



AK5370

USB I/F A/D Converter

Features:

- **Incorporates USB Audio Controller**
 - USB Serial Interface Engine
 - Audio Class Encoder/Decoder
 - 2 Endpoints (FIFO)
 - USB transceiver
- **16 bit A/D Converter**
 - 1 channel
 - Mute/Volume Control
 - AGC pin for external control
 - A/D S/N: 84dB (44.1kHz, Gain = 0dB)
- **On-chip PLL**
 - 5 Sampling Frequencies support
 - 8kHz, 11.025kHz
 - 22.05kHz, 44.1kHz, 48kHz
- **Programmable Gain Amplifier**
 - +20dB to -58dB
- **Single Power Supply, Low Power**
 - +3.3Volts±10%
- **Package**
 - 24pin VSOP

General Description

The AK5370 is AD converter for USB audio, especially USB microphone . The AK5370 integrates USB serial interface engine, USB transceiver, audio class decoder, endpoints, and high quality AD converter into the chip.

As the AK5370 incorporates PLL, it can support several sampling frequencies, 8kHz, 11.025kHz, 22.05kHz, 44.1kHz, and 48kHz with only one crystal. Moreover, the AK5370 integrates volume control, and mute function.

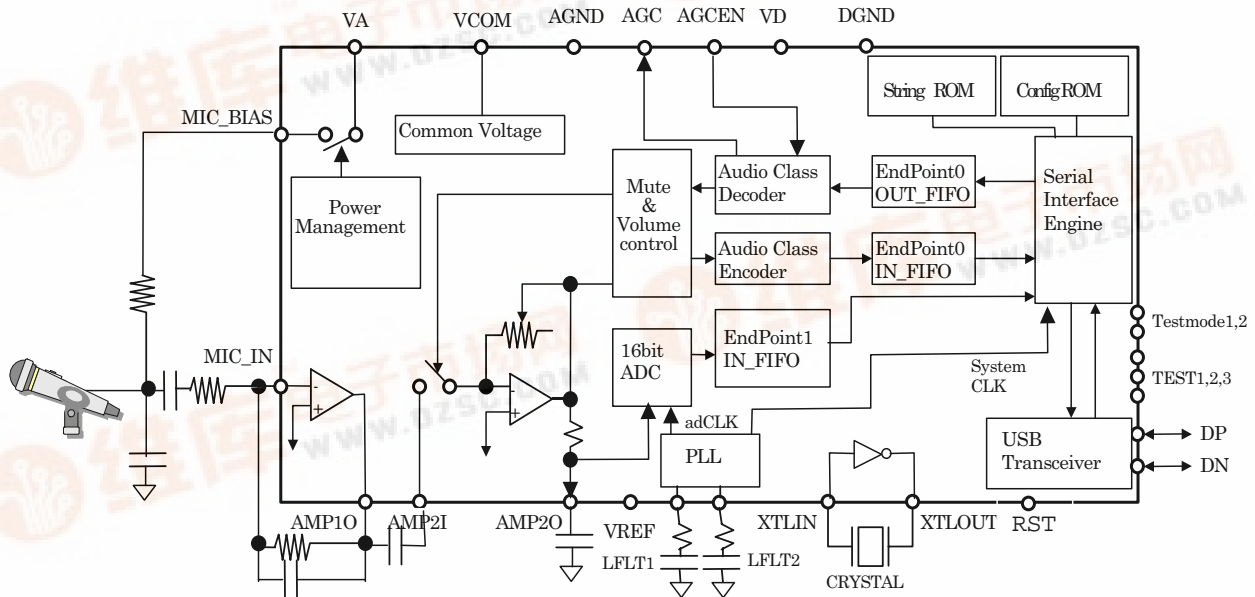
It is possible to make USB microphone with a few external components

This device is good for not only business application such as conferencing but also games, voice recognition, and Karaoke.

Related Documents

For the detail of USB specification, and Audio Class, please refer to the following documents.

- Universal Serial Bus Specification Revision 1.1
- Universal Serial Bus Device Class Definition for Audio Devices, Revision 1.0



Pin/Function				
No.	Signal Name	I/O	Ana / Dig	Description
1	DGND	P	D	Digital Ground
2	VD	P	D	Digital Power Supply, 3.3V
3	DP	I/O	D	USB bus Non-Inverting pin. Because AK5370 is full speed mode device, 1.5kΩ resistor will be connected between D+ node to VD.
4	DN	I/O	D	USB bus Inverting Pin.
5	TESTMODE3	I	D	Please tie down to AGND for normal operation.
6	XTALOUT	O	A	Crystal Oscillator Output, Connect Crystal Resonator
7	XTALIN	I	A	Crystal Oscillator Input, Connect Crystal Resonator
8	TESTMODE2	I	A	Please tie down to AGND for normal operation.
9	LFLT2	O	A	System clock PLL loop filter Pin. Connect 18kΩ resistor and 6800pF capacitor in series externally.
10	LFLT1	O	A	adPLL loop filter Pin. Connect 51kΩ resistor and 8200pF capacitor in series externally.
11	VCOM	O	A	Analog Common Voltage Reference Pin
12	MICIN	I	A	Microphone Input
13	AMP1O	O	A	1 st Amplifier Output Pin
14	AMP2I	I	A	2 nd Amplifier Input Pin
15	VA	P	A	Analog Power Supply, 3.3V
16	AGND	P	A	Analog Ground
17	VREF	O	A	ADC Common Voltage Reference Pin.
18	AMP2O	O	A	2 nd Amplifier Output Pin
19	TESTMODE1	I	A	Please tie down to AGND for normal operation.
20	MICBIAS	O	A	Voltage Reference Output for the Microphone's bias voltage When this chip goes into Suspend mode, this pin goes to Hi-Z.
21	TEST	I	D	Please tie down to AGND for normal operation.
22	AGCE	I	D	AGC Enable Control Input Pin. When the external AGC is used, High level should be applied to this pin. When Low input is applied, AGC configuration ROM data is set FALSE. Then AGC output is set to Low.
23	AGC	O	D	AGC Control Pin When the host requests set AGC_CONTROL request, this pin goes to "H". "L" level AGCE input prevents this AGC_CONTROL request. Low level output at SUSPEND. Default output at Reset is Low.
24	RSTN	I	D	Reset Pin, Low input makes the chip reset state. Schmitt Trigger input.

Absolute Maximum Rating

AGND, DGND=0V

Parameter	Symbol	Min	Max	Units
Power Supplies	Analog VA	-0.3	4.5	V
	Digital VD	-0.3	4.5	V
	DGND-AGND Δ 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 results in permanent damage to the device. Normal operation is not guaranteed at these extremes.

Recommended Operating Condition
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AGND, DGND=0V

Parameter	Symbol	Min	typ	Max	Units
Power Supplies	Analog VA	3.0	3.3	3.6	V
	Digital VD	3.0	3.3	3.6	V

All voltages with respect to ground.

* AKM assumes no responsibility for the usage beyond the condition in this datasheet.

Analog Characteristics				
Ta=25°C, VA=VD=3.3V, Signal Frequency=1kHz, Sampling Frequency Fs=44.1kHz				
Parameter	Min	typ	Max	Units
Mono ADC (1 channel)				
Resolution			16	bits
S/N (A weight) (1 st and 2 nd MIC amplifier are set to 0dB)	76	84		dB
S/(N+D) (-0.5dB analog input) (1 st and 2 nd MIC amplifier are set to 0dB)	62	70		dB
MIC Amplifier (2 nd Stage) <IPGA> Characteristics				
Input Voltage		1.6		V _{p-p}
Gain Control Range	-58		20	dB
Step Size	0	1.0	2.0	dB
Input Impedance @AMP2I pin		20		KΩ
MIC amplifier(1 st Stage)				
Gain range(defined by external resistors)	0		+20	dB
External Feedback Impedance	20			KΩ
MIC Bias				
Output Voltage when 4.7KΩ resistor connected	0.9VA			V _{dc}
Output Impedance		200	500	Ω
Output Current			3	mA
Power Supplies				
	Analog		10.5	mA
	Digital		8.5	mA
	Total		30	mA
	Power Down(Suspend Mode)		4.7	mA

FILTER CHARACTERISTICS

(Ta=25°C VA, VD =3.0 - 3.6 V ; fs = 44.1 kHz)

Parameter		Symbol	Min	typ	Max	Units
A/D Digital Filter (Decimation LPF)						
Passband	+/- 0.2 dB	PB	0		17.64	KHz
Stopband		SB	26.5			KHz
Passband Ripple		PR			+/- 0.2	dB
Stopband Attenuation		SA	68			dB
Group Delay		GD			0.5	ms
A/Ddigital Filter (HPF)						
Frequency Response	-3 dB	FR		6.85		Hz
	-0.5 dB			19.2		Hz
	-0.1 dB			44.9		Hz

Digital DC Characteristics

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 RST pin and levels of all test pins will not be tested.

Parameter	Symbol	Min	Typ	Max	Units
AGCE pin "H" level input voltage	VIH	70%VA			V
AGCE pin "L" level input voltage	VIL			30%VA	V
RSTN pin "H" level voltage	VIHR	2.0			V
RSTN pin "L" level voltage	VILR			0.8	V
"H" level output voltage IOH= 2mA	VOH	2.4			V
"L" level output voltage IOL= -2mA	VOL			0.6	V
Input Leakage Current	Iin			±10	µA

Switching Characteristics

Ta=25°C, VA=VD=3.3V

Parameter	Symbol	Min	Typ	Max	Units
Master Clock Frequency	MCLK	-	11.2896	-	MHz
Reset input width @RSTN pin(low active)	Wrst	1.0			us
Singe Ended Receiver Threshold	Vse	0.8		2.0	V
Main Clock Stable Time Vse(max) of D+ to stabilized MCLK (X'tal oscillator start up + PLL lock-in)	Tostb			100	ms
Reset Signal Recognition Both D+ and D- < Vse(min) to Reset mode	Trst_rec		2.5	5.5	µs
Device Ready Ready for transaction after reset	Tdrr			10	ms
Suspend Recognition Idle state (D+ > Vse(max) & D- < Vse(min)) to Suspend mode	Tsus_rec	3.0			ms
Resume Time First flip of D+/D- from Idle sate To Device Ready*)	Tresm			30	ms

Device Ready: VREF, X'tal oscillator, and PLL get stable and bus trans action with normal rate is ready.

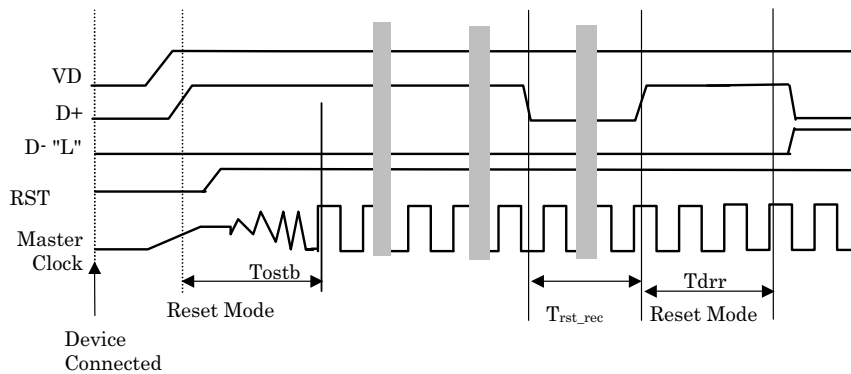


Figure 1. Mode change with respect to BUS States 1 (Power on and device connected)

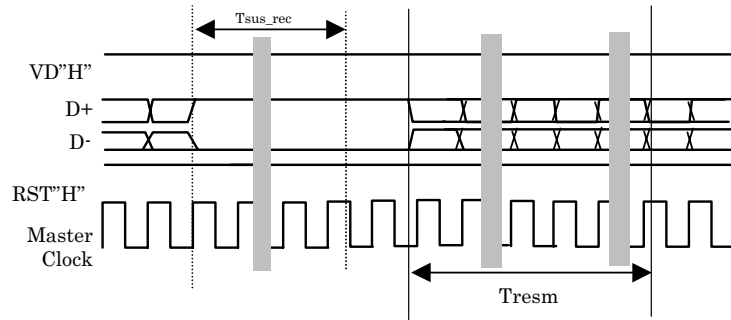


Figure 2. Mode Change with respect to Bus States 2 (Bus transactions)

Transmitter Characteristics							
Ta=25°C; VD=3.3V; DGND=0V; CL=50pF							
Parameter	Symbol	Pins	Conditions	Min	Typ	Max	Units
Data Rate	DR	DP, DN		11.97	12	12.03	MHz
Output Impedance (Hi)	Roh	DP, DN	DP, DN="H"		30		Ω
Output Impedance (Lo)	Rol	DP, DP	DP, DN="L"		30		Ω
"H" level Output Voltage	Vohd	DP, DN	IOH=-200uA	2.8			V
"L" level Output Voltage	Vold	DP, DN	IOH=2.2mA			0.3	V
Tri-state Leakage Current	Iolk	DP, DN	0 < DP, DN < 3.3V	-10		10	μ A
Rise/Fall Time	Trf/Tff	DP, DN		4	12	20	ns
Rise/Fall Time Matching	Trfm	DP, DN			100		%
Crossover Point	Vers	DP, DN			1.6		V

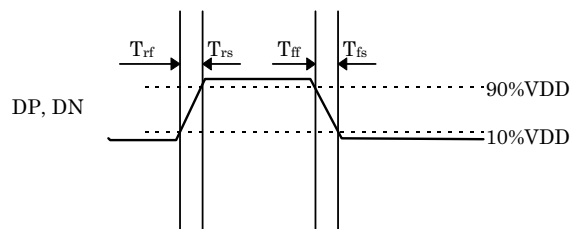


Figure 3. Rise/Fall Time

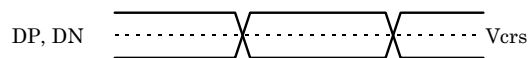


Figure 4. Crossover Point

Receiver Characteristics							
Ta=25°C; VD=3.3V; DGND=0V							
Parameter	Symbol	Pins	Conditions	Min	Typ	Max	Units
Schmitt High Level Voltage	V _{ih}	DP, DN		2.0			V
Schmitt Low Level Voltage	V _{il}	DP, DN				0.8	V

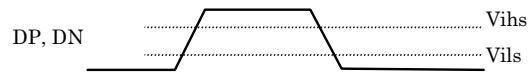


Figure 5. Schmitt Level Voltage

■ Overview of AK5370

The AK5370 is the advanced A/D converter, which converts analog signal of condenser microphone into USB audio class formats. This device is suitable for USB microphone. The AK5370 includes the following blocks:

1. AD converter
2. Pre-Amplifier with variable gain/attenuation
3. Serial Interface Engine
4. Control block of Audio Device Class
 - Support Mute, Gain/Attenuation, Sampling Frequency Control, and AGC (only decode the request)
5. USB transceiver
 - AK4170 compliant
6. FIFO memory for bus synchronization
 - Memory Size (16bit wide x 100 depth)
7. PLL
 - Synchronize Audio Stream data with USB bus I/F

The AK5370 supports 5 sampling frequencies (8kHz, 11.025kHz, 22.05kHz, 44.1kHz, 48kHz) mute control, volume control of Feature Unit in Audio Device Class. In addition to this, as the AK5370 decodes the AGC request, and puts “H” or “L” level to the external pin, AGC pin, it is easy to implement AGC with external circuit.

In order to support these frequencies, the AK5370 incorporates PLL. In addition to this, as the AK5370 consumes low power, it is possible to operate as bus-powered device.

■ Class & Descriptor Overview

USB peripheral usually belongs to a group, “Class”. The AK5370 belongs to Audio Device Class. The Class consists of four Descriptors, Device Descriptor, Configuration Descriptor, Interface Descriptor, and Endpoint Descriptor. The AK5370 has Audio Specific Interface Descriptor and Endpoint Descriptor.

(1) Device Descriptor

Device Descriptor describes the product information; product name, manufacturer, etc. In addition to this, Device Descriptor has Endpoint0 fifo-buffer size. At enumeration phase, host reads 8 bytes from the top of Device Descriptor at first. The host knows by reading **bMaxPacketSize0** in the Device Descriptor, and uses this value for the following transactions, and does not send the bigger data at once.

(2) Configuration Descriptor

Configuration Descriptor informs the host of the number of Interface, Bus-powered/Self-Powered device, etc. This descriptor is the same as Standard Interface Descriptor.

(3) Interface Descriptor

There are two Interfaces in Audio Class; Audio Control (AC) Interface, and Audio Streaming (AS) Interface. Each Audio Interface includes Standard Interface Descriptor and Class-Specific Interface.

Standard AC Interface Descriptor describes interface’s class.

Class-Specific AC Interface Descriptor is a concatenation of all the descriptors that are used to fully describe the audio function.

As the AK5370 has three logical audio functions; Input Terminal, Output Terminal, and Feature Unit (mute, volume, AGC), each terminal and unit has their own Descriptor.

Not only each descriptor has their own information, but also has connection information between the blocks.

For example, **bSourceID** field in Output Terminal Descriptor is 0x03, which is ID of Feature Unit. This means that Feature Unit is connected to Output Terminal.

Standard AS Interface has the interface class name (AUDIO) and sub-class name (AUDIO_STREAMING), the related Endpoint number, etc.

Class-Specific AS Interface Descriptor mainly shows Audio Data Format information that follows as Descriptor.

There is a note for Alternate Setting:

Alternate setting 0 is a zero-bandwidth setting, used to relinquish the claimed bandwidth on the bus when the microphone is not in use. It is the default setting after power-up. The zero bandwidth is implemented by specifying that this alternate setting of the interface has no endpoints associated with it (bNumEndpoints=0).

(4) Endpoint Descriptor

Endpoint Descriptor is a pipe for the data. The AK5370 has two Endpoints. One is Endpoint0 for Control Transfer. Another is Endpoint 1, whose direction is IN, is used for Isochronous Transfer. Standard AS Isochronous Endpoint tells Endpoint type like In/OUT, maximum packet size, synchronization type, etc. to the host. Main information of Class-Specific AS Endpoint Descriptor is sampling frequency.

Figure 6 shows Descriptor's hierarchy.

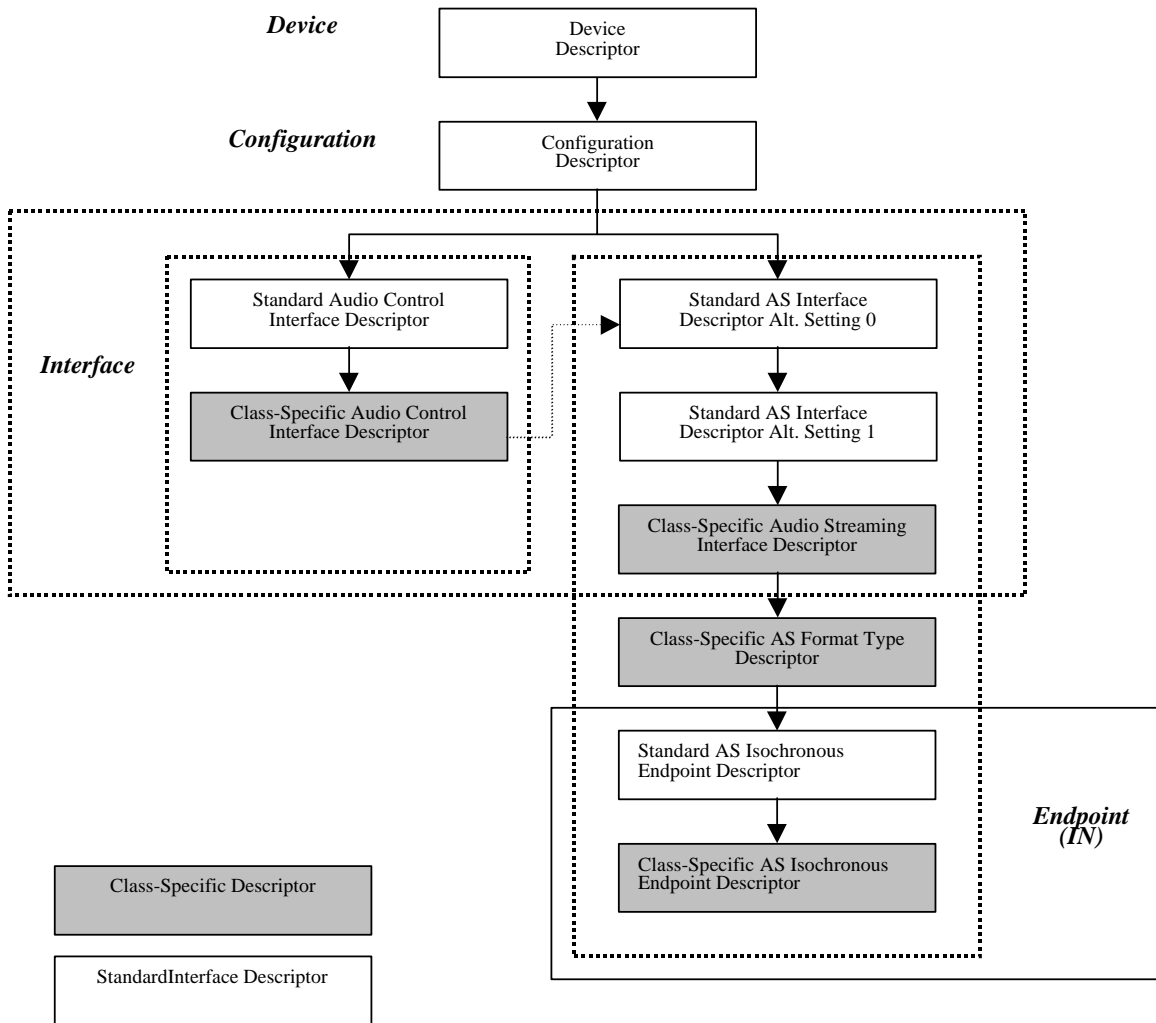


Figure 6. Descriptor Hierarchy

■ Synchronization

The AK5370 operates as Asynchronous Device. A/D converter in the AK5370 operates asynchronously with USB SOF timing. The data from A/D converter are sent continuously to a buffer memory while the data are burstly transferred at the interval of SOF on the USB. In order to control the difference of timing, AK5370 has a FIFO memory with a capacity of 2-frame depth. The average sampling rate calculating from USB frame should be in accordance with A/D sampling rate (fs).

The following figure shows an example. When sampling frequency is set to 44.1kHz, the number of data is almost 44 samples in one frame. But the AK5370 must send 45 samples in once per ten times. Please see **Figure 7**.

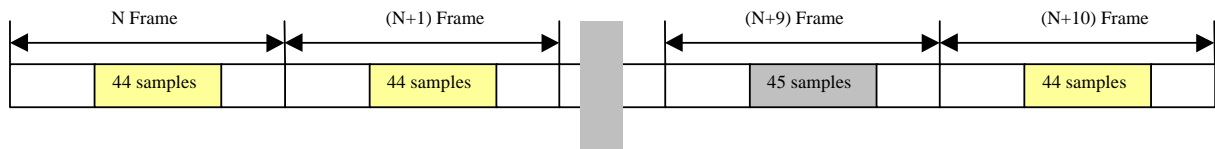


Figure 7. Synchronization

The data sampled by A/D converter in N Frame are output to the USB bus on somewhere the (N+1) frame by issuing IN transfer.

■ Power Management Control

In the normal operation, MICBIAS outputs the voltage to supply the microphone's bias voltage.

When idle state continues for 3ms, the AK5370 goes to suspend state and forces ADC block and other unnecessary block to power-down mode. MICBIAS pin does not supply the bias voltage to save power consumption and is open state under suspend state.

The device resumes the normal operation within 30ms after the device receives resume signal

■ Feature Unit Control & Frequency Control

The AK5370 has three feature unit function; mute, volume, and AGC.

The host issues "SET_FEATURE_UNIT_CONTROL" request to change the volume, the status of mute or AGC. The AK5370 responds to the request for CUR value only, not respond for MIN, MAX, RES value. Note that the AK5370 doesn't have AGC circuit itself and that it decodes AGC request only.

The host can get the CUR/MAX/MIN/RES value of the volume by requesting "GET_FEATURE_CONTROL". However, only CUR value is supported for mute and AGC.

Volume Control Format of USB Audio Class is a) 16-bit integer, b) upper-byte is integer (-127 to 127), and lower-byte is fraction. The AK5370 follows the conversion table described in **Table 1** in page 22 for the volume control request

When the AK5370 receives "SET_ENDPOINT_CONTROL" request, it changes sampling frequency(fs). If fs is not supported, the device forces to set the appropriate fs which it supports. The host can get fs by issuing "GET_ENDPOINT_CONTROL" request.

AK5370 Descriptors Specification

1. Product description

This device is one channel 16-bit ADC with USB I/F for monaural microphone, and operates as IN device.

2. Descriptor structure

This device includes one configuration, two interfaces, which are an audio control interface (0) and an audio streaming interface (1), two endpoints, which are endpoint 0 for default pipe, and endpoint 1 for audio streaming.

The descriptor is partly fixed and partly programmable by means of selectable test pin map. The programmable descriptors are marked with a star.

3. 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	0x0001	00 means Audio Product, 01 is AKMproduct ID ,
12	bcdDevice	2	0x0001	Device release code
14	iManufacturer	1	0x01	“AKM”
15	iProduct	1	0x02	“AK5370”
16	iSerialNumber	1	0x00	Unused
17	bNumConfigurations	1	0x01	One configuration

4. Configuration block

The configuration block consists of a configuration descriptor followed by interface, endpoint, and class-specific descriptors.

4.1 Configuration descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor
1	bDescriptorType	1	0x02	CONFIGURATION descriptor
2	wTotalLength	2	0x0076	Length of entire configuration block Total 118 bytes including this interface descriptor.
4	bNumInterfaces	1	0x02	Two interfaces
5	bConfigurationValue	1	0x01	Index of this configuration
6	iConfiguration	1	0x00	Null string
7	bmAttributes	1	0x80	Bus Powered Device
8	MaxPower	1	0x2D	Power consumption:90mA

4.2 Audio control interface

The audio control interface describes the device structure and is used to manipulate the audio controls.

4.2.1 Interface descriptor

This descriptor describes a standard interface which includes USB class code and the index to class-specific information.

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	Endpoint 0
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x01	AUDIO_CONTROL
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	null string

4.2.2 Class-specific interface header descriptor

Contains general information about the audio device.

Offset	Field	Size	Value	Description
0	bLength	1	0x09	Size of this descriptor
1	bDescriptorType	1	0x24	CS_INTERFACE
2	bDescriptorSubtype	1	0x01	HEADER subtype
3	bcdADC	2	0x0100	Revision of class specification – 1.0
5	wTotalLength	2	0x0026	Total size of class-specific Audio Control Interface descriptors (includes this descriptor)
7	bInCollection	1	0x01	Number of streaming interfaces
8	baInterfaceNr(1)	1	0x01	Streaming interface number 1 belongs to this audio control interface.

4.2.3 Input terminal descriptor

This descriptor describes the signal coming through the input port NumChannels is 1(monaural) and ChannelConfig is set no position. Terminal type is Microphone.

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	ID of associated Output Terminal is 0x02
7	bNrChannels	1	0x01	One channel (Monaural)
8	wChannelConfig	2	0x0000	Mono sets no position bits
10	iChannelNames	1	0x00	Unused
11	iTerminal	1	0x00	Unused

4.2.4 Output terminal descriptor

This descriptor describes the USB stream to host.

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	USB Streamer
6	bAssocTerminal	1	0x01	ID of associate Input Terminal is 0x01
7	bSourceID	1	0x03	From Feature Unit
8	iTerminal	1	0x00	Unused

4.2.5 Feature Unit descriptor

This descriptor describes Mute Control, Volume Control and Automatic Gain Control(AGC) .

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	0x03	ID of this feature Unit
4	bSourceID	1	0x01	ID to Terminal to which this is connected.
5	bControlSize	1	0x01	Size in bytes of an element of the bmaControl()
6	bmaControls(0)	1	0x43*	D0(Mute), and D1(Volume), D6(AGC) is enable
7	iFeature	1	0x00	Unused

*) When "L" level is applied to AGCE pin, bmaControl (0) data is modified to 0x03 to state AGC is not enable.

Note that there is never endpoint descriptor for endpoint 0.

4.3 Audio streaming interface

4.3.1 Zero bandwidth interface descriptor

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	Endpoints 0
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	null string

4.3.2 Interface descriptor

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	Endpoint 1
5	bInterfaceClass	1	0x01	AUDIO
6	bInterfaceSubclass	1	0x02	AUDIO_STREAMING
7	bInterfaceProtocol	1	0x00	Unused
8	iInterface	1	0x00	null string

4.3.3 Class-specific audio streaming interface descriptor

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	0x01	Interface delay
5	wFormatTag	2	0x0001	PCM

4.3.4 Type I format type descriptor

Offset	Field	Size	Value	Description
0	blength	1	0x17	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	0x05	Five frequencies
8	tSamFreq[0]	3	0x001F40	8000Hz
11	tSamFreq[1]	3	0x002B11	11025Hz
14	tSamFreq[2]	3	0x005622	22050Hz
17	tSamFreq[3]	3	0x00AC44	44100Hz
20	tSamFreq[4]	3	0x00BB80	48000Hz

4.4 Endpoint descriptor

4.4.1 Standard Endpoint Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x07	Length of this descriptor
1	bDescriptorType	1	0x05	ENDPOINT descriptor
2	bendpointAddress	1	0x81	Endpoint 1, IN direction
3	bmAttributes	1	0x01	Isochronous, asynchronous, not shared
4	wMaxPacketSize	2	0x0064	2byte*50sample*1ch=100 byte/frame
6	wInterval	1	0x01	One packet every frame (Must be set to 1)

4.4.2 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	GENERAL
3	bmAttributes	1	0x01	Sample rate control
4	bLockDelayUnits	1	0x00	Unused
5	wLockDelay	2	0x0000	

4.5 String descriptor 1

String descriptors use UNICODE. except for LANGID.

4.5.1 LANGID (0x00) Field

Offset	Field	Size	Value	Description
0	bLength	1	0x04	Length of this descriptor
1	bDescriptorType	1	0x03	STRING descriptor
2	bString	2	0x0409	“English(US)”

4.5.2.1 iManufacturer (0x01) Field in Device Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x022	Length of this descriptor
1	bdescriptorType	1	0x03	STRING descriptor
2	bString	6	0x0041 0x004B 0x004D 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020	“AKM ”

4.5.3.1iProduct (0x02) Field in Device Descriptor

Offset	Field	Size	Value	Description
0	bLength	1	0x22	Length of this descriptor
1	bDescriptorType	1	0x03	STRING descriptor
2	bString	12	0x0041 0x004B 0x0035 0x0033 0x0037 0x0030 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020 0x0020	"AK5370"

5. Standard requests

5.1 Clear Feature

The AK5370 accepts “Clear Feature” request without stall. Though this request does not influence to the operation of the device, the AK5370 does not support this request.

5.2 Get Configuration

AKM USB Microphone should return the value, one, to the host.

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	AKM USB Mic. has one configuration.

5.3 Get Descriptor

Offset	Field	Size	Value	Description
0	bmRequestType	1	0x80	
1	bRequest	1	0x06	GET_DESCRIPTOR
2	wValue	2	0xZZZZ	ZZZZ is assigned by host: High Byte is Descriptor Type, Low Byte is Index. DEVICE : 0x0100 : (Index is 0 only) CONFIGURATION : 0x0200 STRING: 0x03??(?? is 00, 01, 02)
4	wIndex	2	0x0000	if wValue is DEVICE or CONFIGURATION, wIndex is zero. If wValue is 0x0300(LANGID), wIndex is zero. If wValue is 0x0301 or 0x0302, wIndex is 0x0409.
6	wLength	2	0xZZZZ	Descriptor Length (ZZZZ is assigned by host)

5.4 Get Interface

AKM USB Microphone has alternate Audio Streaming Interface, zero bandwidth, and normal. So, the device returns the current selected bAlternateSetting value, 0x00(zero bandwidth Audio Streaming Interface) or 0x01(normal Audio Streaming Interface). If wIndex is “0” (Audio Control Interface), the device returns the value, “0x00.

Offset	Field	Size	Value	Description
0	bmRequestType	1	0x81	
1	bRequest	1	0x0A	GET_INTERFACE
2	wValue	2	0x0000	ZERO
4	wIndex	2	0x0000 0x0001	Audio Control Interface Audio Streaming Interface
6	wLength	2	0x0001	AKM USB Mic. Has zero bandwidth Audio Streaming Interface and normal Audio Streaming Interface.

5.5 Get Status

Offset	Field	Size	Value	Description
0	bmRequestType	1	0x80 0x81 0x82	DEVICE INTERFACE ENDPOINT
1	bRequest	1	0x00	GET_STATUS
2	wValue	2	0x0000	ZERO
4	wIndex	2		
6	wLength	2	0x0002	

The AKM USB MIC returns the following status.

- a) Device : 0x00 (AKM USB MIC is bus-powered device)
- b) Interface: 0x00 (All Zero)
- c) Endpoint : 0x00

5.6 Set Address

AKM USB MIC stores the wValue in the internal memory as Device Address. In addition to this, the device returns ACK.

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

5.7 Set Configuration

AKM USB MIC is placed to configured state only wValue of this request is 0x00 01. In addition to this, the device returns ACK.

Offset	Field	Size	Value	Description
0	bmRequestType	1	0x00	Zero
1	bRequest	1	0x09	SET_CONFIGURATION
2	wValue	2	0x0000 0x0001 others	Unconfigured State AKM USB MIC is set to configured state Unconfigured State
4	wIndex	2	0x0000	Zero
6	wLength	2	0x0000	Zero

5.8 Set Feature

The AK5370 accepts “Set Feature” request without stall. However note that the AK5370 does not support this request.

5.9 Set Interface

This request selects the alternate setting on interface 1 to control bandwidth allocation. Only 0x0000 is selected if wIndex is 0x0000 (Audio Control Interface) as current Interface.

Offset	Field	Size	Value	Description
0	bmRequestType	1	0x01	ONE D7 0 = Host to device D6..5 0 = Standard request D4..0 1 = Recipient is interface
1	bRequest	1	0x0B	SET_INTERFACE
2	wValue	2	0x0000 0x0001	Alternate Setting Control Interface or Zero Bandwidth of Streaming Interface Normal Streaming
4	wIndex	2	0x0000 0x0001	Audio Control Interface Audio Streaming Interface
6	wLength	2	0x0000	Zero

5.10 Synch Frame

As AKM USB Microphone does not support this request , pipe is stalled.

6. Device specific requests

AKM USB Microphone supports ONLY SET_CUR as bRequest field in Set Request Values.

6.1 Audio Control Request

AKM USB microphone support ONLY Feature Unit Control Request, not support other requests. Addition to this, it only supports SET_CUR value as bRequest field in Set Feature Unit Control Request Values. All Audio Control Requests are applied to channel 0, which means master channel.

6.1.1 Set Feature Unit Control Request

AKM USB Microphone supports only one form of parameter block.

a) Mute Control

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	0x0300	Upper Byte : bUnit ID field in Feature Unit Descriptor.(0x03) Lower Byte : Audio Control Interface(0x00)
6	wLength	2	0x0001	The Length of Mute Control Parameter Block

The parameter block of mute control is the following.

Offset	Field	Size	Value	Description
0	bMute	1	0x01 0x00	TRUE FALSE

b) Volume Control

Offset	Field	Size	Value	Description
0	bmRequestType	1	0x21	
1	bRequest	1	0x01	SET_CUR
2	wValue	2	0x0200	VOLUME_CONTROL CHANNEL_0
4	wIndex	2	0x0300	Upper Byte : bUnit ID field in Feature Unit Descriptor.(0x03) Lower Byte : Audio Control Interface(0x00)
6	wLength	2	0x0002	Volume Control

The parameter block of mute control is the following.

Offset	Field	Size	Value	Description
0	wVolume	2	0xZZZZ	The value is mapped to the volume register value. (refer to Figure 3 conversion table) ZZZZ is assigned by the host

If the wVolume exceeds the range, the AK5370 forces the value into the range. Please see the conversion table in the Get Feature Unit Control Request.

c) Automatic Gain Control

Offset	Field	Size	Value	Description
0	bmRequestType	1	0x21	
1	bRequest	1	0x01	SET_CUR
2	wValue	2	0x0700	AUTOMATIC_GAIN_CONTROL CHANNEL_0
4	wIndex	2	0x0300	Upper Byte : bUnit ID field in Feature Unit Descriptor.(0x03) Lower Byte : Audio Control Interface(0x00)
6	wLength	2	0x0001	The Length of Mute Control Parameter Block

The parameter block of mute control is the following.

Offset	Field	Size	Value	Description
0	bAGC	1	0x01 0x00	TRUE (AGC pin is "H") FALSE (AGC pin is "L": Default)

6.1.2 Get Feature Unit Control Request

AKM USB Microphone supports only one form of parameter block.

a) 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	0x0300	Upper Byte : bUnit ID field in Feature Unit Descriptor.(0x03) Lower Byte : Audio Control Interface(0x00)
6	wLength	2	0x0001	The Length of Mute Control Parameter Block

The device outputs the current setting of mute status.

Offset	Field	Size	Value	Description
0	bMute	1	0x01	TRUE
			0x00	FALSE

b) Volume Control

Offset	Field	Size	Value	Description
0	bmRequestType	1	0xA1	
1	bRequest	1	0x81	GET_CUR
			0x82	GET_MIN
			0x83	GET_MAX
			0x84	GET_RES
2	wValue	2	0x0200	VOLUME_CONTROL CHANNEL_0
4	wIndex	2	0x0300	Upper Byte : bUnit ID field in Feature Unit Descriptor.(0x03) Lower Byte : Audio Control Interface(0x00)
6	wLength	2	0x0002	Volume Control

The parameter block of Volume Control is the following.

Offset	Field	Size	Value	Description
0	wVolume	2	0xZZYY	bRequest = GET_CUR : returns current volume. YY must be 00h
			0xC600	bRequest = GET_MIN : -58dB
			0x1400	bRequest = GET_MAX : +20dB
			0x0100	bRequest = GET_RES : 1.0dB

Table 1 is the conversion map of USB class and internal volume register.

When host requests the volume value which is larger than the MAX value in the device, the device sets the MAX value to the volume. When host requests the volume value which is smaller than the MIN value in the device, the device sets the MIN value to the volume. RES value is 1.0dB.

Field wVolume	value	Step
0x7FFF	20.0000	1.0dB
-----	-----	
0x1400	20.0000	
0x13FF	19.0000	
-----	-----	
0x1301	19.0000	
0x1300	19.0000	
0x12FF	18.0000	
-----	-----	
0x1201	18.0000	
0x1200	18.0000	
-----	-----	
-----	-----	
0x02FF	2.0000	
-----	-----	
0x0201	2.0000	
0x0200	2.0000	
0x01FF	1.0000	
-----	-----	
0x0101	1.0000	
0x0100	1.0000	
0x00FF	0.0000	
-----	-----	
0x0001	0.0000	
0x0000	0.0000	
0xFFFF	-1.0000	
-----	-----	
0xFF01	-1.0000	
0xFF00	-1.0000	
0xFEFF	-2.0000	
-----	-----	
0xFE01	-2.0000	
0xFE00	-2.0000	
-----	-----	
-----	-----	
0xC700	-57.0000	
0xC6FF	-58.0000	
-----	-----	
0xC601	-58.0000	
0xC600	-58.0000	
0xC5FF	-58.0000	
-----	-----	
0x8000	-58.0000	

Table 1 Conversion Table of Volume Control

c) Automatic Gain Control

Offset	Field	Size	Value	Description
0	bmRequestType	1	0xA1	
1	bRequest	1	0x81	GET_CUR
2	wValue	2	0x0700	AUTOMATIC_GAIN_CONTROL CHANNEL_0
4	wIndex	2	0x0300	Upper Byte : bUnit ID field in Feature Unit Descriptor.(0x03) Lower Byte : Audio Control Interface(0x00)
6	wLength	2	0x0001	The Length of Mute Control Parameter Block

The device outputs the current setting of AGC.

Offset	Field	Size	Value	Description
0	bAGC	1	0x01 0x00	TRUE (AGC pin is "H") FALSE (AGC pin is "L")

6.2 Endpoint Control Request

The AK5370 supports five sampling frequencies. The sampling rate is changed when “Set Endpoint Control Request ” is issued. SET_CUR, GET_CUR of bRequest is only supported. GET_MIN, GET_MAX, and GET_RES of bRequest are not supported.

6.2.1 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) Lower byte: zero
4	wIndex	2	0x0081	Upper Byte : zero Lower Byte : Endpoint Address (0x81)
6	wLength	2	0x0003	The Length of Sampling Frequency Parameter Block

The parameter block of mute control is the following.

Offset	Field	Size	Value	Description
0	iSampleFreq	3	0xYYYYYY	The following five values are valid. Others are invalid. 0x001F40 : 8kHz 0x002B11 : 11.025kHz 0x005622 : 22.05kHz 0x00AC44 : 44.1kHz(default) 0x00BB80 : 48kHz

If the iSampleFreq is different from the above values, the AK5370 forces sampling frequency to the appropriate value.

6.2.2 Get Endpoint Control Request

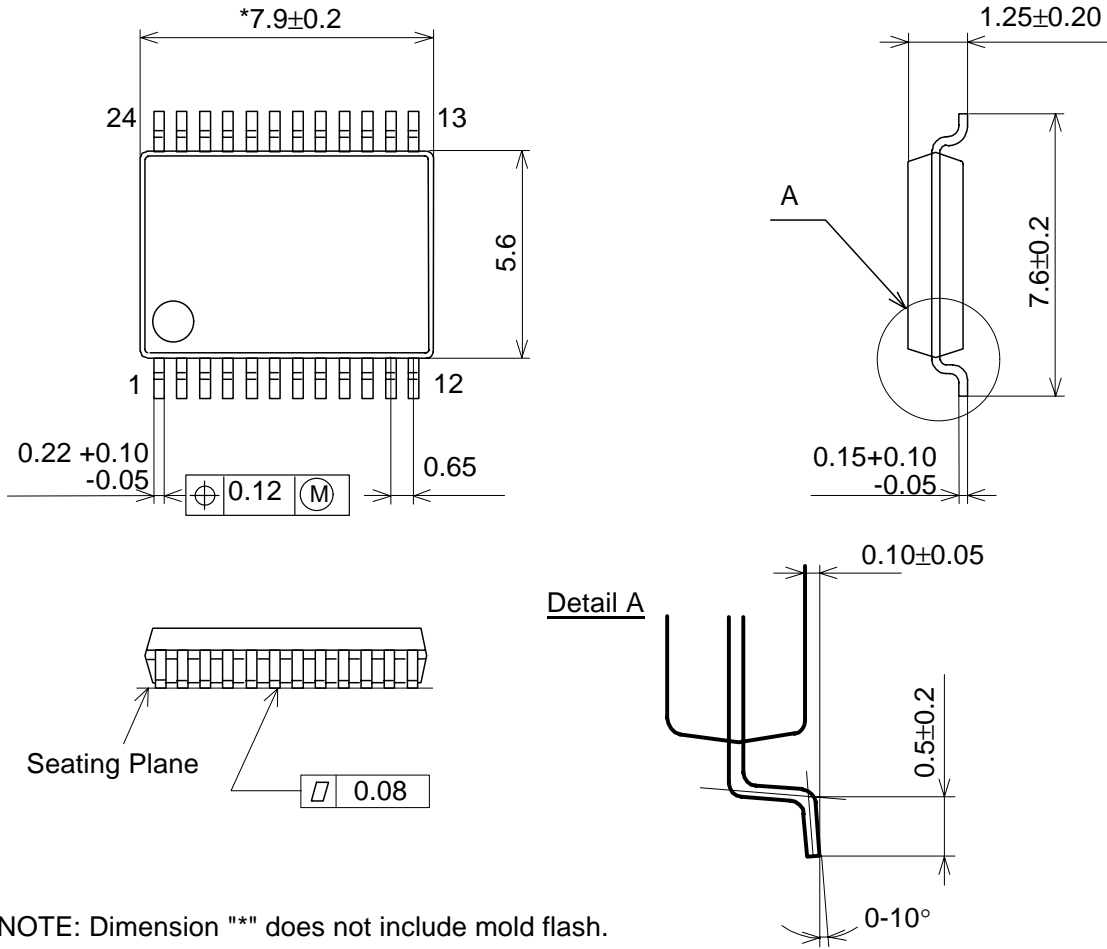
Offset	Field	Size	Value	Description
0	bmRequestType	1	0xA2	
1	bRequest	1	0x81	GET_CUR
2	wValue	2	0x0100	Upper byte: SAMPLING_FREQ_CONTROL (0x01) Lower byte: zero
4	wIndex	2	0x0081	Upper Byte : zero Lower Byte : Endpoint Address (0x81)
6	wLength	2	0x0003	The Length of Sampling Frequency Parameter Block

The parameter block of mute control is the following.

Offset	Field	Size	Value	Description
0	iSampleFreq	3	0xYYYYYY	The following five values are valid. Others are invalid. 0x001F40 : 8kHz 0x002B11 : 11.025kHz 0x005622 : 22.05kHz 0x00AC44 : 44.1kHz 0x00BB80 : 48kHz

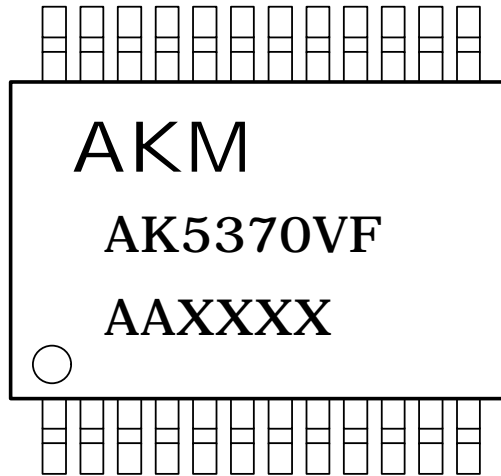
Package

24pin VSOP (Unit: mm)



NOTE: Dimension "*" does not include mold flash.

Marking



- 1) Pin #1 indication
- 2) AA: LOT#
- 3) Date Code: XXXXX(4 digits)
- 4) Marketing Code: AK5370VF
- 5) Asahi Kasei Logo

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