AK4620A

24-Bit 192kHz Audio CODEC with IPGA

GENERAL DESCRIPTION

The AK4620A is a high performance 24-bit CODEC that supports up to 192kHz record and playback. The on-board analog-to-digital converter has a high dynamic range due to AKM's Enhanced Dual-Bit architecture. The DAC utilizes AKM's Advanced Multi-Bit architecture that achieves low out-of-band noise and high jitter tolerance through the use of Switched Capacitor Filter (SCF) technology. The AK4620A has an input Programmable Gain Amplifier and is ideal for Pro Audio sound cards, Digital Audio Workstations, DVD-R, hard disk, CD-R recording/playback systems, and musical instrument recording.

FEATURES

- **24-bit 2-channel ADC**
  - **Selectable Single-ended or Differential Input**
  - **High Performance Linear Phase Digital Anti-Alias Filter**
    - **Passband: 0 ~ 20.25kHz (@fs=44.1kHz)**
    - **Ripple: ± 0.005dB**
    - **Stopband Attenuation: 100dB**
  - **S/(N+D): 92dB (single-ended)**
    100dB (differential)
  - **S/N: 110dB (single-ended)**
    113dB (differential)
  - **Digital High-pass Filter for Offset Cancellation**
  - **Input PGA: 0dB to +18dB, 0.5dB/step (for single-ended input)**
  - **Input Digital Attenuator: 0dB to – 63dB, 0.5dB/step**
  - **Overflow Flag**
  - **Audio Interface Format: MSB justified or I^2S**

- **24-bit 2-channel DAC**
  - **24-bit 8 times Oversampling Linear Phase Digital Filter**
    - **Ripple: ±0.005dB**
    - **Stopband Attenuation: 75dB**
  - **Switched-cap Low Pass Filter**
  - **Differential Outputs**
  - **S/(N+D): 100dB**
  - **S/N: 115dB**
  - **De-emphasis for 32kHz, 44.1kHz, 48kHz Sampling**
  - **Output Digital Attenuator: Linear 255 steps**
  - **Soft Mute**
  - **Zero Detection Function**
  - **Audio interface format: MSB justified, LSB justified, I^2S, or DSD**

- **High Jitter Tolerance**
- **Sampling Rate: Up to 216kHz**
- **μP Interface: 3-wire Serial Interface**
- **Master Clock**
  - **128fs/192fs/256fs/384fs/512fs/768fs/1024fs**
- **Power Supply: 5V ± 5%(Analog), 3V~3.6V with 5V tolerant I/O(Digital)**
- **Small 30-pin VSOP package**
- **Ta: -10 to 70 °C**

■ Block Diagram

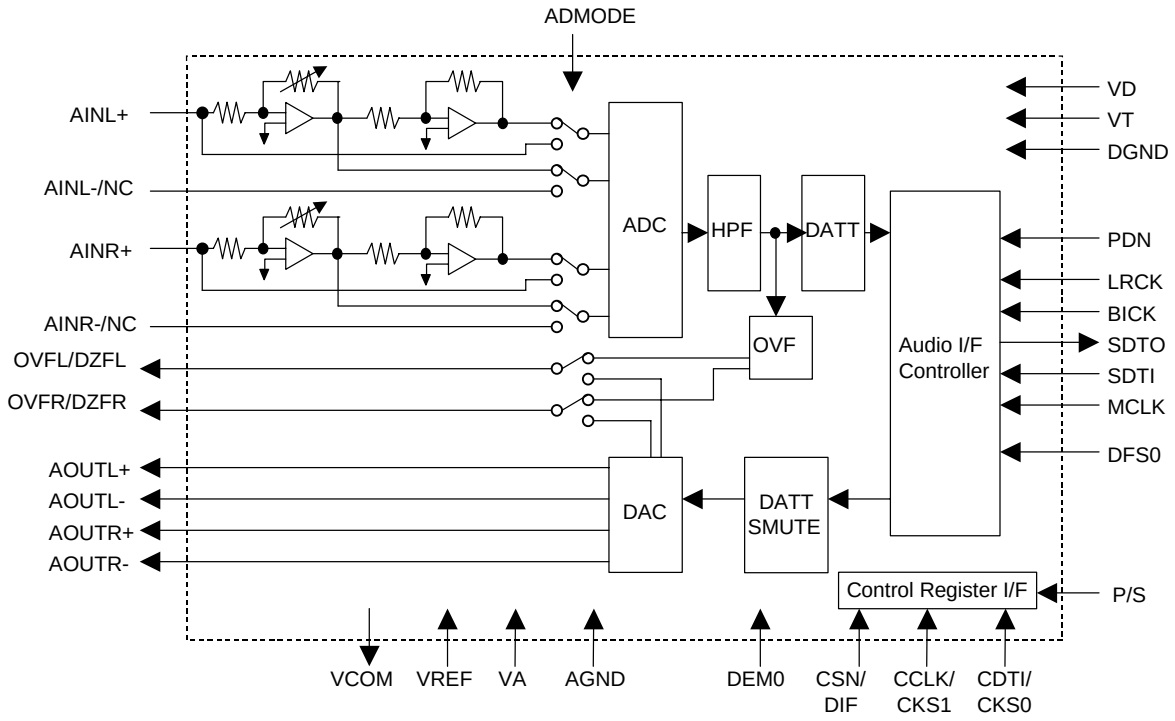


Figure 1. Block Diagram

- **Compatibility with AK4528 / AK4524**

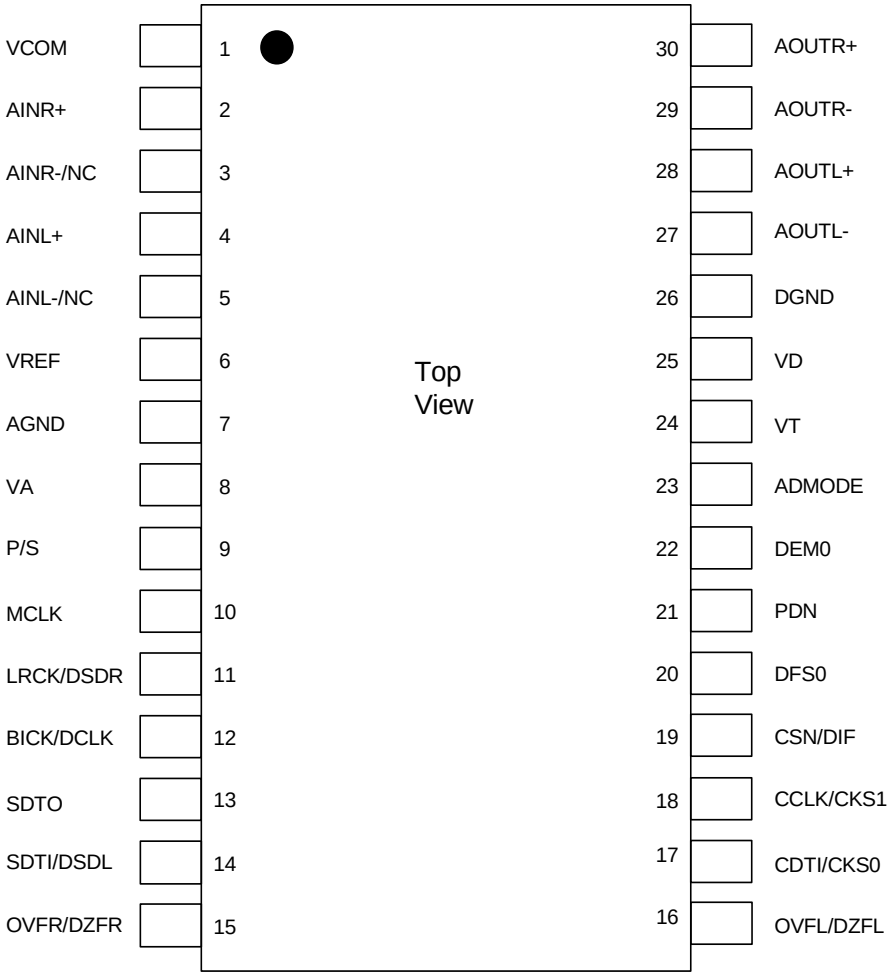
Function	AK4524	AK4528	AK4620A	
Max fs	96kHz	108kHz	216kHz	
ADC Inputs	Single-ended	Differential	Single-ended	Differential
Input analog PGA	0dB ~ +18dB 0.5dB/step	-	0 ~ +18dB 0.5dB/step	-
Input digital ATT	Mute, -72dB ~ 0dB Pseudo-log step	Mute, -72dB ~ 0dB Pseudo-log step	Mute,-63.5dB ~ 0dB 0.5dB/step	Mute,-63.5dB ~ 0dB 0.5dB/step
ADC S/(N+D)	90dB	94dB	92dB	100dB
ADC DR, S/N	100dB	108dB	110dB	113dB
ADC Digital Filter SA	75dB	75dB	100dB	
ADC Overflow detection	-	-	X	
DAC S/(N+D)	94dB	94dB	100dB	
DAC DR, S/N	110dB	110dB	115dB	
Output digital Attenuator	Mute, -72dB ~ 0dB Pseudo-log step	Mute, -72dB ~ 0dB Pseudo-log step	Mute, -48dB ~ 0dB Linear 256 steps	Mute, -48dB ~ 0dB Linear 256 steps
DAC DSD mode	-	-	X	
DAC Zero-data detection	-	-	X	
X'tal Oscillating Circuit	X	-	-	
Master Mode	X	-	-	
Parallel Mode	-	X	X	

X: Available, -: NOT available

■ Ordering Guide

AK4620AVF	-10~+70°C	30pin VSOP (0.65mm pitch)
AKD4620A	Evaluation Board	

■ Pin Layout



PIN/FUNCTION

No.	Pin Name	I/O	Function
1	VCOM	O	Common Voltage Output Pin, VA/2 Bias voltage of ADC inputs and DAC outputs.
2	AINR+	I	Rch Positive Input Pin
3	AINR-	I	Rch Negative Input Pin (when ADMODE pin="H")
		I	No Connect pin (when ADMODE pin="L") No internal bonding. This pin should be open.
4	AINL+	I	Lch Positive Input Pin
5	AINL-	I	Lch Negative Input Pin (when ADMODE pin="H")
		I	No Connect pin (when ADMODE pin="L") No internal bonding. This pin should be open.
6	VREF	I	Voltage Reference Input Pin, VA Used as a voltage reference by ADC & DAC. VREF is connected externally to filtered VA.
7	AGND	-	Analog Ground Pin
8	VA	-	Analog Power Supply Pin, 4.75 ~ 5.25V
9	P/S	I	Parallel/Serial Mode Select Pin "L": Serial Mode, "H": Parallel Mode Do not change this pin during PDN pin = "H".
10	MCLK	I	Master Clock Input Pin
11	LRCK	I	Input/Output Channel Clock Pin (in Parallel mode or when D/P bit="0" in Serial Mode)
	DSDR	I	DSD Rch Data Input Pin (when D/P bit="1" in Serial Mode)
12	BICK	I	Audio Serial Data Clock Pin (in Parallel mode or when D/P bit="0" in Serial Mode)
	DCLK	I	DSD Clock Pin (when D/P bit="1" in Serial Mode)
13	SDTO	O	Audio Serial Data Output Pin
14	SDTI	I	Audio Serial Data Input Pin (in Parallel mode or when D/P bit="0" in Serial Mode)
	DSDL	I	DSD Lch Data Input Pin (when D/P bit="1" in Serial Mode)
15	OVFR	O	Rch Over Flow Flag Pin (in Parallel mode or when ZOS bit="0" in Serial Mode)
	DZFR	O	Rch Zero Detection Flag Pin (when ZOS bit="1" in Serial Mode)
16	OVFL	O	Lch Over Flow Flag Pin (in Parallel mode or when ZOS bit="0" in Serial Mode)
	DZFL	O	Lch Zero Detection Flag Pin (when ZOS bit="1" in Serial Mode)
17	CDTI	I	Control Data Input Pin (in Serial Mode)
	CKS0	I	Master Clock Select Pin (in Parallel Mode)
18	CCLK	I	Control Data Clock Pin (in Serial Mode)
	CKS1	I	Master Clock Select Pin (in Parallel Mode)
19	CSN	I	Chip Select Pin in Serial Mode (in Serial Mode)
	DIF	I	Digital Audio Interface Select Pin (in Parallel Mode) "L": 24bit MSB justified, "H": I^2S compatible
20	DFS0	I	Double Speed Sampling Mode Pin
21	PDN	I	Power-Down Mode Pin "L": Power down reset and initialize the control register, "H": Power up
22	DEM0	I	De-emphasis Control Pin
23	ADMODE	I	Analog Input Mode Select Pin "L": Single-ended Input & IPGA Enable "H": Differential Input & IPGA Bypass

PIN/FUNCTION (Continued)

24	VT	-	Input Buffer Tolerant Pin, 3.0 ~ 5.25V
25	VD	-	Digital Power Supply Pin, 3.0 ~ 3.6V
26	DGND	-	Digital Ground Pin
27	AOUTL-	O	Lch Negative Analog Output Pin
28	AOUTL+	O	Lch Positive Analog Output Pin
29	AOUTR-	O	Rch Negative Analog Output Pin
30	AOUTR+	O	Rch Positive Analog Output Pin

Note. Do not allow digital input pins (P/S, MCLK, LRCK/DSDR, BICK/DCLK, SDTI/DSDL, CDTI/CKS0, CCLK/CKS1, CSN/DIF, DFS0, PDN, DEM0 and ADMODE pins) to float.

■ Handling of Unused Pin

The unused I/O pin should be processed appropriately as below.

Classification	Pin Name	Setting
Analog Input	AINL+, AINL-/NC, AINR+, AINR+NC	These pins should be open when ADMODE pin = “L”.
	AINL+, AINL-/NC	AINL+ pin is connected to AINL-/NC pin when ADMODE pin = “H”.
	AINR+, AINR-/NC	AINR+ pin is connected to AINR-/NC pin when ADMODE pin = “H”.
Analog Output	AOUTL+, AOUTL-, AOUTR+, AOUTR-	These pins should be open.
Digital Input	DEM0	This pin should be connected to DVSS.
Digital Output	OVFL/DZFL, OVFR/DZFR	These pins should be open.

ABSOLUTE MAXIMUM RATINGS

(AGND, DGND=0V;Note 1)

Parameter		Symbol	min	max	Units
Power Supplies:	Analog	VA	-0.3	6.0	V
	Digital	VD	-0.3	6.0	V
	Input Tolerant	VT	-0.3	6.0	V
	|AGND – DGND| (Note 2)	ΔGND	-	0.3	V
Input Current, Any Pin Except Supplies		IIN	-	±10	mA
Analog Input Voltage (Note 3)		VINA	-0.3	VA+0.3	V
Digital Input Voltage (Note 4)		VIND	-0.3	VT+0.3	V
Ambient Temperature (powered applied)		Ta	-10	70	°C
Storage Temperature		Tstg	-65	150	°C

Note 1. All voltages with respect to ground.
Note 2. AGND and DGND must be connected to the same analog ground plane.
Note 3. AINL+, AINL-/NC, AINR+ and AINR-/NC pins
Note 4. P/S, MCLK, LRCK/DSDR, BICK/DCLK, SDTI/DSDL, CDTI/CKS0, CCLK/CKS1, CSN/DIF, DFS0, PDN, DEM0 and ADMODE pins.

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

RECOMMENDED OPERATING CONDITIONS

(AGND, DGND=0V;Note 1)

Parameter		Symbol	min	typ	max	Units
Power Supplies	Analog	VA	4.75	5.0	5.25	V
(Note 5)	Digital	VD	3.0	3.3	3.6	V
	Input Tolerant	VT	VD	5.0	5.25	V
Voltage Reference		VREF	3.0	-	VA	V

Note 5. The power up sequence among VA, VD and VT is not critical.

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

ANALOG CHARACTERISTICS (ADC: Single-ended Input)

(Ta=25°C; VA=5V, VD=3.3V, VT=5V; AGND=DGND=0V; VREF=VA; fs=44.1kHz; Signal Frequency =1kHz; 24bit Data; Measurement frequency=20Hz ~ 20kHz at fs=44.1kHz, 40Hz ~ 40kHz at fs=96kHz, 40Hz ~ 40kHz at fs=192kHz; unless otherwise specified)

Parameter			min	typ	max	Units
Input PGA Characteristics:						
Input Voltage		(Note 6)	2.77	3.07	3.37	Vpp
Input Resistance		(Note 7)	0.7	5.1	-	kΩ
Step Size			0.2	0.5	0.8	dB
Gain Control Range			0		18	dB
ADC Analog Input Characteristics: IPGA=0dB						
Resolution					24	Bits
S/(N+D)	fs=44.1kHz	-1dBFS	82	92		dB
	BW=20kHz	-60dBFS	-	47		dB
	fs=96kHz	-1dBFS	-	92		dB
	BW=40kHz	-60dBFS	-	44		dB
	fs=192kHz	-1dBFS	-	92		dB
	BW=40kHz	-60dBFS	-	44		dB
Dynamic Range		(-60dBFS with A-weighted)	-	110		dB
S/N		(A-weighted)	101	110		dB
Interchannel Isolation			90	105		dB
Interchannel Gain Mismatch				0.2	0.5	dB
Gain Drift				150	-	ppm/°C
Power Supply Rejection		(Note 8)	-	50		dB

ANALOG CHARACTERISTICS (ADC: Differential Input)

(Ta=25°C; VA=5V, VD=3.3V, VT=5V; AGND=DGND=0V; VREF=VA; fs=44.1kHz; Signal Frequency =1kHz; 24bit Data; Measurement frequency=20Hz ~ 20kHz at fs=44.1kHz, 40Hz ~ 40kHz at fs=96kHz, 40Hz ~ 40kHz at fs=192kHz; unless otherwise specified)

Parameter			min	typ	max	Units
ADC Analog Input Characteristics:						
Resolution					24	Bits
Input Voltage		(Note 9)	±2.62	±2.82	±3.02	Vpp
Input Resistance		fs=44.1kHz	8	14	-	kΩ
		fs=48kHz	-	13	-	kΩ
		fs=96kHz	-	13	-	kΩ
		fs=192kHz	-	13	-	kΩ
S/(N+D)	fs=44.1kHz	-1dBFS	90	100		dB
	BW=20kHz	-60dBFS	-	50		dB
	fs=96kHz	-1dBFS	-	100		dB
	BW=40kHz	-60dBFS	-	46		dB
	fs=192kHz	-1dBFS	-	100		dB
	BW=40kHz	-60dBFS	-	46		dB
Dynamic Range		(-60dBFS with A-weighted)	-	113		dB
S/N		(A-weighted)	103	113		dB
Interchannel Isolation			90	120		dB
Interchannel Gain Mismatch				0.1	0.5	dB
Gain Drift				20	-	ppm/°C
Power Supply Rejection		(Note 8)	-	50		dB

Note 6. Full scale (0dB) of the input voltage at PGA=0dB.
This voltage is proportional to VREF. Vin(typ) = 3.07Vpp x VREF/5.
Note 7. These values become smaller when a gain of IPGA is large.
IPGA=0dB; typ. 5.1kΩ, IPGA=+18dB; typ. 1.18kΩ
Note 8. PSR is applied to VA, VD, VT with 1kHz, 50mVpp. VREF pin is held a constant voltage.
Note 9. Full scale (0dB) of the input voltage at 0dB. This voltage is proportional to VREF.
Vin (typ) = ±2.82Vpp x VREF/5.

ANALOG CHARACTERISTICS (DAC)

(Ta=25°C; VA=5V, VD=3.3V, VT=5V; AGND=DGND=0V; VREF=VA; fs=44.1kHz; Signal Frequency =1kHz; 24bit Data; Measurement frequency=20Hz ~ 20kHz at fs=44.1kHz, 40Hz ~ 40kHz at fs=96kHz, 40Hz ~ 40kHz at fs=192kHz; unless otherwise specified)

DAC Analog Output Characteristics:						
Parameter			**min**	**typ**	**max**	**Units**
Resolution					24	Bits
Dynamic Characteristics						
S/(N+D)	fs=44.1kHz	0dBFS	90	100		dB
	BW=20kHz	–60dBFS	-	52		dB
	fs=96kHz	0dBFS	-	97		dB
	BW=40kHz	–60dBFS	-	49		dB
	fs=192kHz	0dBFS	-	97		dB
	BW=40kHz	–60dBFS	-	49		dB
Dynamic Range (–60dBFS with A-weighted) (Note 10, Note 11)			-	115		dB
S/N (A-weighted) (Note 11, Note 12)			107	115		dB
Interchannel Isolation (1kHz)			90	110		dB
DC Accuracy						
Interchannel Gain Mismatch				0.15	0.3	dB
Gain Drift (Note 13)				20	-	ppm/°C
Output Voltage (Note 14)			±2.6	±2.8	±3.0	Vpp
Load Capacitance					25	pF
Load Resistance (Note 15)			3			kΩ

Note 10. 100dB at 16bit data and 114dB at 20bit data.
Note 11. By Figure 19. External LPF Circuit Example 2 for PCM.
Note 12. S/N does not depend on input bit length.
Note 13. The voltage on VREF is held +5V externally.
Note 14. Full-scale voltage(0dB). Output voltage scales with the voltage of VREF.
AOUT (typ.@0dB) = (AOUT+) - (AOUT-) = 5.6Vpp x VREF/5.
Note 15. For AC-load.

Parameter		**min**	**typ**	**max**	**Units**
Power Supplies					
Power Supply Current					
Normal Operation (PDN pin = "H")					
VA: ADC Single-ended Mode			60	90	mA
ADC Differential Mode			51	77	mA
VD+VT (fs=44.1kHz)			10	-	mA
(fs=96kHz)			18	-	mA
(fs=192kHz)			22	33	mA
Power-down mode (PDN pin = "L") (Note 16)					
VA			10	100	μA
VD+VT			10	100	μA

Note 16. All digital input pins are held VT or DGND.

ADC FILTER CHARACTERISTICS (fs=44.1kHz)

(Ta=25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; Normal Speed Mode)

Parameter		Symbol	min	typ	max	Units
ADC Digital Filter (Decimation LPF):						
Passband (Note 17)	–0.005dB	PB	0		19.8	kHz
	–0.02dB		-	20.25	-	kHz
	–0.06dB		-	20.4	-	kHz
	–6.0dB		-	22.05	-	kHz
Stopband (Note 17)		SB	24.3			kHz
Passband Ripple		PR			±0.005	dB
Stopband Attenuation		SA	100			dB
Group Delay (Note 18)		GD		43.2		1/fs
Group Delay Distortion		ΔGD		0		μs
ADC Digital Filter (HPF):						
Frequency Response (Note 17)	–3dB	FR		0.9		Hz
	–0.1dB			6.0		Hz

ADC FILTER CHARACTERISTICS (fs=96kHz)

(Ta=25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; Double Speed Mode)

Parameter		Symbol	min	typ	max	Units
ADC Digital Filter (Decimation LPF):						
Passband (Note 17)	–0.005dB	PB	0		43.0	kHz
	–0.02dB		-	44.08	-	kHz
	–0.06dB		-	44.5	-	kHz
	–6.0dB		-	48.0	-	kHz
Stopband (Note 17)		SB	53.0			kHz
Passband Ripple		PR			±0.005	dB
Stopband Attenuation		SA	100			dB
Group Delay (Note 18)		GD		43.1		1/fs
Group Delay Distortion		ΔGD		0		μs
ADC Digital Filter (HPF):						
Frequency Response (Note 17)	–3dB	FR		2.0		Hz
	–0.1dB			13.0		Hz

FILTER CHARACTERISTICS (fs=192kHz)

(Ta=25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; Quad Speed Mode)

Parameter		Symbol	min	typ	max	Units
ADC Digital Filter (Decimation LPF):						
Passband (Note 17)	–0.005dB	PB	0		86.0	kHz
	–0.02dB		-	88.18	-	kHz
	–0.06dB		-	89.0	-	kHz
	–6.0dB		-	96.0	-	kHz
Stopband (Note 17)		SB	106.0			kHz
Passband Ripple		PR			±0.005	dB
Stopband Attenuation		SA	100			dB
Group Delay (Note 18)		GD		38.2		1/fs
Group Delay Distortion		ΔGD		0		μs
ADC Digital Filter (HPF):						
Frequency Response (Note 17)	–3dB	FR		4.0		Hz
	–0.1dB			26.0		Hz

Note 17. The passband and stopband frequencies scale with fs. The reference frequency of these responses is 1kHz.
Note 18. The calculated delay time induced by digital filtering. This time is from the input of an analog signal to the setting of 24bit data both channels to the ADC output register for ADC.

DAC SHARP ROLL-OFF FILTER CHARACTERISTICS (fs = 44.1kHz)

(Ta = 25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; fs = 44.1kHz; Normal Speed Mode; DEM = OFF; SLOW = "0")

Parameter			Symbol	min	typ	max	Units
Digital Filter							
Passband	±0.01dB	(Note 19)	PB	0		20.0	kHz
	-6.0dB			-	22.05	-	kHz
Stopband		(Note 19)	SB	24.1			kHz
Passband Ripple			PR			± 0.005	dB
Stopband Attenuation			SA	75			dB
Group Delay		(Note 20)	GD	-	28	-	1/fs
Digital Filter + SCF							
Frequency Response: 0 ~ 20.0kHz				-	± 0.2	-	dB

DAC SHARP ROLL-OFF FILTER CHARACTERISTICS (fs = 96kHz)

(Ta = 25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; fs = 96kHz; Double Speed Mode; DEM = OFF; SLOW = "0")

Parameter			Symbol	min	typ	max	Units
Digital Filter							
Passband	±0.01dB	(Note 19)	PB	0		43.5	kHz
	-6.0dB			-	48.0	-	kHz
Stopband		(Note 19)	SB	52.5			kHz
Passband Ripple			PR			± 0.005	dB
Stopband Attenuation			SA	75			dB
Group Delay		(Note 20)	GD	-	28	-	1/fs
Digital Filter + SCF							
Frequency Response: 0 ~ 40.0kHz				-	± 0.3	-	dB

DAC SHARP ROLL-OFF FILTER CHARACTERISTICS (fs = 192kHz)

(Ta = 25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; fs = 192kHz; Quad Speed Mode; DEM = OFF; SLOW = "0")

Parameter			symbol	min	typ	max	Units
Digital Filter							
Passband	±0.01dB	(Note 19)	PB	0		87.0	kHz
	-6.0dB			-	96.0	-	kHz
Stopband		(Note 19)	SB	105			kHz
Passband Ripple			PR			± 0.005	dB
Stopband Attenuation			SA	75			dB
Group Delay		(Note 20)	GD	-	28	-	1/fs
Digital Filter + SCF							
Frequency Response: 0 ~ 80.0kHz				-	+0/-1	-	dB

Note 19. The passband and stopband frequencies scale with fs.
For example, PB = 0.4535×fs (@±0.01dB), SB = 0.546×fs.

Note 20. Delay time caused by digital filtering. This time is from setting the 16/20/24bit data of both channels to input register to the output of analog signal.

DAC SLOW ROLL-OFF FILTER CHARACTERISTICS (fs = 44.1kHz)

(Ta = 25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; fs = 44.1kHz; Normal Speed Mode; DEM = OFF; SLOW = "1")

Parameter			Symbol	min	typ	max	Units
Digital Filter							
Passband	±0.04dB	(Note 21)	PB	0		8.1	kHz
	-3.0dB			-	18.2	-	kHz
Stopband		(Note 21)	SB	39.2			kHz
Passband Ripple			PR			± 0.005	dB
Stopband Attenuation			SA	72			dB
Group Delay		(Note 20)	GD	-	28	-	1/fs
Digital Filter + SCF							
Frequency Response: 0 ~ 20.0kHz				-	+0/-5	-	dB

DAC SLOW ROLL-OFF FILTER CHARACTERISTICS (fs = 96kHz)

(Ta = 25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; fs = 96kHz; Double Speed Mode; DEM = OFF; SLOW = "1")

Parameter			Symbol	min	typ	max	Units
Digital Filter							
Passband	±0.04dB	(Note 21)	PB	0		17.7	kHz
	-3.0dB			-	39.6	-	kHz
Stopband		(Note 21)	SB	85.3			kHz
Passband Ripple			PR			± 0.005	dB
Stopband Attenuation			SA	72			dB
Group Delay		(Note 20)	GD	-	28	-	1/fs
Digital Filter + SCF							
Frequency Response: 0 ~ 40.0kHz				-	+0/-4	-	dB

DAC SLOW ROLL-OFF FILTER CHARACTERISTICS (fs = 192kHz)

(Ta = 25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; fs = 192kHz; Quad Speed Mode; DEM = OFF; SLOW = "1")

Parameter			Symbol	min	typ	max	Units
Digital Filter							
Passband	±0.04dB	(Note 21)	PB	0		35.5	kHz
	-3.0dB			-	79.1	-	kHz
Stopband		(Note 21)	SB	171			kHz
Passband Ripple			PR			± 0.005	dB
Stopband Attenuation			SA	72			dB
Group Delay		(Note 20)	GD	-	28	-	1/fs
Digital Filter + SCF							
Frequency Response: 0 ~ 80.0kHz				-	+0/-5	-	dB

Note 21. The passband and stopband frequencies scale with fs.
For example, PB = 0.185×fs (@±0.04dB), SB = 0.888×fs.

DIGITAL CHARACTERISTICS

(Ta=25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V)

Parameter	Symbol	min	typ	max	Units
High-Level Input Voltage	VIH	70%VD	-	VT	V
Low-Level Input Voltage	VIL	-	-	30%VD	V
High-Level Output Voltage (Iout=-100μA)	VOH	VD-0.5	-	-	V
Low-Level Output Voltage (Iout=100μA)	VOL	-	-	0.5	V
Input Leakage Current	Iin	-	-	±10	μA

SWITCHING CHARACTERISTICS

(Ta=25°C; VA=4.75 ~ 5.25V; VD=3.0 ~ 3.6V, VT=3.0 ~ 5.25V; C_L=20pF)

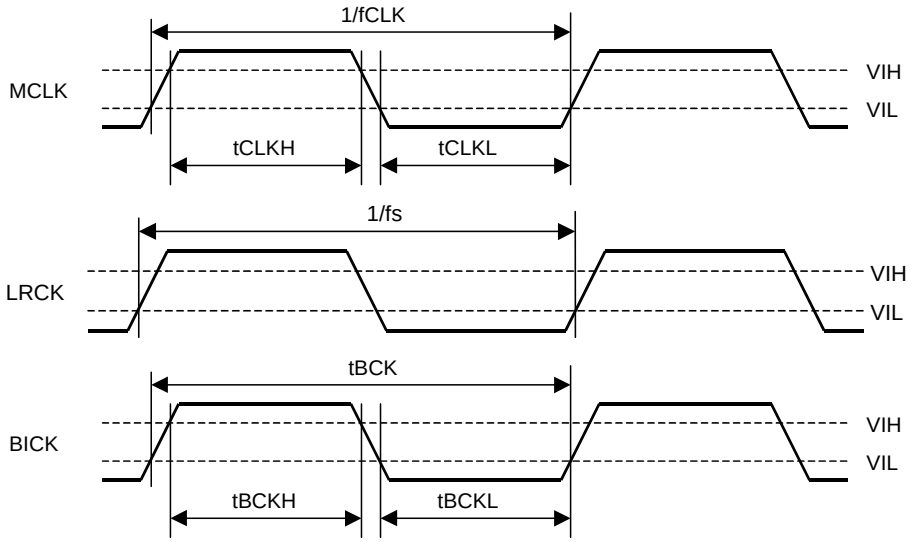
Parameter	Symbol	min	typ	max	Units
Master Clock Timing					
Frequency	fCLK	8.192		55.296	MHz
Pulse Width Low	tCLKL	0.4/fCLK			ns
Pulse Width High	tCLKH	0.4/fCLK			ns
LRCK Frequency (Note 22)					
Normal Speed Mode (DFS0="0", DFS1="0")	fsn	32		54	kHz
Double Speed Mode (DFS0="1", DFS1="0")	fsd	54		108	kHz
Quad Speed Mode (DFS0="0", DFS1="1")	fsq	108		216	kHz
Duty Cycle		45		55	%
PCM Audio Interface Timing					
BICK Period					
Normal Speed Mode	tBCK	1/128fsn			ns
Double Speed Mode	tBCK	1/64fsd			ns
Quad Speed Mode	tBCK	1/64fsq			ns
BICK Pulse Width Low	tBCKL	33			ns
Pulse Width High	tBCKH	33			ns
LRCK Edge to BICK "↑" (Note 23)	tLRB	20			ns
BICK "↑" to LRCK Edge (Note 23)	tBLR	20			ns
LRCK to SDTO (MSB) (Except I^2S mode)	tLRS			20	ns
BICK "↓" to SDTO	tBSD			20	ns
SDTI Hold Time	tSDH	20			ns
SDTI Setup Time	tSDS	20			ns
DSD Audio Interface Timing					
DCLK Period	tDCK	1/64fs			ns
DCLK Pulse Width Low	tDCKL	160			ns
Pulse Width High	tDCKH	160			ns
DCLK Edge to DSDL/R (Note 24)	tDDD	-20		20	ns

Note 22. When the normal/double/quad speed modes are switched, the AK4620A should be reset by PDN pin or RSTN bit.
Note 23. BICK rising edge must not occur at the same time as LRCK edge.
Note 24. DSD data transmitting device must meet this time.

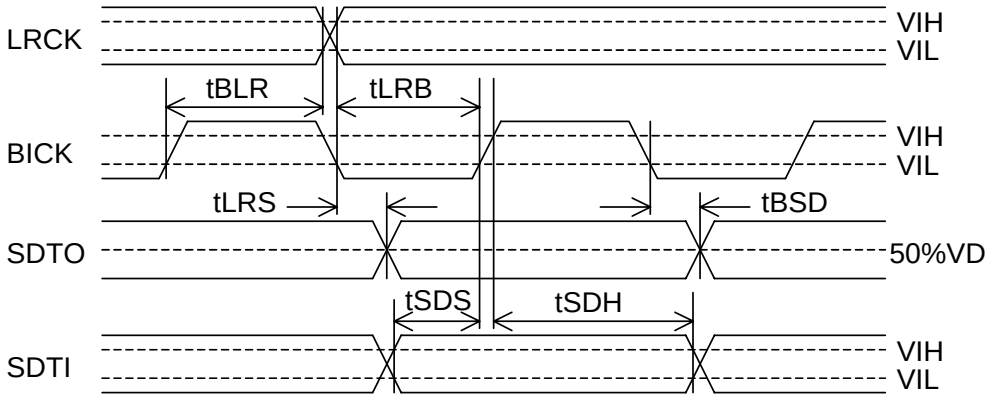
Parameter	Symbol	min	typ	max	Units
Control Interface Timing					
CCLK Period	tCCK	200			ns
CCLK Pulse Width Low	tCCKL	80			ns
Pulse Width High	tCCKH	80			ns
CDTI Setup Time	tCDS	50			ns
CDTI Hold Time	tCDH	50			ns
CSN "H" Time	tCSW	150			ns
CSN "↓" to CCLK "↑"	tCSS	50			ns
CCLK "↑" to CSN "↑"	tCSH	50			ns
Reset Timing					
PDN Pulse Width (Note 25)	tPD	150			ns
RSTAD "↑" to SDTO valid (Note 26)	tPDV		516		1/fs

Note 25. The AK4620A can be reset by bringing PDN pin "L".
Note 26. These cycles are the number of LRCK rising from RSTAD bit.

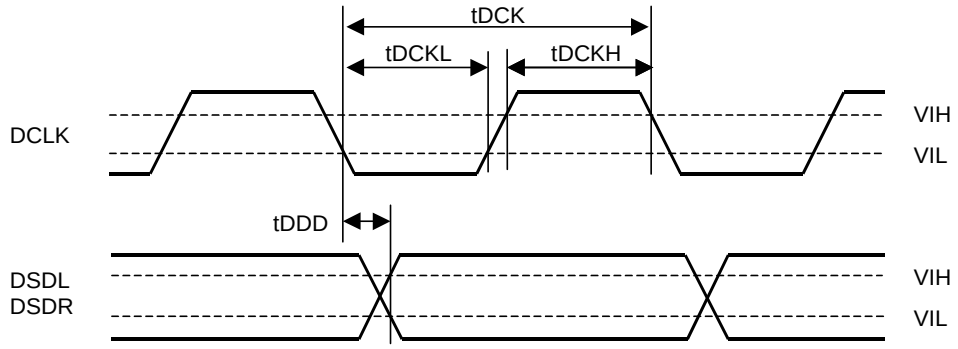
■ Timing Diagram



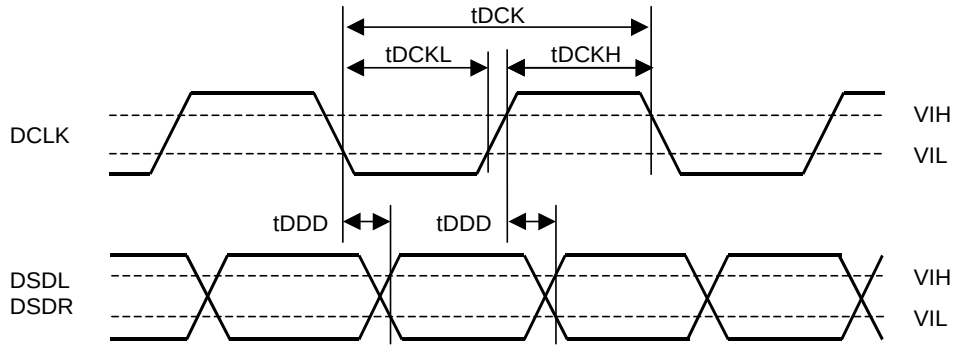
Clock Timing



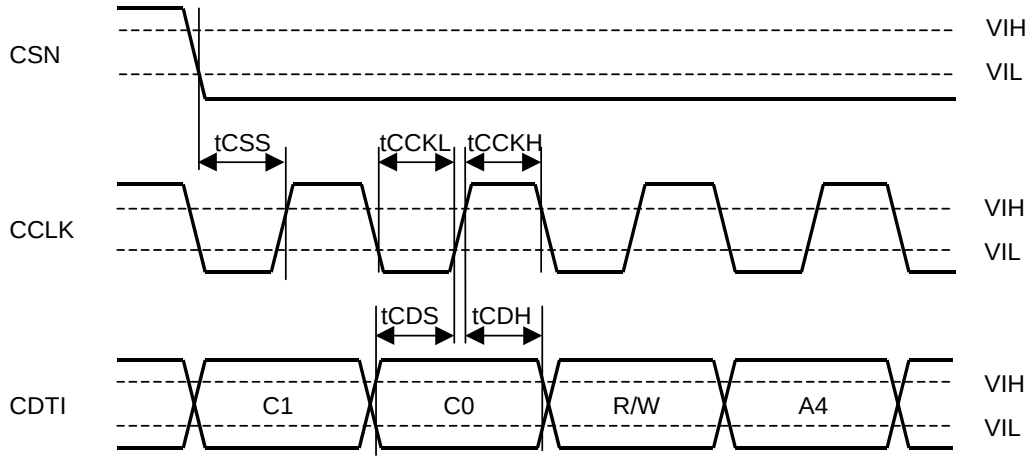
Audio Interface Timing (PCM mode)



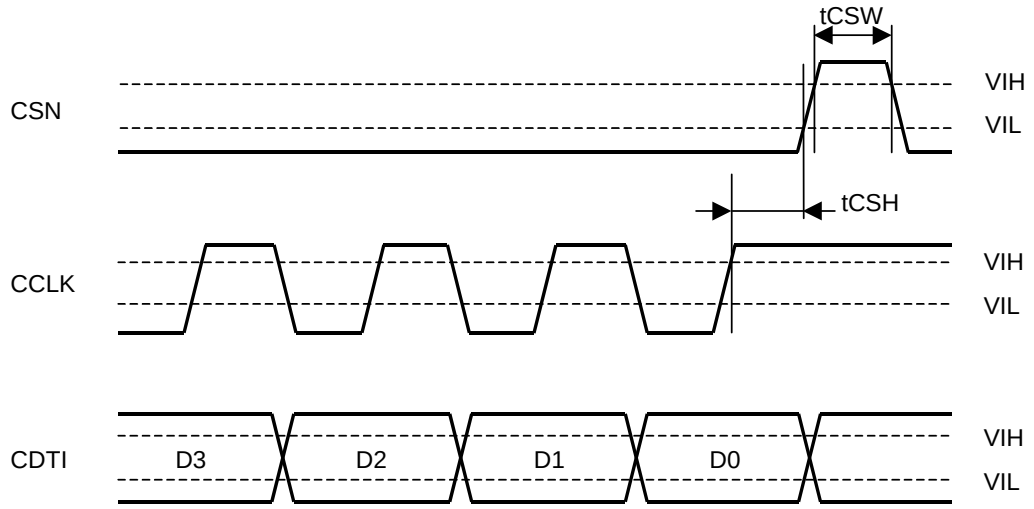
Audio Serial Interface Timing (DSD Normal Mode, DCKB bit = “0”)



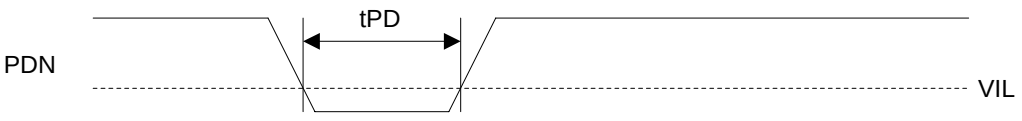
Audio Serial Interface Timing (DSD Phase Modulation Mode, DCKB bit = “0”)



WRITE Command Input Timing



WRITE Data Input Timing



Power Down & Reset Timing

OPERATION OVERVIEW

■ D/A Conversion Mode

In serial mode, the AK4620A can digitize either PCM data or DSD data. The P/D bit controls PCM/DSD mode. When DSD mode, DSD data input occurs on DCLK, DSDL and DSDR pins. The ADC and IPGA are in power down mode. In PCM mode, PCM data input occurs on BICK, SDTI and LRCK pins. When PCM/DSD mode changes (D/P bit), the AK4620A should be reset by setting RSTAD and RSTDA bits to "0" or by grounding the PDN pin. It takes from 2/fs to 3/fs to change the mode. In parallel mode, AK4620A can only process PCM data.

D/P bit	DAC mode	ADC mode
0	PCM	PCM
1	DSD	Power down

Table 1. DSD/PCM Mode Control

■ System Clock Input

1. PCM Mode

AK4620A requires MCLK, BICK and LRCK external clocks. MCLK should be synchronized with LRCK but the phase is not critical. External clocks (MCLK, BICK and LRCK) should always be present whenever the AK4620A is in normal operation mode (PDN pin = "H" and either the ADC and DAC is in normal operation mode). If these clocks are not provided, the AK4620A may draw excess current due to dynamic refresh of internal logic. If the external clocks are not present, the AK4620A should be in the power-down mode (PDN pin = "L" or power down both the ADC and DAC by the register). After exiting reset (PDN pin = "L" → "H") at power-up etc., the AK4620A is in power-down mode until MCLK and LRCK are provided.

As the AK4620A includes the phase detect circuit for LRCK, the AK4620A is reset automatically when the synchronization is out of phase by changing the clock frequencies.

1-1. Serial mode (P/S pin= "L")

As shown in Table 2, Table 3 and Table 4, select the MCLK frequency by setting CMODE, CKS0-1 and DFS0-1 (DFS0 bit and DFS0 pin are internally ORd). These registers are changed when RSTAD bit = RSTDA bit = "0".

DFS1 bit	OR of DFS0 bit / DFS0 pin	Mode	Sampling Rate	
0	0	Normal speed	32kHz-54kHz	Default
0	1	Double speed	54kHz-108kHz	
1	0	Quad speed	108kHz-216kHz	
1	1	N/A	-	

Table 2. Sampling speed in serial mode

CMODE bit	CKS1 bit	CKS0 bit	MCLK Normal Speed (DFS1-0 = "00")	MCLK Double Speed (DFS1-0 = "01")	MCLK Quad Speed (DFS1-0 = "10")	
0	0	0	256fs	N/A	N/A	Default
0	0	1	512fs	256fs	128fs	
0	1	0	1024fs	512fs	256fs	
0	1	1	N/A	Auto Setting Mode (*)	N/A	
1	0	0	384fs	N/A	N/A	
1	0	1	768fs	384fs	192fs	

Table 3. Master clock frequency in serial mode ("*": refer to Table 4)

The Auto Setting Mode detects MCLK/LRCK ratio and selects Normal/Double/Quad speed mode automatically.

MCLK/LRCK ratio	Mode	Sampling Rate
512 or 768	Normal speed	32kHz-54kHz
256 or 384	Double speed	54kHz-108kHz
128 or 192	Quad speed	108kHz-216kHz

Table 4. Auto Setting Mode in serial mode (DFS1-0 = "01", CMODE bit = "1", CKS1-0 bit = "11")

1-2. Parallel mode (P/S pin= "H")

As shown in Table 5, Table 6 and Table 7, select the MCLK frequency with the CKS0-1 and DFS0 pins. These pins should be changed when the PDN pin = "L".

DFS0 pin	Mode	Sampling Rate
L	Normal speed	32kHz-54kHz
H	Double speed	54kHz-108kHz

Table 5. Sampling speed in parallel mode

CKS1 pin	CKS0 pin	MCLK Normal Speed (DFS0 pin = "L")	MCLK Double Speed (DFS0 pin = "H")
L	L	256fs	N/A
L	H	512fs	256fs
H	L	384fs	Auto Setting Mode (*)
H	H	1024fs	512fs

Table 6. Master clock frequency in parallel mode ("*"; refer to Table 7.)

The Auto Setting Mode detects MCLK/LRCK ratio and selects Normal/Double/Quad speed mode automatically.

MCLK/LRCK ratio	Mode	Sampling Rate
512 or 768	Normal speed	32kHz-54kHz
256 or 384	Double speed	54kHz-108kHz
128 or 192	Quad speed	108kHz-216kHz

Table 7. Auto Setting Mode in parallel mode (DFS0 pin = "H", CKS1 pin = "H", CKS0 pin = "L")

MCLK (Normal speed)	fs=44.1kHz	fs=48kHz
256fs	11.2896MHz	12.288MHz
512fs	22.5792MHz	24.576MHz
1024fs	45.1584MHz	49.152MHz
384fs	16.9344MHz	18.432MHz
768fs	33.8688MHz	36.864MHz

MCLK (Double speed)	fs=88.2kHz	fs=96kHz
N/A	N/A	N/A
256fs	22.5792MHz	24.576MHz
512fs	45.1584MHz	49.152MHz
N/A	N/A	N/A
384fs	33.8688MHz	36.864MHz

MCLK (Quad speed)	fs=176.4kHz	fs=192kHz
128fs	22.5792MHz	24.576MHz
256fs	45.1584MHz	49.152MHz
192fs	33.8688MHz	36.864MHz

Table 8. Master clock frequency example

2. DSD Mode

The external clocks, which are required to operate the AK4620A, are MCLK and DCLK. The master clock (MCLK) should be synchronized with DSD clock (DCLK) but the phase is not critical. The frequency of MCLK is set by DCKS bit.

All external clocks (MCLK, DCLK) must be present whenever the AK4620A is in the normal operation mode (PDN pin = "H"). If these clocks are not provided, the AK4620A may draw excess current because the device utilizes dynamically refreshed logic. The AK4620A should be reset by PDN pin = "L" after these clocks are provided. If the external clocks are not present, the AK4620A should be in the power-down mode (PDN pin = "L"). After exiting reset (PDN pin = "↑") at power-up etc., the AK4620A is in the power-down mode until MCLK is provided.

■ Audio Serial Interface Format

1. PCM Mode

Five serial modes are supported and selected by the DIF2-0 bits in Serial Mode (two modes by DIF pin in Parallel Mode) as shown in Table 9 and Table 10. In all modes the serial data has MSB first, 2's complement format. The SDTO is clocked out on the falling edge of BICK and the SDTI is latched on the rising edge. Mode2 can be used for 20 and 16 MSB justified formats by zeroing the unused LSBs.

Mode	DIF2	DIF1	DIF0	SDTO	SDTI	LRCK	BICK	
0	0	0	0	24bit, MSB justified	16bit, LSB justified	H/L	≥ 48fs	
1	0	0	1	24bit, MSB justified	20bit, LSB justified	H/L	≥ 48fs	
2	0	1	0	24bit, MSB justified	24bit, MSB justified	H/L	≥ 48fs	Default
3	0	1	1	24bit, I^2S	24bit, I^2S	L/H	≥ 48fs	
4	1	0	0	24bit, MSB justified	24bit, LSB justified	H/L	≥ 48fs	

Table 9. Audio data format (Serial Mode)

Mode	DIF pin	SDTO	SDTI	LRCK	BICK
2	L	24bit, MSB justified	24bit, MSB justified	H/L	≥ 48fs
3	H	24bit, I^2S	24bit, I^2S	L/H	≥ 48fs

Table 10. Audio data format (Parallel Mode)

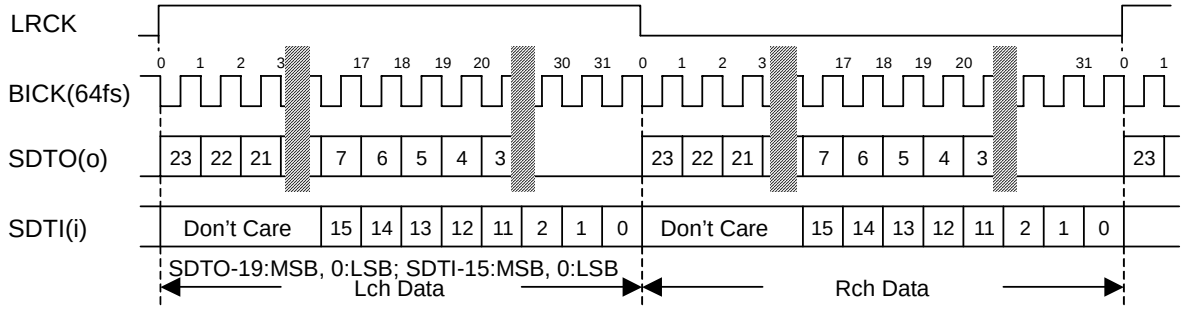


Figure 2. Mode 0 Timing

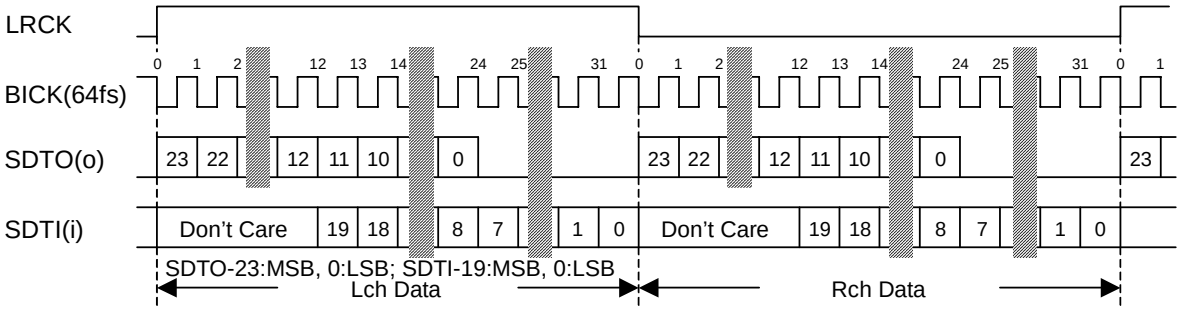


Figure 3. Mode 1 Timing

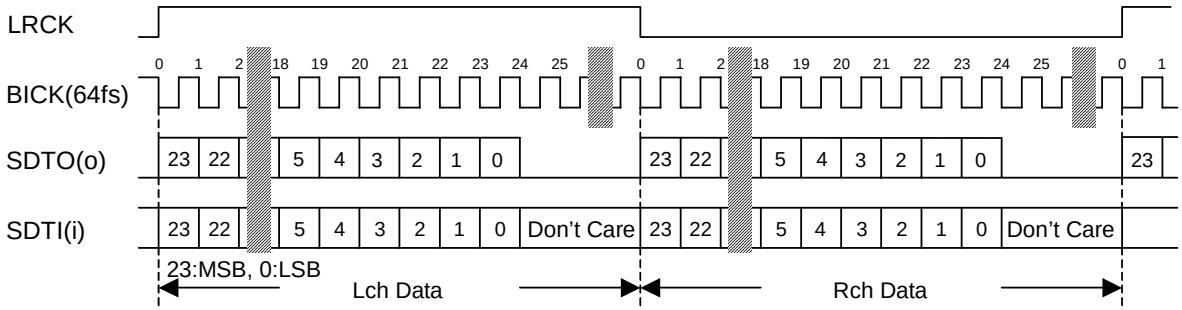


Figure 4. Mode 2 Timing

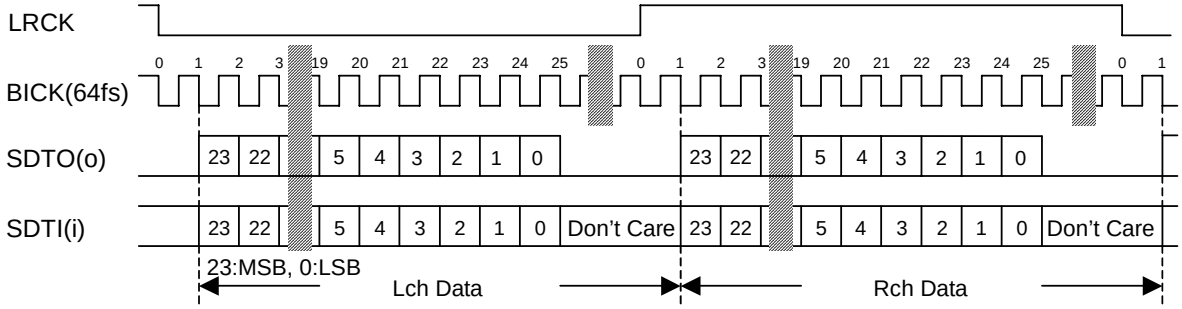


Figure 5. Mode 3 Timing

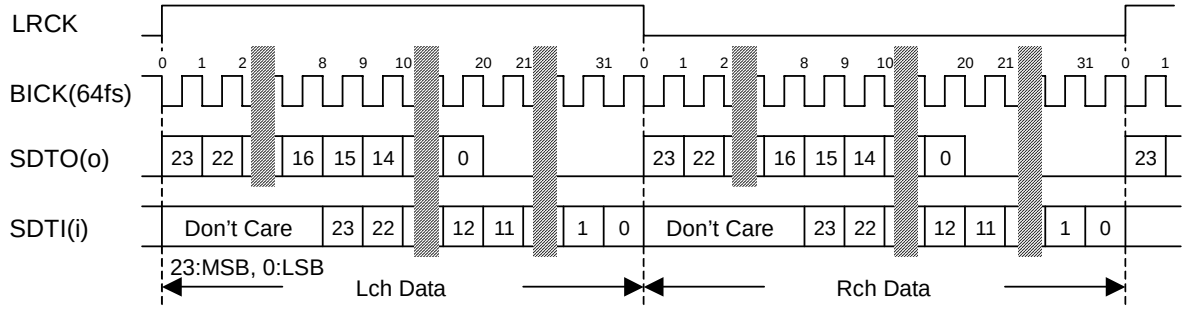


Figure 6. Mode 4 Timing

2. DSD Mode

In DSD mode, DIF0-2 is ignored. The frequency of DCLK is fixed at 64fs. The DCKB bit inverts the polarity of DCLK.

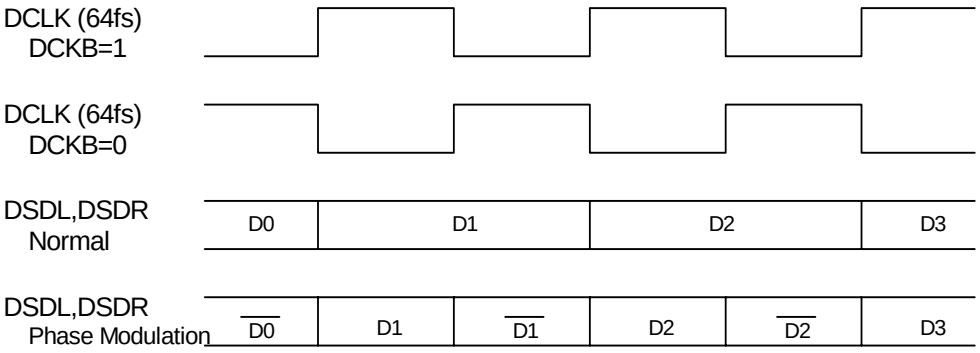


Figure 7. DSD Mode Timing

■ D/A conversion mode switching timing

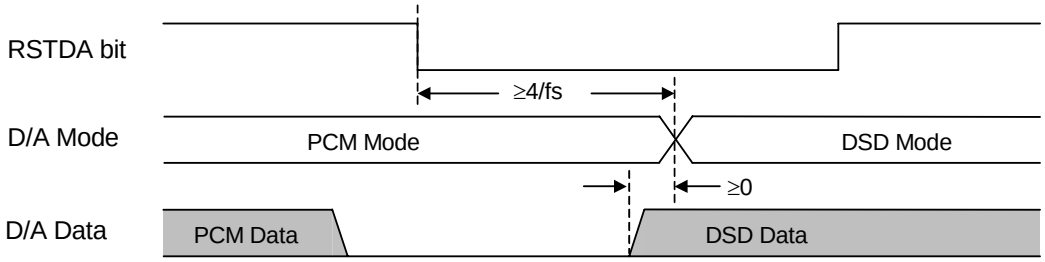


Figure 8. D/A Mode Switching Timing (PCM to DSD)

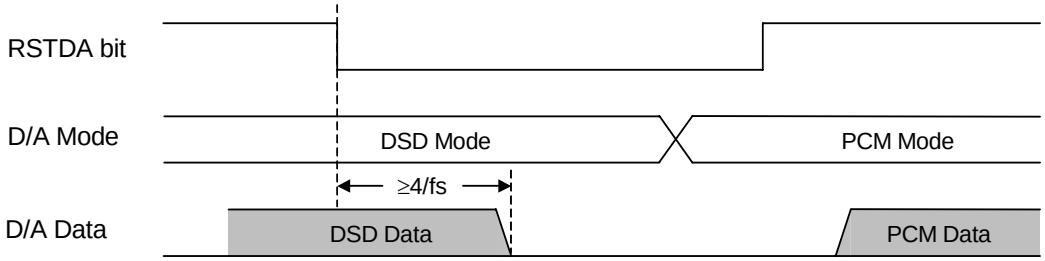


Figure 9. D/A Mode Switching Mode Timing (DSD to PCM)

Caution: In DSD mode, the signal level ranges from 25% to 75%. Peak levels of DSD signal above this range are not recommended by the SACD format book (Scarlet Book).

■ Input Volume

The AK4620A includes two channel-independent analog volumes (IPGA), each with 32 levels in 0.5dB increments. These are located in front of the ADC while digital volume controls (IATT) with 128 levels (including MUTE) are located after the ADC. Control of both of these volume settings is handled by the same register address. When the MSB of the register is "1", the IPGA changes and when the MSB = "0" the IATT changes.

The IPGA is an analog volume control that improves the S/N ratio compared with digital volume controls (Table 11). Level changes only occur during zero-crossings to minimize switching noise. Channel independent zero-crossing detection is used. If there are no zero-crossings, then the level will change after a time-out. The time-out period scales with fs. The periods of 256/fs, 512/fs, 1024/fs and 2048/fs are selected by ZTM1-0 bits in normal speed mode. If a new value is written to the IPGA register before the IPGA changes at the zero crossing or time-out, the previous value becomes invalid. The timer (channel independent) for time-out is reset and the timer restarts for the new IPGA value. ZCEI bits in the control register enable zero-crossing detection.

The IATT is a log volume that is linear-interpolated internally. When changing the level, the transition between ATT values has 29 levels and is done by soft changes, eliminating any switching noise.

	Input Gain Setting		
	0dB	+6dB	+18dB
fs=44.1kHz, A-weight	110dB	108dB	101dB

Table 11. IPGA+ADC S/N (typ.)

ZTM1	ZTM0	Normal speed	Double speed	Quad speed	
0	0	256/fs	512/fs	1024/fs	
0	1	512/fs	1024/fs	2048/fs	
1	0	1024/fs	2048/fs	4096/fs	Default
1	1	2048/fs	4096/fs	8192/fs	

Table 12. LRCK cycles for timeout period

■ Output Volume

The AK4620A includes channel independent digital output volumes (ATT) with 256 levels at linear steps including MUTE. These volumes are in front of the DAC and can attenuate the input data from 0dB to −48dB and mute. When changing levels, transitions are executed via soft changes, eliminating any switching noise. The transition time of 1 level and all 256 levels is shown in Table 13.

Sampling Speed	Transition Time	
	1 Level	255 to 0
Normal Speed Mode	4LRCK	1020LRCK
Double Speed Mode	8LRCK	2040LRCK
Quad Speed Mode	16LRCK	4080LRCK

Table 13. ATT Transition Time

■ Overflow Detection

The ADC has a channel independent overflow detection function. This function is enabled in the parallel control mode, or when the ZOS bit = ZOE bit = "0"in serial control mode. OVFL/R pins go to "H" if each Lch/Rch analog input overflows (exceeds -0.3dBFS). The output of each OVFL/R pin has same group delay as ADC against analog input. OVFL/R pin is "L" for 516/fs (=10.8ms @fs=48kHz) after PDN pin = "↑", and then overflow detection is enabled.

■ Zero detection

The DAC has a channel-independent zero detect function. The zero detect function is enabled when the ZOS bit = "1" and the ZOE bit = "0"in serial control mode. When the input data at both channels is continuously zero for 8192 LRCK cycles, the DZF pin of each channel goes to "H". The DZF pin of each channel immediately goes to "L" if the input data of each channel is not zero after DZF "H". If the RSTDA bit is "0", the DZF pins of both channels go to "H". DZF pins of both channels go to "L" at 4~5/fs after the RSTDA bit becomes "1". Zero detect function can be disabled by the ZOE bit. In this case, the DZF pins of both channels are always "L". The DZFB bit can invert the polarity of the DZF pin.

■ Digital High Pass Filter

The ADC has a digital high pass filter for DC offset cancellation. The cut-off frequency of the HPF is 0.9Hz at fs=44.1kHz. The digital high pass filter cutoff frequency scales with the sampling rate (fs). In parallel mode, the HPF is always enabled. In serial mode, the HPF can control each channel by HPLN/HPRN bits.

■ De-emphasis Filter

The DAC includes a digital de-emphasis filter (tc=50/15μs) via an integrated IIR filter. This filter corresponds to three frequencies (32kHz, 44.1kHz, 48kHz). This setting is done via control register (DEM1-0 bits). This filter is always OFF in double and quad speed modes. The DEM0 pin and DEM0 bit are OR'd in serial control mode. In parallel control mode, the DEM1 bit is fixed to "0" and only the DEM0 pin can be controlled (44.1kHz or OFF). When in DSD mode, DEM1-0 bits are ignored. The setting value is held even if PCM mode and DSD mode are switched.

No	DEM1	DEM0	Mode	
0	0	0	44.1kHz	
1	0	1	OFF	Default
2	1	0	48kHz	
3	1	1	32kHz	

Table 14. De-emphasis control (Normal Speed Mode)

■ ADC Single-ended/Differential Input Mode

The ADC has a selectable single-ended or differential input mode. This mode can be selected by ADMODE pin, AML bit and AMR bit. (See Table 15 and Table 16) In differential input mode, the IPGA is powered-down and bypassed. IATT can be controlled in differential mode.

ADMODE pin	Lch	Rch
L	Single-ended	Single-ended
H	Differential	Differential

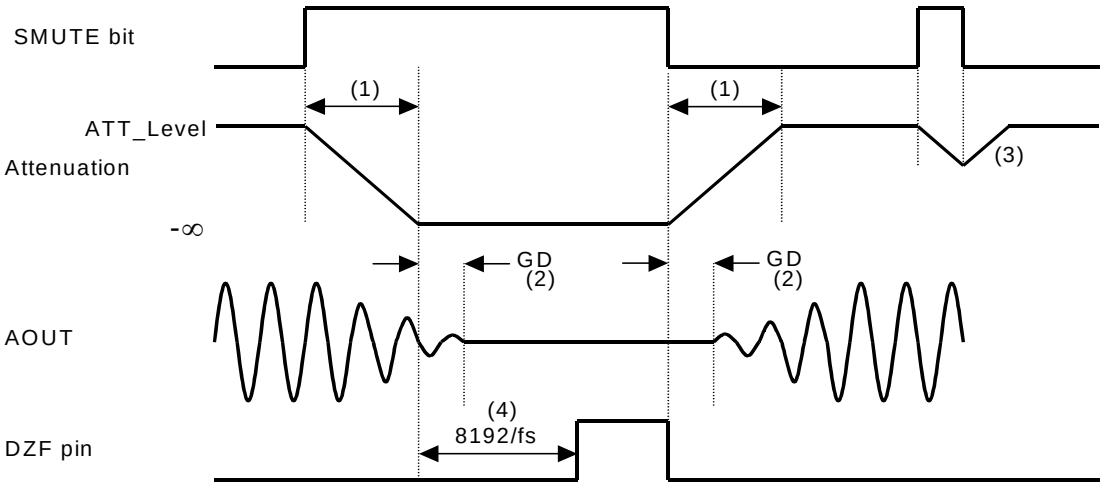
Table 15. ADC Input Mode in parallel mode

ADMODE pin	AML bit	AMR bit	Lch	Rch
L	0	0	Single-ended	Single-ended
	0	1	Single-ended	Differential
	1	0	Differential	Single-ended
	1	1	Differential	Differential
H	X	X	Differential	Differential

Table 16. ADC Input Mode in serial mode (X: Don't care)

■ Soft Mute Operation

Soft mute operation is performed in the digital domain of the DAC input. When the SMUTE bit goes to "1", the output signal is attenuated by –∞ during ATT_DATA × ATT transition time (Table 12) from the current ATT level. When SMUTE bit is returned to "0", the mute is cancelled and the output attenuation gradually changes to the ATT level during ATT_DATA × ATT transition time. If soft mute is cancelled before attenuating to –∞ after starting the operation, the attenuation is discontinued and returns to ATT level by the same cycle. The soft mute is effective for changing the signal source without stopping the signal transmission.



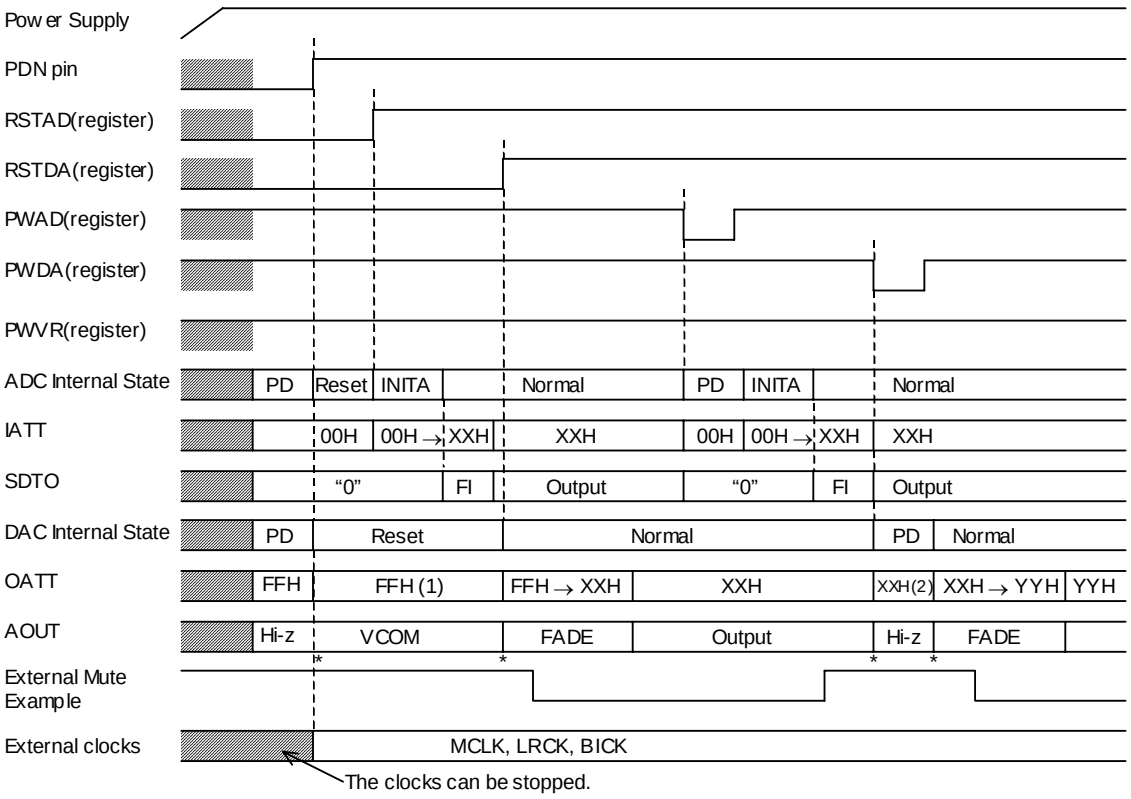
Notes:

(1) ATT_DATA × ATT transition time (Table 12). For example, this time is 1020LRCK cycles (1020/fs) at ATT_DATA=255 in Normal Speed Mode.
(2) Analog output corresponding to digital input has group delay (GD).
(3) If the soft mute is cancelled before attenuating –∞ after starting the operation, the attenuation is discontinued and returned to ATT level by the same cycle.
(4) When the input data at each channel is continuously zero for 8192 LRCK cycles, DZF pin of each channel goes to "H". DZF pin immediately goes to "L" if input data are not zero after going DZF pin "H".

Figure 10. Soft Mute and Zero Detection

■ Power Down & Reset

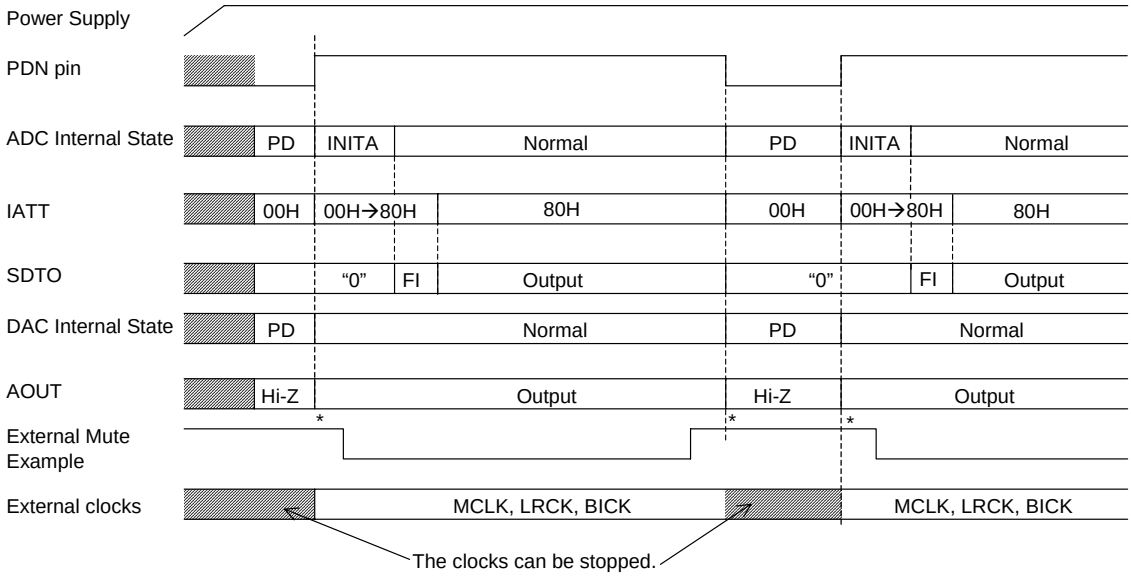
The ADC and DAC of AK4620A are placed in power-down mode by bringing the PDN pin = "L". Each digital filter is also reset at the same time. The internal register values are initialized by bringing PDN pin to "L". This reset should always be done after power-up. As both control registers of the ADC and the DAC go to the reset state (RSTAD bit = RSTDA bit = "0"), each register should be cleared after performing the reset. In the case of the ADC, an analog initialization cycle starts after exiting the power-down or reset state. The output data (SDTO) is available after 516 cycles of LRCK clock. This initialization cycle does not affect the DAC operation. Power down mode can be also controlled by the registers (PWAD bit, PWDA bit).



- INITA: Initializing period of ADC analog section (516/fs).
- PD: Power down state. The contents of all registers are held.
- XXH, YYH: The current value in ATT registers.
- FI: Fade in. After exiting power down and reset state, ATT value fades in.
- FADE: After exiting power down and reset state, ATT value fades in/out.
  (1) When RSTDA is "L" and OATT value is written to "XXH", OATT value changes from FFH to XXH according to fade operation.
  (2) When PWDA is "L" and OATT value is written to "YYH", OATT value changes from XXH to YYH according to fade operation.
- AOUT: Some pop noise may occur at "*".

Figure 11. Reset & Power down sequence in serial mode

In parallel mode, both ADC and DAC are powered up with releasing internal reset state when PDN pin is set to “H”. When PDN pin is “L”, IATT is set to “00H (Mute)”. After exiting power down mode, IATTs fade in to “80H (0dB)”. At that time, ADC s output “0” during first 516/fs cycles. DAC does not have the initialization cycle and the operation of fade-in.



- INITA: Initializing period of ADC analog section (516/fs).
- PD: Power down state.
- FI: Fade in. After exiting power down and reset state, ATT value fades in.
- AOUT: Some pop noise may occur at “*”.

Figure 12. Reset & Power Down Sequence in parallel mode

■ Serial Control Interface

The internal registers may be written to the 3-wire μP interface pins: CSN, CCLK, CDTI. The data on this interface consists of Chip address (2bits, C0/1) Read/Write (1 bit), Register address (MSB first, 5 bits) and Control data (MSB first, 8 bits). Address and data is clocked in on the rising edge of CCLK. Data is latched out after the 16th rising edge of CCLK, following a high-to-low transition of CSN. Operation of the control serial port may be completely asynchronous with the audio sample rate. The maximum clock speed of the CCLK is 5MHz. The chip address is fixed to "10". The access to the chip address except for "10" is invalid. PDN pin = "L" resets the registers to their default values.

Function	Parallel mode	Serial mode
ADC Single-ended/Differential Input mode	X	X
Overflow detection	X	X
Zero detection	-	X
Soft Mute	-	X
Input Volume	-	X
Output Volume	-	X
HPF OFF	-	X
DSD mode	-	X
16/20/24 bit LSB justified format of DAC	-	X
MCLK = 256fs @ Quad Speed	-	X
De-emphasis: 32kHz, 48kHz	-	X

Table 17. Function List (X: available, -: not available)

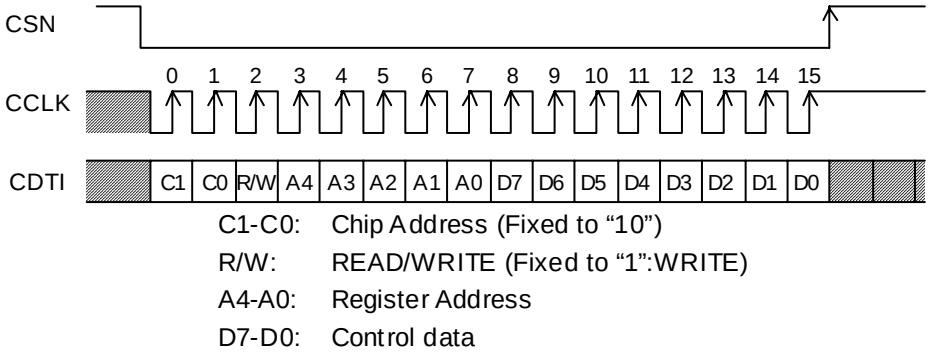


Figure 13. Control I/F Timing

* READ command is not supported.
* The control data can not be written when the CCLK rising edge is 15times or less or 17times or more during CSN is "L".

■ Register Map

Addr	Register Name	D7	D6	D5	D4	D3	D2	D1	D0
00H	Power Down Control	SLOW	DZFB	ZOE	ZOS	0	PWVR	PWAD	PWDA
01H	Reset Control	D/P	DCKS	DCKB	0	AML	AMR	RSTAD	RSTDA
02H	Clock and Format Control	DIF2	DIF1	DIF0	CMODE	CKS1	CKS0	DFS1	DFS0
03H	Deem and Volume Control	SMUTE	HPRN	HPLN	ZCEI	ZTM1	ZTM0	DEM1	DEM0
04H	Lch IPGA Control	IPGL7	IPGL6	IPGL5	IPGL4	IPGL3	IPGL2	IPGL1	IPGL0
05H	Rch IPGA Control	IPGR7	IPGR6	IPGR5	IPGR4	IPGR3	IPGR2	IPGR1	IPGR0
06H	Lch ATT Control	ATTL7	ATTL6	ATTL5	ATTL4	ATTL3	ATTL2	ATTL1	ATTL0
07H	Rch ATT Control	ATTR7	ATTR6	ATTR5	ATTR4	ATTR3	ATTR2	ATTR1	ATTR0

Note: Data should not be written to addresses 08H through 1FH.
PDN pin = “L” resets the registers to their default values.

■ Control Register Setup Sequence

When the PDN pin goes “L” to “H” upon power-up etc., the AK4620A will be ready for normal operation by the next sequence. In this case, all control registers are set to default values and the AK4620A is in the reset state.

(1) Set the clock mode and the audio data interface mode.
(2) Cancel the reset state by setting RSTAD bit or RSTDA bit to “1”. Refer to Reset Contorl Register (01H).
(3) ADC output and DAC output should be muted externally until canceling each reset state.

The clock mode should be changed after setting RSTAD bit and RSTDA bit to “0”. At that time, ADC outputs and DAC outputs should be muted externally.

■ Register Definitions

Addr	Register Name	D7	D6	D5	D4	D3	D2	D1	D0
00H	Power Down Control	SLOW	DZFB	ZOE	ZOS	0	PWVR	PWAD	PWDA
DEFAULT		0	0	0	0	0	1	1	1

PWDA: DAC power down
0: Power down
1: Power up (Default)
"0" powers down only the DAC section and then the AOUTs go to Hi-Z immediately. The contents of all registers are not initialized and enabled to write to the registers. After exiting power down mode, the OATTs fade in/out the setting value of the control register (06H & 07H). The analog output should be muted externally as some pop noise may occur when entering and exiting this mode.

PWAD: ADC power down
0: Power down
1: Power up (Default)
"0" powers down only the ADC and then the SDTO goes "L" immediately. The IPGAs also go "00H", but the contents of all registers are not initialized and enabled to write to the registers. After exiting power down mode, the IPGAs fade in the setting value of the control register (04H & 05H). At that time, the ADCs output "0" during first 516 LRCK cycles.

PWVR: Vref power down
0: Power down
1: Power up (Default)
"0" powers all sections down and then both ADC and DAC do not operate. The contents of all register values are not initialized and enabled to write to the registers. When PWAD and PWDA bits go to "0" and PWVR bit goes to "1", only the VREF section can be powered up.

ZOS: Zero-detection/ Overflow-detection control for #15 and 16 pins.
0: Overflow detection for ADC input (Default)
1: Zero detection for DAC input.

ZOE: Zero-detection / Overflow-detection Disable
0: Enable (Default)
1: Disable. Outputs "L".

DZFB: Inverting Enable of DZF
0: DZF goes "H" at Zero Detection (Default)
1: DZF goes "L" at Zero Detection

SLOW: DAC Slow Roll-off Filter Enable
0: Sharp Roll-off Filter (Default)
1: Slow Roll-off Filter

Addr	Register Name	D7	D6	D5	D4	D3	D2	D1	D0
01H	Reset Control	D/P	DCKS	DCKB	0	AML	AMR	RSTAD	RSTDA
DEFAULT		0	0	0	0	0	0	0	0

RSTDA: DAC reset
0: Reset (Default)
1: Normal Operation
"0" resets the internal timing and the AOUTs go to VCOM voltage immediately. The contents of all registers are not initialized and enabled to write to the registers. After exiting the power down mode, the OATTs fade in the setting values of the control register (06H & 07H). The analog outputs should be muted externally since pop noise may occur when entering to and exiting from this mode.

RSTAD: ADC reset
0: Reset (Default)
1: Normal Operation
"0" resets the internal timing and then SDTO goes to "L" immediately. The IPGAs also go "00H", but the contents of all registers are not initialized and enabled to write to the register. After exiting the power down mode, the IPGAs fade in the setting value of the control register (04H & 05H). At that time, the ADCs output "0" during first 516 LRCK cycles.

AML, AMR: default "0" (see Table 16)

DCKB: Polarity of DCLK (DSD Only)
0: DSD data is available upon DCLK falling edge. (Default)
1: DSD data is available upon DCLK rising edge.

DCKS: Master Clock Frequency Select at DSD mode (DSD only)
0: 512fs (Default)
1: 768fs

D/P: DSD/PCM Mode Select
0: PCM mode (Default)
1: DSD mode

Addr	Register Name	D7	D6	D5	D4	D3	D2	D1	D0
02H	Clock and Format Control	DIF2	DIF1	DIF0	CMODE	CKS1	CKS0	DFS1	DFS0
DEFAULT		0	1	0	0	0	0	0	0

DFS1-0: Sampling Speed Control (see Table 2)
Default: Normal speed

CMODE, CKS1-0: Master Clock Frequency Select (see Table 3)
Default: 256fs

DIF2-0: Audio data interface modes (see Table 9)
000: Mode 0
001: Mode 1
010: Mode 2
011: Mode 3
100: Mode 4
Default: 24bit MSB justified for both ADC and DAC

Addr	Register Name	D7	D6	D5	D4	D3	D2	D1	D0
03H	Deem and Volume Control	SMUTE	HPRN	HPLN	ZCEI	ZTM1	ZTM0	DEM1	DEM0
DEFAULT		0	0	0	1	1	0	0	1

DEM1-0: De-emphasis response (see Table 3)

00: 44.1kHz

01: OFF (Default)

10: 48kHz

11: 32kHz

ZTM1-0: Zero-crossing timeout period select (see Table 11)

Default: 1024fs

ZCEI: ADC IPGA Zero crossing enable

0: Input PGA gain changes occur immediately

1: Input PGA gain changes occur only on zero-crossing or after timeout. (Default)

HPLN/RN: Left/Right channel Digital High Pass Filter Disable

0: Enable (Default)

1: Disable

SMUTE: DAC Input Soft Mute control

0: Normal operation (Default)

1: DAC outputs soft-muted

The soft mute is independent of the output ATT and performed digitally.

Addr	Register Name	D7	D6	D5	D4	D3	D2	D1	D0
04H	Lch IPGA Control	IPGL7	IPGL6	IPGL5	IPGL4	IPGL3	IPGL2	IPGL1	IPGL0
05H	Rch IPGA Control	IPGR7	IPGR6	IPGR5	IPGR4	IPGR3	IPGR2	IPGR1	IPGR0
DEFAULT		1	0	0	0	0	0	0	0

IPGL/R7-0: ADC Input Gain Level
Refer to Table 10
Default: 80H (0dB)

The AK4620A includes two channel-independent analog volumes (IPGA), each with 32 levels in 0.5dB increments. These are located in front of the ADC while digital volume controls (IATT) with 128 levels (including MUTE) are located after the ADC. Control of both of these volume settings is handled by the same register address (04H for L-ch, 05H for R-ch). When the MSB of the register is "1", the IPGA changes and when the MSB= "0" the IATT changes. 80H is the crossover point of the IPGA and DATT, and both IPGA/IATT are set to 0dB.

The IPGAs are set to "00H" when the PDN pin goes "L". After returning to "H", the IPGAs fade in the default value, "80H" by 531(1/fs) cycles. The IPGAs are set to "00H" when PWAD goes "0". After returning to "1", the IPGAs fade in the current value, but the ADC output is "0" during the first 516(1/fs) cycles. The IPAGs are set to "00H" when RSTAD goes "0". After returning to "1", the IPGAs fade in to the current value, but the ADC outputs "0" during the first 516(1/fs) cycles. IATTs can be controlled in differential mode.

Data	Analog Volume (dB)	Digital ATT (dB)	Total Gain (dB)	Step width (dB)	
FFH ~ A5H	+18	0	+18	-	**IPGA** Analog volume with 0.5dB/step
A4H	+18	0	+18	-	
A3H	+17.5	0	+17.5	0.5	
:	:	:	:	:	
82H	+1.0	0	+1.0	0.5	
81H	+0.5	0	+0.5	0.5	
80H	0	0	0	0.5	
7FH	0	-0.5	-0.5	0.5	**IATT** Digital volume with 0.5dB/step. Soft-changes between each level.
7EH	0	-1.0	-1.0	0.5	
:	:	:	:	:	
02H	0	-63.0	-63.0	0.5	
01H	0	-63.5	-63.5	0.5	
00H	0	MUTE	MUTE		

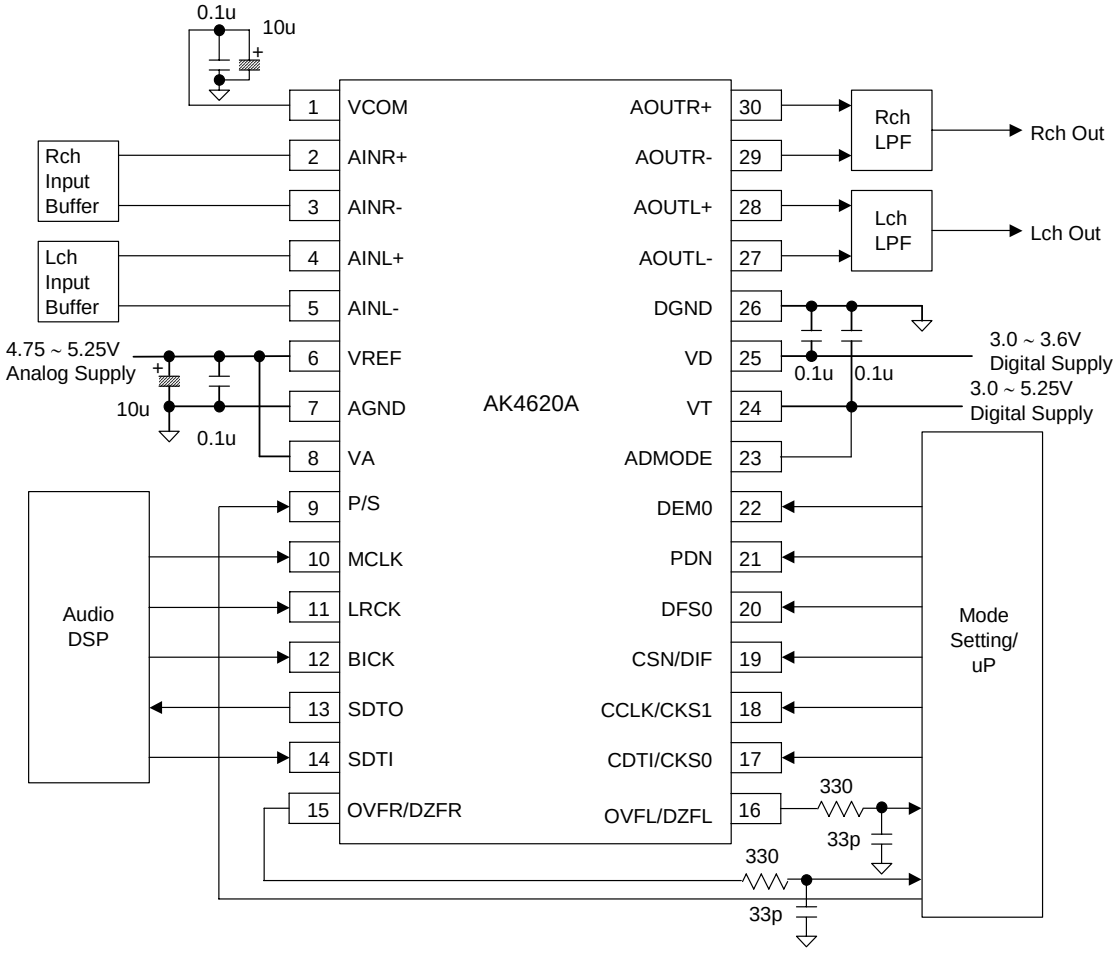
Table 10. IPGA code table

Addr	Register Name	D7	D6	D5	D4	D3	D2	D1	D0
06H	Lch OATT Control	ATTL7	ATTL6	ATTL5	ATTL4	ATTL3	ATTL2	ATTL1	ATTL0
07H	Rch OATT Control	ATTR7	ATTR6	ATTR5	ATTR4	ATTR3	ATTR2	ATTR1	ATTR0
DEFAULT		1	1	1	1	1	1	1	1

ATT7-0: Attenuation Level
ATT = 20 $\log_{10}$(ATT_DATA / 255) [dB]
FFH : 0dB (Default)
00H : Mute

SYSTEM DESIGN

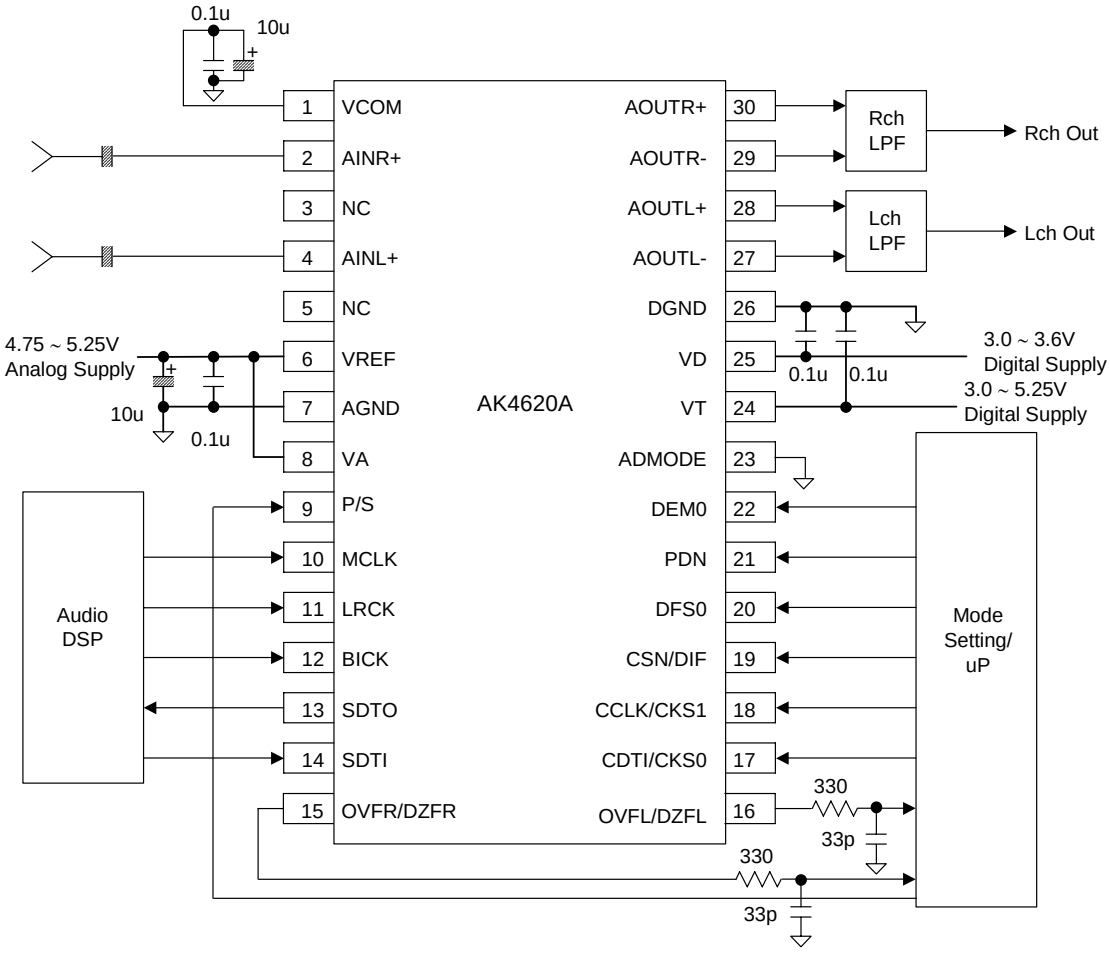
Figure 14 & Figure 15 shows the system connection diagram. An evaluation board (AKD4620A) is available, which demonstrates application circuits, the optimum layout, power supply arrangements and measurement results.



Notes:

- AGND and DGND must be connected to the same analog ground plane.
- When AOUT+/- drives some capacitive load, some resistance should be added in series between AOUT+/- and capacitive load.
- All digital input pins must not be left floating.
- When OVFR/DZFR pin and OVFL/DZFL pin are used, a 330Ω resistor and a 33pF capacitor should be added to OVFR/DZFR pin and OVFL/DZFL pin to avoid the coupling from SDTO pin.

Figure 14. Typical Connection Diagram (Differential mode)



Notes:

- AGND and DGND must be connected to the same analog ground plane.
- When AOUT+/- drives some capacitive load, some resistor should be added in series between AOUT+/- and capacitive load.
- All digital input pins must not be left floating.
- When OVFR/DZFR pin and OVFL/DZFL pin are used, a 330Ω resistor and a 33pF capacitor should be added to OVFR/DZFR pin and OVFL/DZFL pin to avoid the coupling from SDTO pin.

Figure 15. Typical Connection Diagram (Single-ended mode)

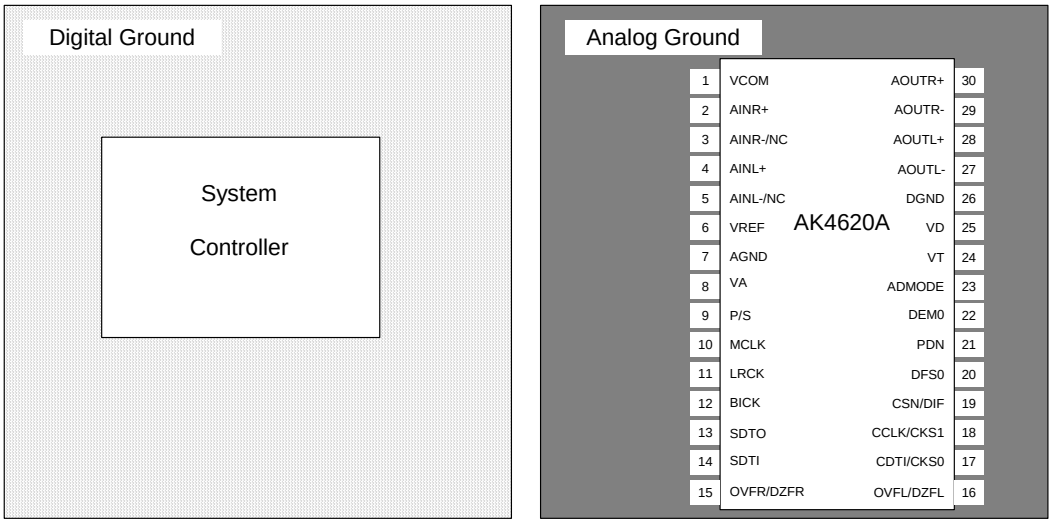


Figure 16. Ground Layout

1. Grounding and Power Supply Decoupling

The AK4620A requires careful attention to power supply and grounding layout. To minimize coupling from digital noise, decoupling capacitors should be connected to VA, VD and VT respectively. VA is supplied from the analog supply in the system, and VD and VT are supplied from the digital supply in the system. Power lines of VA, VD and VT should be distributed separately from the point with low impedance of regulator etc. The power up sequence is not critical among VA, VD and VT. **AGND and DGND must be connected to one analog ground plane.** Decoupling capacitors should be as near to the AK4620A as possible, with the small value ceramic capacitor being the nearest.

2. Voltage Reference

The differential voltage between VREF and AGND sets the analog input/output range. VREF pin is normally connected to VA with a 0.1μF ceramic capacitor. VCOM is the signal ground of this chip. A 10μF electrolytic capacitor in parallel with a 0.1μF ceramic capacitor attached to VCOM pin eliminates the effects of high frequency noise. No load current may be drawn from VCOM pin. All signals, especially clocks, should be kept away from the VREF and VCOM pins in order to avoid unwanted coupling into the AK4620A.

3. ADC Output

The ADC output data format is 2's complement. The DC offset, including the ADC's own DC offset, is removed by the internal HPF. The AK4620A samples the analog inputs at 128fs. The digital filter rejects noise above the stopband except for multiples of 128fs.

4. Analog Inputs

4-1. Single-ended Input (ADMODE pin = "L")

The IPGA inputs are single-ended. The input resistance of IPGA is typically 5.1kΩ at IPGA=0dB and typically 1.18kΩ at IPGA=+18dB. The input signal is typically AC coupled through a capacitor. The cut-off frequency is fc = (1/2πRC). The input signal range scales with the VREF voltage and is nominally 3.07Vpp (VREF=5V) centered around the internal common voltage (about VA/2). In single-ended mode, the AK4620A includes an anti-aliasing filter (RC filter) to attenuate noise around 128fs.

4-2. Full-Differential Input (ADMODE pin = "H")

The AK4620A can accept input voltages from AGND to VA. The input signal range scales with the VREF voltage and is nominally 2.82Vpp (VREF = 5V), centered around the internal common voltage (about VA/2). Figure 17 shows an input buffer circuit example. This is a fully differential input buffer circuit with an inverted amplifier (gain: −10dB). The capacitor of 10nF between AINL+/– (AINR+/–) decreases the clock feedthrough noise of the modulator, and composes a 1st order LPF (fc=360kHz) with a 22Ω resistor before the capacitor. This circuit also has a 1st order LPF (fc=370kHz) composed of op-amp. The evaluation board should be referred about the detail.

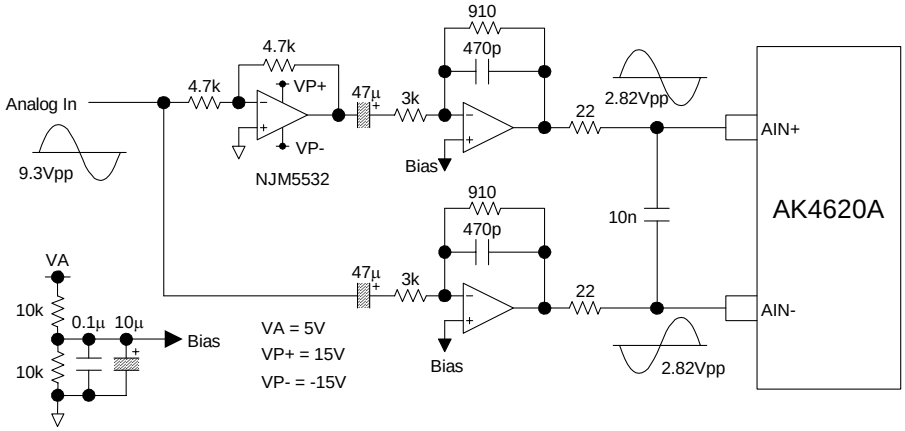


Figure 17. Input Buffer example in differential mode

5. Analog Outputs

The analog outputs are fully differential and 2.8Vpp (typ. VREF = 5V), centered around VCOM. The differential outputs are summed externally: Vout = (AOUT+)-(AOUT-) between AOUT+ and AOUT-. If the summing gain is 1, the output range is 5.6Vpp (typ. VREF = 5V). The bias voltage of the external summing circuit is supplied externally. The input data format is 2's complement. The output voltage is a positive full scale for 7FFFFFH(@24bit) and a negative full scale for 800000H(@24bit). The ideal AOUT is 0V for 000000H(@24bit).

The internal switched-capacitor filter and the external LPF attenuate the noise generated by the delta-sigma modulator beyond the audio passband. Figure 18 shows an example of external LPF circuit summing the differential outputs by an op-amp. Figure 19 shows an example of differential outputs and LPF circuit example by three op-amps.

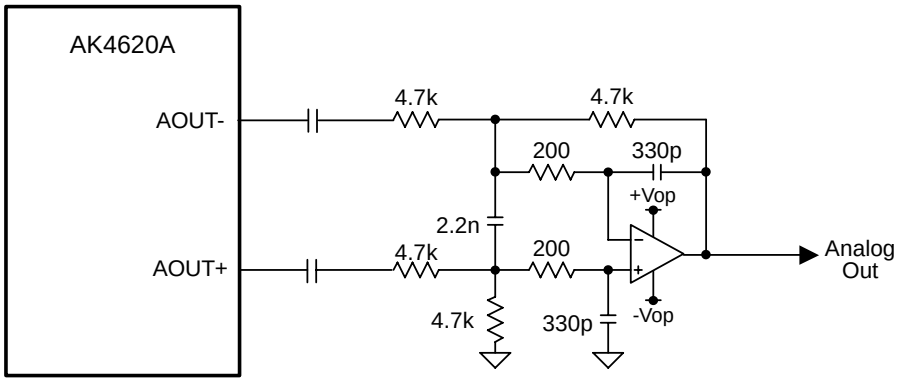


Figure 18. External LPF Circuit Example 1 for PCM (fc = 136kHz, Q=0.694)

Frequency Response	Gain
20kHz	–0.01dB
40kHz	–0.06dB
80kHz	–0.59dB

Table 18. Filter Response of External LPF Circuit Example 1 for PCM

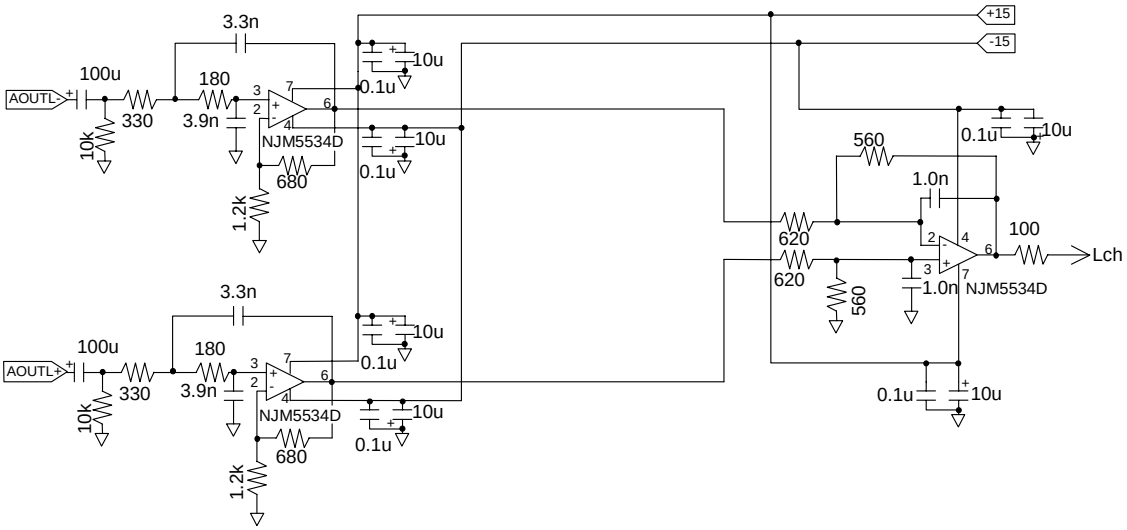


Figure 19. External LPF Circuit Example 2 for PCM

		1st Stage	2nd Stage	Total
Cut-off Frequency		182kHz	284kHz	-
Q		0.637	-	-
Gain		+3.9dB	-0.88dB	+3.02dB
Frequency Response	20kHz	-0.025	-0.021	-0.046dB
	40kHz	-0.106	-0.085	-0.191dB
	80kHz	-0.517	-0.331	-0.848dB

Table 19. Filter Response of External LPF Circuit Example 2 for PCM

It is recommended by SACD format book (Scarlet Book) that the filter response at SACD playback is an analog low pass filter with a cut-off frequency of maximum 50kHz and a slope of minimum 30dB/Oct. The AK4620A can achieve this filter response by combination of the internal filter (Table 20) and an external filter (Figure 20).

Frequency	Gain
20kHz	–0.4dB
50kHz	–2.8dB
100kHz	–15.5dB

Table 20. Internal Filter Response at DSD mode

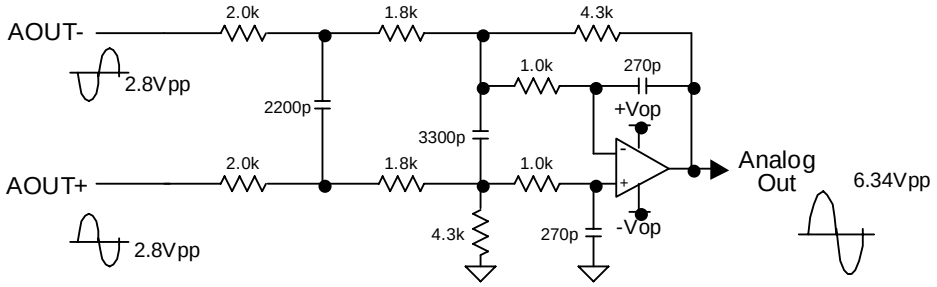


Figure 20. External 3rd order LPF Circuit Example for DSD

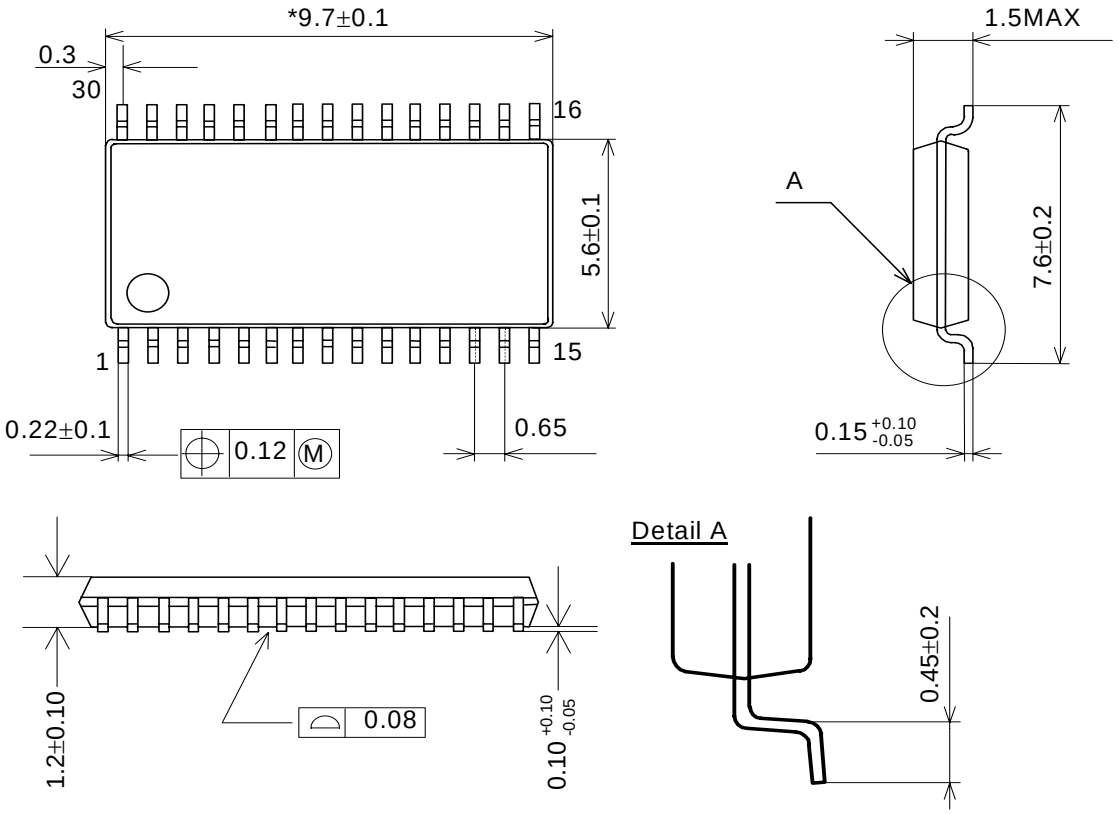
Frequency	Gain
20kHz	–0.05dB
50kHz	–0.51dB
100kHz	–16.8dB

DC gain = 1.07dB

Table 21. 3rd order LPF (Figure 20) Response

PACKAGE

30pin VSOP (Unit: mm)

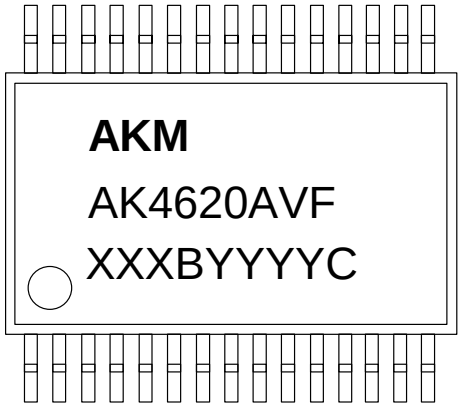


NOTE: Dimension "*" does not include mold flash.

■ Material & Lead finish

Package molding compound:	Epoxy
Lead frame material:	Cu
Lead frame surface treatment:	Solder plate (Pb Free)

MARKING



XXXBYYYYC Date code identifier

XXXB : Lot number (X : Digit number, B : Alpha character)
YYYYC : Assembly date (Y : Digit number, C : Alpha character)

Revision History

Date (YY/MM/DD)	Revision	Reason	Page	Contents
04/12/14	00	First Edition		