622 | 22050Hz                 |
| 20     | tSamFreq[4]        | 3    | 0x007D00 | 32000Hz                 |
| 23     | tSamFreq[5]        | 3    | 0x00AC44 | 44100Hz                 |
| 26     | tSamFreq[6]        | 3    | 0x00BB80 | 48000Hz                 |

**3.5.5 Endpoint descriptor**

| Offset | Field            | Size | Value  | Description                           |
|--------|------------------|------|--------|---------------------------------------|
| 0      | bLength          | 1    | 0x09   | Length of this descriptor             |
| 1      | bDescriptorType  | 1    | 0x05   | ENDPOINT descriptor                   |
| 2      | bEndpointAddress | 1    | 0x02   | Endpoint 2, OUT direction             |
| 3      | bmAttributes     | 1    | 0x09   | Adaptive Isochronous                  |
| 4      | wMaxPacketSize   | 2    | 0x00C8 | 2byte*(48+2)sample*2ch=200 byte/frame |
| 6      | bInterval        | 1    | 0x01   | 1millisecond (Must be set to 1)       |
| 7      | bRefresh         | 1    | 0x00   | Unused                                |
| 8      | bSynchAddress    | 1    | 0x00   | Unused                                |

**3.5.6 Class-specific isochronous audio data endpoint descriptor**

| Offset | Field              | Size | Value  | Description             |
|--------|--------------------|------|--------|-------------------------|
| 0      | bLength            | 1    | 0x07   | Size of this descriptor |
| 1      | bDescriptorType    | 1    | 0x25   | CS_ENDPOINT             |
| 2      | bDescriptorSubtype | 1    | 0x01   | EP_GENERAL              |
| 3      | bmAttributes       | 1    | 0x01   | Sample rate control     |
| 4      | bLockDelayUnits    | 1    | 0x00   | Unused                  |
| 5      | wLockDelay         | 2    | 0x0000 | Unused                  |

**3.6 Interface #3 (HID Class)**

**3.6.1 Standard Interface Descriptor**

| Offset | Field              | Size | Value | Description             |
|--------|--------------------|------|-------|-------------------------|
| 0      | bLength            | 1    | 0x09  | Size of this descriptor |
| 1      | bDescriptorType    | 1    | 0x04  | INTERFACE descriptor    |
| 2      | bInterfaceNumber   | 1    | 0x03  | Index of this interface |
| 3      | bAlternateSetting  | 1    | 0x00  | Index of this setting   |
| 4      | bNumEndpoints      | 1    | 0x01  | endpoint 1              |
| 5      | bInterfaceClass    | 1    | 0x03  | HID                     |
| 6      | bInterfaceSubclass | 1    | 0x00  | Non-Boot Device         |
| 7      | bInterfaceProtocol | 1    | 0x00  | Unused                  |
| 8      | iInterface         | 1    | 0x00  | null string             |

**3.6.2 HID Descriptor**

| Offset | Field             | Size | Value  | Description             |
|--------|-------------------|------|--------|-------------------------|
| 0      | bLength           | 1    | 0x09   | Size of this descriptor |
| 1      | bDescriptorType   | 1    | 0x21   | HID                     |
| 2      | bcdHID            | 2    | 0x0110 | HID spec rev #1.10      |
| 4      | bCountryCode      | 1    | 0x00   |                         |
| 5      | bNumDescriptor    | 1    | 0x01   |                         |
| 6      | bDescriptorType   | 1    | 0x22   | Report Descriptor       |
| 7      | bDescriptorLength | 2    | 0x001f | 31 bytes                |

**3.6.3 Endpoint Descriptor**

| Offset | Field            | Size | Value  | Description               |
|--------|------------------|------|--------|---------------------------|
| 0      | bLength          | 1    | 0x07   | Length of this descriptor |
| 1      | bDescriptorType  | 1    | 0x05   | ENDPOINT descriptor       |
| 2      | bendpointAddress | 1    | 0x83   | Endpoint 3, IN direction  |
| 3      | bmAttributes     | 1    | 0x03   | Interrupt                 |
| 4      | wMaxPacketSize   | 2    | 0x0001 |                           |
| 6      | wInterval        | 1    | 0x40   | 64ms Interval             |





## 4 Standard Device Requests

### 4.1 Clear Feature

The AK4571 return ACK without ERROR

| Offset | Field         | Size | Value            | Description                                 |
|--------|---------------|------|------------------|---|
| 0      | bmRequestType | 1    | 0x00<br>0x02     | Device<br>Endpoint                          |
| 1      | bRequest      | 1    | 0x01             | CLEAR_FEATURE                               |
| 2      | wValue        | 2    | 0x0000<br>0x0001 | clear ENDPOINT0 HALT<br>clear REMOTE_WAKEUP |
| 4      | wIndex        | 2    | 0x0000           |   |
| 6      | wLength       | 2    | 0x0000           |   |

### 4.2 Get Configuration

The AK4571 returns "1".

| Offset | Field         | Size | Value  | Description       |
|--------|---------------|------|--------|-------------------|
| 0      | bmRequestType | 1    | 0x80   |                   |
| 1      | bRequest      | 1    | 0x08   | GET_CONFIGURATION |
| 2      | wValue        | 2    | 0x0000 |                   |
| 4      | wIndex        | 2    | 0x0000 |                   |
| 6      | wLength       | 2    | 0x0001 |                   |

### 4.3 Get Descriptor

The AK4571 returns the descriptor that is specified in wValue field.

| Offset | Field         | Size | Value  | Description   |
|--------|---------------|------|--------|---|
| 0      | bmRequestType | 1    | 0x80   |   |
| 1      | bRequest      | 1    | 0x06   | GET_DESCRIPTOR  |
| 2      | wValue        | 2    | 0xZZZZ | ZZZZ is assigned by host:<br>High Byte is Desc. type, Low Byte is Index.<br>DEVICE : 0x0100 : (Index is 0 only)<br>CONFIGURATION : 0x0200 |
| 4      | wIndex        | 2    | 0x0000 |   |
| 6      | wLength       | 2    | 0xZZZZ | Descriptor Length (ZZZZ is assigned by host)  |

### 4.4 Get Interface

The AK4571 returns the current alternate value for the interface that is specified in wIndex field. "0x00" or "0x01" is returned for Interface#1, or Interface#2. Only "0x00" is returned for Interface#0 or Interface#3.

| Offset | Field         | Size | Value                                | Description  |
|--------|---------------|------|--------------------------------------|--|
| 0      | bmRequestType | 1    | 0x81                                 |  |
| 1      | bRequest      | 1    | 0x0A                                 | GET_INTERFACE  |
| 2      | wValue        | 2    | 0x0000                               | ZERO   |
| 4      | wIndex        | 2    | 0x0000<br>0x0001<br>0x0002<br>0x0003 | Audio Control Interface<br>Audio Streaming Interface for A/D<br>Audio Streaming Interface for D/A<br>HID Interface |
| 6      | wLength       | 2    | 0x0001                               | AK4571 has both a zero bandwidth Audio Streaming Interface and a normal Audio Streaming Interface.                 |

4.5 Get Status

4.5.1 Get Status

| Offset | Field         | Size | Value  | Description   |
|--------|---------------|------|--|---|
| 0      | bmRequestType | 1    | 0x80<br>0x81<br>0x82   | DEVICE<br>INTERFACE<br>ENDPOINT   |
| 1      | bRequest      | 1    | 0x00   | GET_STATUS  |
| 2      | wValue        | 2    | 0x0000   | ZERO  |
| 4      | wIndex        | 2    | 0x0000<br>0x0001<br>0x0002<br>0x0003<br>0x0000<br>0x0081<br>0x0002<br>0x0083<br>0x0084 | bmRequestType is "DEVICE"<br>bmRequestType is "INTERFACE "<br>bmRequestType is "INTERFACE "<br>bmRequestType is "INTERFACE "<br>bmRequestType is "ENDPOINT"<br>bmRequestType is "ENDPOINT" *)<br>bmRequestType is "ENDPOINT" *)<br>bmRequestType is "ENDPOINT" *) |
| 6      | wLength       | 2    | 0x0002   |   |

\*)This request is valid after "SET\_INTERFACE request (except for Alt0)" for each interface is issued. If the AK4571 receives GET\_STATUS request prior to SET\_INTERFACE request, it returns STALL. If SET\_INTERFACE request with Alt1 is issued, GET\_STATUS request is valid even if alternate value is returned to "0".

The AK4571 has the following two bytes.

- a) Device: 0x0000 (Bus Powered, No-remote wakeup)
- b) Interface: 0x0000
- c) Endpoint: 0x0000

4.6 Set Address

The AK4571 stores wValue, and returns ACK. It responds to the requests in which this address is specified after receiving this request.

| Offset | Field         | Size | Value  | Description                               |
|--------|---------------|------|--------|---|
| 0      | BmRequestType | 1    | 0x00   | Zero                                      |
| 1      | BRequest      | 1    | 0x05   | SET_ADDRESS                               |
| 2      | wValue        | 2    | 0xZZZZ | Device Address : ZZZZ is assigned by host |
| 4      | wIndex        | 2    | 0x0000 | Zero                                      |
| 6      | wLength       | 2    | 0x0000 | Zero                                      |

4.7 Set Configuration

The AK4571 is set to the configuration state, and returns ACK. As the AK4571 is defined as a single-configuration device, only "0x00" or "0x01" are valid terms.

| Offset | Field         | Size | Value                      | Description  |
|--------|---------------|------|----------------------------|--|
| 0      | bmRequestType | 1    | 0x00                       | Zero   |
| 1      | bRequest      | 1    | 0x09                       | SET_CONFIGURATION  |
| 2      | wValue        | 2    | 0x0000<br>0x0001<br>others | Unconfigured State<br>AK4571 is set to configuration state<br>Unconfigured State |
| 4      | wIndex        | 2    | 0x0000                     | Zero   |
| 6      | wLength       | 2    | 0x0000                     | Zero   |



#### 4.8 Set Feature

| Offset | Field         | Size | Value            | Description                        |
|--------|---------------|------|------------------|------------------------------------|
| 0      | bmRequestType | 1    | 0x00<br>0x02     | Device<br>Endpoint                 |
| 1      | bRequest      | 1    | 0x03             | SET_FEATURE                        |
| 2      | wValue        | 2    | 0x0000<br>0x0001 | ENDPOINT(0) HALT<br>REMOETE_WAKEUP |
| 4      | wIndex        | 2    | 0x0000           |                                    |
| 6      | wLength       | 2    | 0x0000           |                                    |

If **wValue** is ENDPOINT(0) HALT, the AK4571 returns STALL. If **wValue** is REMOTE\_WAKEUP, the AK4571 returns ACK without additional processing because it does not have a remote wakeup function.

#### 4.9 Set Interface

The AK4571 set alternate value that is specified in **wValue** for the interface that is specified in **wIndex** field. Either Alt0 or Alt1 can be set for Interface#1 or Interface #2. Only Alt0 is valid for Interface#0 or Interface#3.

| Offset | Field         | Size | Value                                | Description   |
|--------|---------------|------|--------------------------------------|---|
| 0      | bmRequestType | 1    | 0x01                                 | ONE<br>D7 0 = Host to device<br>D6..5 0 = Standard request<br>D4..0 1 = Recipient is interface            |
| 1      | bRequest      | 1    | 0x0B                                 | SET_INTERFACE   |
| 2      | wValue        | 2    | 0x0000 or<br>0x0001                  | Zero bandwidth Alternate Setting<br>Normal Isochronous Streaming  |
| 4      | wIndex        | 2    | 0x0000<br>0x0001<br>0x0002<br>0x0003 | Audio Control Interface<br>Audio Streaming Interface IN<br>Audio Streaming Interface OUT<br>HID Interface |
| 6      | wLength       | 2    | 0x0000                               | Zero  |

#### 4.10 Synch Frame

The AK4571 does not support this request.

## 5 Device Specific Requests

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If the AK4571 receives a request that is not supported, or if it receives an invalid parameter, the AK4571 returns STALL.

### 5.1 Set Feature Unit Control Request

#### 5.1.1 Mute Control

Mute is controlled via the master channel. Both left channel and right channel of lineout are muted at the same time.

| Offset | Field         | Size | Value                      | Description  |
|--------|---------------|------|----------------------------|--|
| 0      | bmRequestType | 1    | 0x21                       |  |
| 1      | bRequest      | 1    | 0x01                       | SET_CUR  |
| 2      | wValue        | 2    | 0x0100                     | MUTE_CONTROL   CHANNEL_0   |
| 4      | wIndex        | 2    | 0x0500<br>0x0600<br>0x0800 | Mute for MIC Recording Volume   interface 0<br>Mute for MIC Playback Volume   interface 0<br>Mute for LineOut Volume   interface 0 |
| 6      | wLength       | 2    | 0x0001                     | The Length of Mute Control Parameter Block   |

Parameter:

| Offset | Field | Size | Value        | Description   |
|--------|-------|------|--------------|---------------|
| 0      | bMute | 1    | 0x01<br>0x00 | TRUE<br>FALSE |

If invalid data is set, (i.e the parameter is not one of the above values), the AK4571 returns STALL at data phase, and keeps previous value.

#### 5.1.2 Bass Boost

| Offset | Field         | Size | Value  | Description                                |
|--------|---------------|------|--------|--|
| 0      | bmRequestType | 1    | 0x21   |  |
| 1      | bRequest      | 1    | 0x01   | SET_CUR                                    |
| 2      | wValue        | 2    | 0x0900 | BASS_BOOST   CHANNEL_0                     |
| 4      | wIndex        | 2    | 0x0800 | LineOut BASS BOOST   interface 0           |
| 6      | wLength       | 2    | 0x0001 | The Length of Mute Control Parameter Block |

Parameter:

| Offset | Field      | Size | Value        | Description   |
|--------|------------|------|--------------|---------------|
| 0      | bBassBoost | 1    | 0x01<br>0x00 | TRUE<br>FALSE |

If invalid data is set, (i.e the parameter is not one of the above values), the AK4571 returns STALL at data phase, and keeps previous value.

**5.1.3 Volume Control**

The ADC volume is controlled via the master channel, and the DAC volume is controlled via channel 1 (Left channel) and channel 2 (Right channel) independently.

| Offset | Field         | Size | Value                                | Description   |
|--------|---------------|------|--------------------------------------|---|
| 0      | bmRequestType | 1    | 0x21                                 |   |
| 1      | bRequest      | 1    | 0x01                                 | SET_CUR   |
| 2      | wValue        | 2    | 0x0200<br>0x0201<br>0x0202           | A/D: VOLUME_CONTROL   Master Channel<br>DAC: VOLUME_CONTROL   CHANNEL_1<br>DAC: VOLUME_CONTROL   CHANNEL_2  |
| 4      | wIndex        | 2    | 0x0500<br>0x0600<br>0x0800<br>0x0800 | A/D Feature Unit ID: 0x05 (MIC REC Master CH)<br>A/D Feature Unit ID: 0x06 (MIC PLAY Master CH)<br>D/A Feature Unit ID: 0x08 (Lineout Lch Volume)<br>D/A Feature Unit ID: 0x08 (Lineout Rch Volume)<br>Lower Byte: Audio Control Interface (0x00) |
| 6      | wLength       | 2    | 0x0002                               | Volume Control  |

Parameter:

| Offset | Field   | Size | Value  | Description              |
|--------|---------|------|--------|--------------------------|
| 0      | wVolume | 2    | 0xZZZZ | The value is set by host |

The data format for volume follows USB's "Device Class Definition for Audio Devices". If the parameter value is larger than the maximum value, the AK4571 defaults to the maximum value. If the parameter is smaller than minimum value, it defaults to the minimum value.

■ Volume for FU1 (ID5: MIC Recording), and FU2 (ID6: MIC Playback)

The AK4571 recognizes the lower byte of the USB Audio Volume format as 00H.

| Volume Value | USB Audio Class Format |
|--------------|------------------------|
| 24.0dB       | 0x7FFF                 |
| -----        | -----                  |
| 24.0dB       | 0x1800                 |
| 23.0dB       | 0x17FF                 |
| -----        | -----                  |
| 0.0dB        | 0x0000                 |
| -----        | -----                  |
| -30.0dB      | 0xE200                 |
| -31.0dB      | 0xE1FF                 |
| -----        | -----                  |
| -31.0dB      | 0x8000                 |

■ Volume for FU 3 (ID 8: LineOut)

The AK4571 recognizes the lower byte of the USB Audio Volume format as 00H.

| Volume Value | USB Audio Class Format |
|--------------|------------------------|
| 0.0dB        | 0x7FFF                 |
| -----        | -----                  |
| 0.0dB        | 0x0000                 |
| -1.0dB       | 0xFF00                 |
| -2.0dB       | 0xFE00                 |
| -----        | -----                  |
| -46.0dB      | 0xD200                 |
| -47.0dB      | 0xD100                 |
| -----        | -----                  |
| -47.0dB      | 0x8000                 |

## 5.2 Set Selector Unit Control Request

### 5.2.1 Selector Control

| Offset | Field         | Size | Value  | Description                                |
|--------|---------------|------|--------|--|
| 0      | bmRequestType | 1    | 0x21   |  |
| 1      | bRequest      | 1    | 0x01   | SET_CUR                                    |
| 2      | wValue        | 2    | 0x0000 | ZERO                                       |
| 4      | wIndex        | 2    | 0x0700 | SELECTOR UNIT CONTROL   Interface 0        |
| 6      | wLength       | 2    | 0x0001 | The Length of Mute Control Parameter Block |

Parameter:

| Offset | Field     | Size | Value | Description              |
|--------|-----------|------|-------|--------------------------|
| 0      | bSelector | 1    | 0xZZ  | The value is set by host |

The AK4571 returns ACK, but ignores this value.

5.3 Get Feature Unit Control Request

5.3.1 Mute Control

| Offset | Field         | Size | Value                      | Description  |
|--------|---------------|------|----------------------------|--|
| 0      | bmRequestType | 1    | 0xA1                       |  |
| 1      | bRequest      | 1    | 0x81                       | GET_CUR  |
| 2      | wValue        | 2    | 0x0100                     | MUTE_CONTROL   CHANNEL_0   |
| 4      | wIndex        | 2    | 0x0500<br>0x0600<br>0x0800 | Mute for MIC Recording Volume   interface 0<br>Mute for MIC Playback Volume   interface 0<br>Mute for Lineout Volume   interface 0<br>Lower Byte : Audio Control Interface(0x00) |
| 6      | wLength       | 2    | 0x0001                     | The Length of Mute Control Parameter Block   |

The AK4571 returns current value.

| Offset | Field | Size | Value        | Description   |
|--------|-------|------|--------------|---------------|
| 0      | bMute | 1    | 0x01<br>0x00 | TRUE<br>FALSE |

Default: Mute OFF (0x00): FU1 (ID5), FU3 (ID8)  
Mute ON (0x01): FU2 (ID6)

5.3.2 Bass Boost Control

| Offset | Field         | Size | Value  | Description                                |
|--------|---------------|------|--------|--|
| 0      | bmRequestType | 1    | 0xA1   |  |
| 1      | bRequest      | 1    | 0x81   | GET_CUR                                    |
| 2      | wValue        | 2    | 0x0900 | BASS_BOOST   CHANNEL_0                     |
| 4      | wIndex        | 2    | 0x0800 | Feature Unit   interface 0                 |
| 6      | wLength       | 2    | 0x0001 | The Length of Mute Control Parameter Block |

The AK4571 returns current value.

| Offset | Field      | Size | Value        | Description   |
|--------|------------|------|--------------|---------------|
| 0      | bBassBoost | 1    | 0x01<br>0x00 | TRUE<br>FALSE |

Default BASS BOOST OFF(0x00):

## 5.3.3 Volume Control

| Offset | Field         | Size | Value                        | Description  |
|--------|---------------|------|------------------------------|--|
| 0      | bmRequestType | 1    | 0xA1                         |  |
| 1      | bRequest      | 1    | 0x81<br>0x82<br>0x83<br>0x84 | GET_CUR<br>GET_MIN<br>GET_MAX<br>GET_RES   |
| 2      | wValue        | 2    | 0x0200<br>0x0201<br>0x0202   | VOLUME_CONTROL   Master CH (FU5, FU6)<br>VOLUME_CONTROL   CHANNEL_1 (FU8)<br>VOLUME_CONTROL   CHANNEL_2 (FU8)  |
| 4      | wIndex        | 2    | 0x0500<br>0x0600<br>0x0800   | MIC Recording Volume   interface 0<br>MIC Playback Volume   interface 0<br>Lineout Volume   interface 0<br>Lower Byte: Audio Control Interface(0x00) |
| 6      | wLength       | 2    | 0x0002                       | Volume Control   |

The AK4571 returns the following **wVolume** (two bytes). When it receives a request with other combinations, it returns STALL.

| bRequest | wValue | wIndex | wVolume (2 bytes) | Desciptorn                                       |
|----------|--------|--------|-------------------|--|
| 0x81     | 0x0200 | 0x0500 | 0xZZZZ            | Returns current MIC volume of recording path.    |
| 0x81     | 0x0200 | 0x0600 | 0xZZZZ            | Returns current MIC volume of playback path.     |
| 0x81     | 0x0201 | 0x0800 | 0xZZZZ            | Returns current Left channel volume of Lineout   |
| 0x81     | 0x0202 | 0x0800 | 0xZZZZ            | Returns current Right channel volume of Lineout  |
| 0x82     | 0x0200 | 0x0500 | 0xE100            | Returns minimum MIC recording volume (-31dB)     |
| 0x82     | 0x0200 | 0x0600 | 0xE100            | Returns minimum MIC playback volume (-31dB)      |
| 0x82     | 0x0201 | 0x0800 | 0xD100            | Returns minimum Lineout volume (-47dB)           |
| 0x82     | 0x0202 | 0x0800 | 0xD100            | Returns minimum Lineout volume (-47dB)           |
| 0x83     | 0x0200 | 0x0500 | 0x1800            | Returns maximum MIC recording volume (+24dB)     |
| 0x83     | 0x0200 | 0x0600 | 0x1800            | Returns maximum MIC playback volume (+24dB)      |
| 0x83     | 0x0201 | 0x0800 | 0x0000            | Returns maximum Line Out Volume (0dB)            |
| 0x83     | 0x0202 | 0x0800 | 0x0000            | Returns maximum Line Out Volume (0dB)            |
| 0x84     | 0x0200 | 0x0500 | 0x0100            | Returns resolution of MIC recording volume (1dB) |
| 0x84     | 0x0200 | 0x0600 | 0x0100            | Returns resolution of MIC playback volume (1dB)  |
| 0x84     | 0x0201 | 0x0800 | 0x0100            | Returns resolution of LineOut Volume (1dB)       |
| 0x84     | 0x0202 | 0x0800 | 0x0100            | Returns resolution of LineOut Volume (1dB)       |

Default:                   0dB(0x0000)

5.4 Get Selector Unit Control Request

5.4.1 Selector Control

| Offset | Field         | Size | Value  | Description                                    |
|--------|---------------|------|--------|--|
| 0      | bmRequestType | 1    | 0xa1   |  |
| 1      | bRequest      | 1    | 0x81   | GET_CUR  |
| 2      | wValue        | 2    | 0x0000 | ZERO   |
| 4      | wIndex        | 2    | 0x0700 | SELECTOR UNIT CONTROL   interface 0            |
| 6      | wLength       | 2    | 0x0001 | The Length of Selector Control Parameter Block |

Parameter:

| Offset | Field     | Size | Value | Description |
|--------|-----------|------|-------|-------------|
| 0      | bSelector | 1    | 0xZZ  | "0x01"      |

5.5 Get Mixer Unit Control Request

5.5.1 Mixer Control

| Offset | Field         | Size | Value                        | Description                                 |
|--------|---------------|------|------------------------------|---|
| 0      | bmRequestType | 1    | 0xa1                         |   |
| 1      | bRequest      | 1    | 0x81<br>0x82<br>0x83<br>0x84 | GET_CUR<br>GET_MIN<br>GET_MAX<br>GET_RES    |
| 2      | wValue        | 2    | 0x0000                       | ZERO  |
| 4      | wIndex        | 2    | 0x0900                       | MIXER UNIT   interface 0                    |
| 6      | wLength       | 2    | 0x000C                       | The Length of Mixer Control Parameter Block |

Parameter:

| Offset | Field  | Size | Value | Description |
|--------|--------|------|-------|-------------|
| 0      | bMixer | 12   | 0xZZ  |             |

The AK4571 returns 6 words of "0x0100" for GET\_RES request, and returns the following 6 words for GET\_CUR, GET\_MIN, and GET\_MAX requests.

| Offset | Value  | Description                      |
|--------|--------|----------------------------------|
| 0      | 0x0000 | Mic 1ch ---- LineOut Lch: 0dB    |
| 2      | 0x0000 | Mic 1ch ---- Lineout Rch: 0dB    |
| 4      | 0x0000 | DAC Lch ---- Lineout Lch: 0dB    |
| 6      | 0x8000 | DAC Lch ---- Lineout Rch: -127dB |
| 8      | 0x8000 | DAC Rch ---- Lineout Lch: -127dB |
| 10     | 0x0000 | DAC Rch ---- Lineout Rch: 0dB    |

## 5.6 Endpoint Control Request

The ADC and DAC can independently operate at seven sampling frequencies. The sampling rate is set by a Set Endpoint Control Request. The AK4571 supports SET\_CUR/GET\_CUR for the **bRequest** field, but does not support GET\_MIN, GET\_MAX, or GET\_RES for the **bRequest** field.

### 5.6.1 Set Endpoint Control Request

| Offset | Field         | Size | Value            | Description   |
|--------|---------------|------|------------------|---|
| 0      | bmRequestType | 1    | 0x22             |   |
| 1      | bRequest      | 1    | 0x01             | SET_CUR   |
| 2      | wValue        | 2    | 0x0100           | Upper byte: SAMPLING_FREQ_CONTROL (0x01)<br>Lower byte : zero |
| 4      | wIndex        | 2    | 0x0081<br>0x0002 | Endpoint Address (0x81: A/D)<br>Endpoint Address (0x02: D/A)  |
| 6      | wLength       | 2    | 0x0003           | The Length of Sampling Frequency Parameter Block              |

Parameter:

| Offset | Field       | Size | Value    | Description   |
|--------|-------------|------|----------|---|
| 0      | iSampleFreq | 3    | 0xYYYYYY | The following seven values are valid. Others are invalid.<br>0x001F40 : 8kHz<br>0x002B11 : 11.025kHz<br>0x003E80 : 16kHz<br>0x005622 : 22.05kHz<br>0x007D00 : 32kHz<br>0x00AC44 : 44.1kHz<br>0x00BB80 : 48kHz |

The sampling rates of the ADC and DAC can be set independently. If the value entered is not one of the valid settings, the AK4571 ignores the entered value without returning STALL and keeps the previously entered value.

### 5.6.2 Get Endpoint Control Request for IN endpoint

| Offset | Field         | Size | Value            | Description   |
|--------|---------------|------|------------------|---|
| 0      | bmRequestType | 1    | 0xA2             |   |
| 1      | bRequest      | 1    | 0x81             | GET_CUR   |
| 2      | wValue        | 2    | 0x0100           | Upper byte: SAMPLING_FREQ_CONTROL (0x01)<br>Lower byte : zero |
| 4      | wIndex        | 2    | 0x0081<br>0x0002 | Endpoint Address (0x81: A/D)<br>Endpoint Address (0x02: D/A)  |
| 6      | wLength       | 2    | 0x0003           | The Length of Sampling Frequency Parameter Block              |

Parameter:

| Offset | Field       | Size | Value    | Description   |
|--------|-------------|------|----------|---|
| 0      | iSampleFreq | 3    | 0xYYYYYY | The following seven values are valid. Others are invalid.<br>0x001F40 : 8kHz<br>0x002B11 : 11.025kHz<br>0x003E80 : 16kHz<br>0x005622 : 22.05kHz<br>0x007D00 : 32kHz<br>0x00AC44 : 44.1kHz ( default of this LSI )<br>0x00BB80 : 48kHz |



5.7 HID Related Request

5.7.1 Get Descriptor (HID/Report)

| Offset | Field         | Size | Value            | Description                                  |
|--------|---------------|------|------------------|--|
| 0      | BmRequestType | 1    | 0x81             |  |
| 1      | BRequest      | 1    | 0x06             | GET_DESCRIPTOR                               |
| 2      | wValue        | 2    | 0x2100<br>0x2200 | HID Descriptor<br>Report Descriptor          |
| 4      | wIndex        | 2    | 0x0003           | Interface Number (#3)                        |
| 6      | wLength       | 2    | 0xZZZZ           | Descriptor Length (ZZZZ is assigned by host) |

The AK4571 returns a HID Descriptor if **wValue** is 0x2100. The AK4571 returns the following 31 bytes if **wValue** is 0x2200.

|   |            |                           |
|---|------------|---------------------------|
| Report Descriptor                                       |            |                           |
| Usage Page (Consumer)                                   | 0x05, 0x0c |                           |
| Usage (Consumer Control)                                | 0x09, 0x01 |                           |
| Collection (Application)                                | 0xA1, 0x01 |                           |
| Logical Minimum (0)                                     | 0x15, 0x00 |                           |
| Logical Maximum (1)                                     | 0x25, 0x01 |                           |
| Usage (Volume Increment)                                | 0x09, 0xE9 |                           |
| Usage (Volume Decrement)                                | 0x09, 0xEA |                           |
| Report Size (1)   | 0x75, 0x01 | Data Length (1 bit)       |
| Report Count (2)  | 0x95, 0x02 | Number of Data (INC, DEC) |
| Input (Data, Variable, Absolute, No_Wrap, No_Preferred) | 0x81, 0x2A |                           |
| Usage (Mute)  | 0x09, 0xE2 |                           |
| Report Count (1)  | 0x95, 0x01 |                           |
| Input (Data, Variable, Relative, No_Wrap, No_Preferred) | 0x81, 0x2E |                           |
| Report Count (5)  | 0x95, 0x05 |                           |
| Input (Constant)  | 0x81, 0x01 |                           |
| End Collection  | 0xC0       |                           |

### 5.7.2 Get Report Request

| Offset | Field         | Size | Value  | Description                    |
|--------|---------------|------|--------|--------------------------------|
| 0      | bmRequestType | 1    | 0xA1   | Class Specific Request         |
| 1      | BRequest      | 1    | 0x01   | GET_REPORT                     |
| 2      | Wvalue        | 2    | 0x0100 | Report Type (IN) and Report ID |
| 4      | Windex        | 2    | 0x0003 | Interface No (#3)              |
| 6      | WLength       | 2    | 0xZZZZ | Report Descriptor Length       |

The AK4571 transmits one byte data that is the same format as Interrupt transaction. If it receives a request, it sends the internal register value that reflects the button-press state of OMUTE, INC and DEC pins. Note that the AK4571 does not clear the register after it receives this request. (It clears the register only on an Interrupt transfer)

### 5.8 String Related Request

| Offset | Field         | Size | Value      | Description  |
|--------|---------------|------|------------|--|
| 0      | BmRequestType | 1    | 0x80       |  |
| 1      | BRequest      | 1    | 0x06       | GET_DESCRIPTOR (String)  |
| 2      | wValue        | 2    | 0x03??     | 0x03?? is assigned by host:<br>0x0300: LangID<br>0x0301: iManufacturer<br>0x0302: iProduct |
| 4      | wIndex        | 2    | don't care |  |
| 6      | wLength       | 2    | 0xZZZZ     | Descriptor Length (ZZZZ is assigned by host)   |

The AK4571 returns String Descriptor that is specified in **wValue**.

6 System Block Diagram

Figure 14 shows the system block diagram when a 1Kbit EEPROM is used.

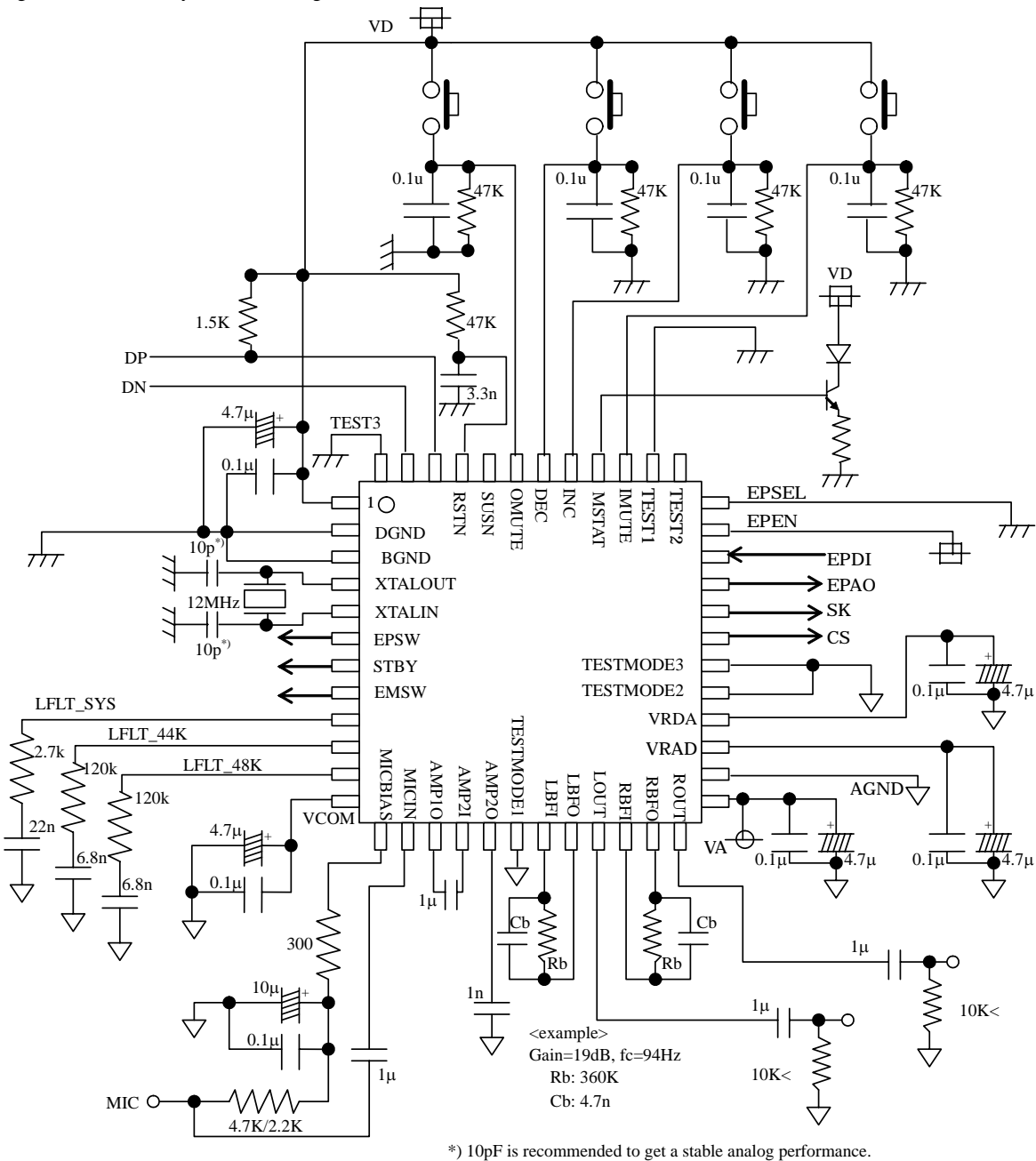
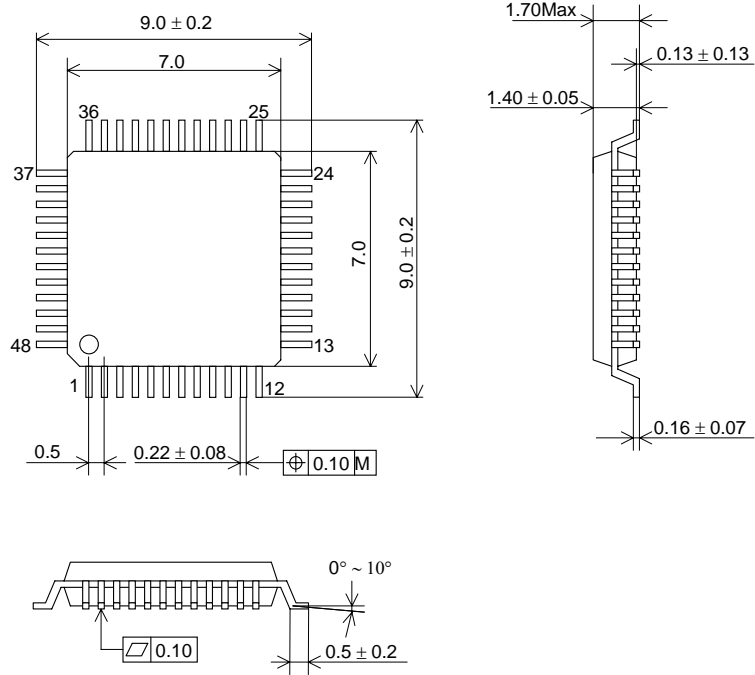


Figure 14 System Block Diagram

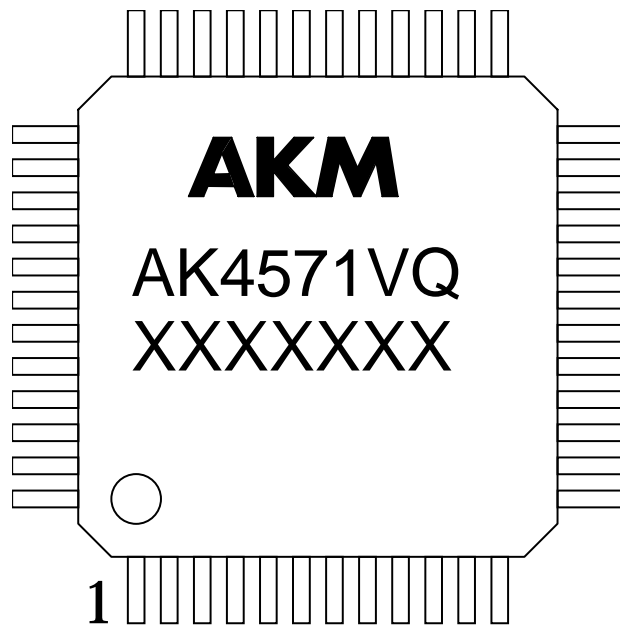
7 Package

48pin LQFP(Unit:mm)



8 Marking

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- 1) Pin #1 indication
- 2) Date Code: XXXXXXXX (7 digits)
- 3) Marking Code: AK4571VQ
- 4) Asahi Kasei Logo

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