

**ALS 120**  
**Integrated Audio Controller**  
**w/ 3D + ALSFM Synthesizer**

**Revision 1.30**  
**October 06, 1997**

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### 1.0 Introduction

Sound system designs based on the ALS120 Integrated Audio Subsystems are true Plug and Play systems. ALS120 Integrated Audio Subsystems bring forth a new age of highly integrated, single chip sound products. They are cost-efficient audio solutions for motherboard and add-in card implementations. Avance Logic, Inc. has taken the approach of integrating the following functions into a single ASIC.

- Subsystem control logic
- Digital to analog and analog to digital converters
- Mixer functions
- 3-D Sound Effect Processor
- Built-in ALSFM synthesizer w/ FM DAC
- IDE CD-ROM Interface Logic
- Enhanced normal & digital game port
- E<sup>2</sup>PROM Interface Logic
- I<sup>2</sup>S Interface Logic

By bringing these functions into a single ASIC, the overall product cost is reduced. Additionally, reliability and compatibility are improved by the reduced number of components required to build a sound system.

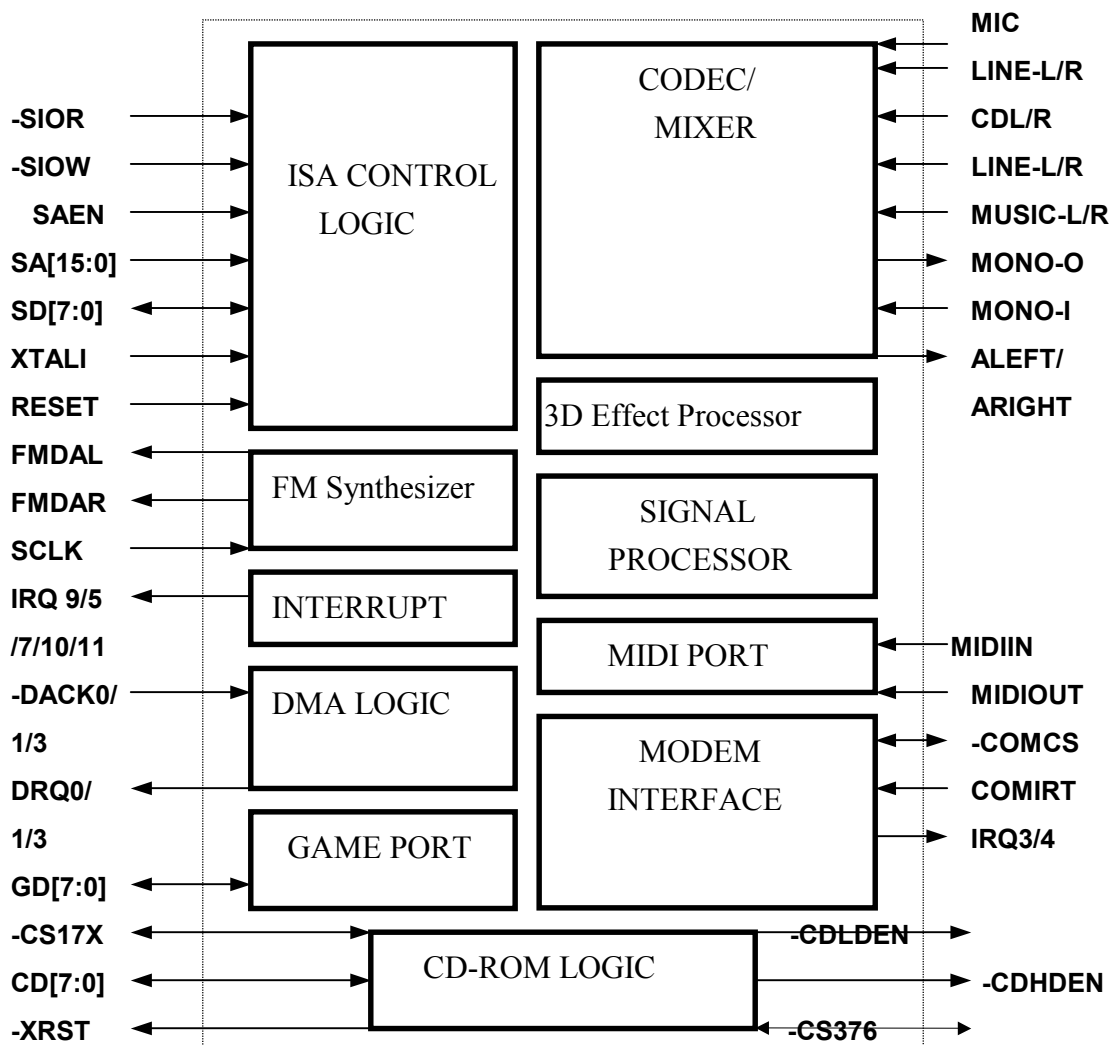
ALS120 Integrated Audio Subsystems fully support the ISA Plug and Play standard. For non-ISA Plug and Play compatible systems, a software utility is available that sets the IRQ and DMA resources. Add-in sound cards and motherboard implementations designed around the ALS120 Integrated Audio Subsystems are completely jumper and switch free.

ALS120 Integrated Audio Subsystems support the following functions:

- Audio Input
  - ✓ CD-ROM Audio
  - ✓ Monaural In
  - ✓ Stereo Line In
  - ✓ Microphone In

- Audio Output
  - ✓ Stereo Line Out
  - ✓ Mono/modem Out
- Enhanced normal & digital game/MIDI Port
  - ✓ External MIDI input and output
  - ✓ Joystick input
- IDE CD-ROM Interface Logic
  - ✓ ATAPI IDE
- E<sup>2</sup>PROM/I<sup>2</sup>S/YAC512 Interface

**FIGURE 1.1 ALS120 FUNCTIONAL BLOCK DIAGRAM**



## **2.0 Features & Applications**

- Single, mixed-signal, high performance VLSI sound ASIC
- Compatible with Sound Blaster™, Sound Blaster Pro™, Sound Blaster 16 Emulation and Windows Sound System™
- Built-in 3D Sound Effect Processor
- Built-in ALSFM Synthesizer w/ external wavetable support
- ISA Plug and Play support logic
- External PNP modem chip interface
- I<sup>2</sup>S/E<sup>2</sup>PROM interface logic
- Supports Sound Blaster ADPCM decompression
- MPU-401 MIDI controller with FIFO
- Supports 8-bit Type F DMA playback
- Software selectable DMA lines(0, 1, 3)
- Software selectable interrupt lines(5, 7, 9, 10, 11)
- 8/16 bit mono/stereo digital audio from 4 kHz to 48 kHz
- 16 bit CD-ROM interface
- Enhanced normal & digital game port support
- Flexible general purpose I/O function control
- MIDI port with input and output FIFO
- Full duplex for concurrent recording and playback
- 16 bit PNP address I/O decoder
- 5.0V digital/analog mode
- 100 pin PQFP package

### **Applications:**

- Windows and MPC level 2 compatible audio sub-system
- PC games
- Computer based audio reproduction
- Karoke/music sound box
- Voice annotations or voice E-mail interface

### 3.0 Module I/O Pins

#### ISA Address

Item	Pin Name	Type	Pin No.	Description
1	SA0	I	92	ISA SYSTEM ADDRESS BIT 0
2	SA1	I	93	ISA SYSTEM ADDRESS BIT 1
3	SA2	I	94	ISA SYSTEM ADDRESS BIT 2
4	SA3	I	95	ISA SYSTEM ADDRESS BIT 3
5	SA4	I	96	ISA SYSTEM ADDRESS BIT 4
6	SA5	I	97	ISA SYSTEM ADDRESS BIT 5
7	SA6	I	98	ISA SYSTEM ADDRESS BIT 6
8	SA7	I	99	ISA SYSTEM ADDRESS BIT 7
9	SA8	I	100	ISA SYSTEM ADDRESS BIT 8
10	SA9	I	1	ISA SYSTEM ADDRESS BIT 9
11	SA10	I	2	ISA SYSTEM ADDRESS BIT 10
12	SA11	I	3	ISA SYSTEM ADDRESS BIT 11
13	SA12	I	4	ISA SYSTEM ADDRESS BIT 12
14	SA13	I	5	ISA SYSTEM ADDRESS BIT 13
15	SA14	I	6	ISA SYSTEM ADDRESS BIT 14
16	SA15	I	7	ISA SYSTEM ADDRESS BIT 15
17	SAEN	I	8	ISA DMA ADDRESS ENABLE

**ISA Data**

Item	Pin Name	Type	Pin No.	Description
18	SD0	I/O	9	ISA SYSTEM DATA BIT 0
19	SD1	I/O	10	ISA SYSTEM DATA BIT 1
20	SD2	I/O	11	ISA SYSTEM DATA BIT 2
21	SD3	I/O	12	ISA SYSTEM DATA BIT 3
22	SD4	I/O	14	ISA SYSTEM DATA BIT 4
23	SD5	I/O	15	ISA SYSTEM DATA BIT 5
24	SD6	I/O	16	ISA SYSTEM DATA BIT 6
25	SD7	I/O	17	ISA SYSTEM DATA BIT 7

**ISA CONTROL**

Item	Pin Name	Type	Pin No.	Description
26	-SIOW	I	63	ISA I/O WRITE STROBE
27	-SIOR	I	64	ISA I/O READ STROBE
28	RESET	I	19	ISA SYSTEM RESET
29	XTALI	I	76	CRYSTAL/OSCILLATOR IN
30	XTALO	O	75	CRYSTAL OUT

**ISA DMA**

Item	Pin Name	Type	Pin No.	Description
31	DRQ0	hiZ	68	ISA DMA REQUEST 0
32	DRQ1	hiZ	67	ISA DMA REQUEST 1
33	DRQ3	hiZ	66	ISA DMA REQUEST 3
34	-DACK0	I	62	ISA DMA ACKNOWLEDGE 0
35	-DACK1	I	61	ISA DMA ACKNOWLEDGE 1
36	-DACK3	I	60	ISA DMA ACKNOWLEDGE 3



**ISA INTERRUPT**

Item	Pin Name	Type	Pin No.	Description
37	IRQ2/9	O	53	ISA INTERRUPT REQUEST 2/9
38	IRQ5	O	55	ISA INTERRUPT REQUEST 5
39	IRQ7	O	54	ISA INTERRUPT REQUEST 7
40	IRQ10	O	56	ISA INTERRUPT REQUEST 10
41	IRQ11	O	57	ISA INTERRUPT REQUEST 11

**MIDI INTERFACE**

Item	Pin Name	Type	Pin No.	Description
42	MIDIIN	I	58	MIDI SERIAL INPUT
43	MIDIOUT	I/O	59	MIDI SERIAL OUTPUT

**MODEM**

Item	Pin Name	Type	Pin No.	Description
44	-COMCS	I/O	73	MODEM CHIP SELECT
45	COMIRT	I/O	69	MODEM INTERRUPT REQUEST
46	IRQ3	O	71	ISA INTERRUPT REQUEST 3
47	IRQ4	O	70	ISA INTERRUPT REQUEST 4

**ANALOG AUDIO**

Item	Pin Name	Type	Pin No.	Description
48	MIC	I	39	MICROPHONE INPUT
49	LINE-L	I	33	EXTERNAL LINE INPUT LEFT
50	LINE-R	I	46	EXTERNAL LINE INPUT RIGHT
51	CDL	I	32	EXTERNAL CD AUDIO INPUT LEFT
52	CDR	I	47	EXTERNALCD AUDIO INPUT RIGHT
53	MUSIC-L	I	35	EXTERNAL WAVETABLE MUSIC INPUT LEFT

54	MUSIC-R	I	44	EXTERNAL WAVETABLE MUSIC INPUT RIGHT
55	MONO-I	I	51	PC SPEAKER/MODEM MONO INPUT
56	MONO-O	O	40	PC SPEAKER/MODEM MONO OUTPUT
57	ALEFT	O	34	AUDIO MIXER LEFT OUTPUT
58	ARIGHT	O	45	AUDIO MIXER RIGHT OUTPUT
59	VREF1	O	41	2.5V REFERENCE VOLTAGE OUTPUT
60	VREF2	O	38	2.5V REFERENCE VOLTAGE OUPUT
61	ADL-O	I	30	LEFT A/D CONVERTER ANTI-ALIAS FILTER
62	ADR-O	I	49	RIGHT A/D CONVERTER ANTI-ALIAS FILTER
63	ADL-I	I	29	LEFT INPUT MIXER LOOP BACK FILTER
64	ADR-I	I	50	RIGHT INPUT MIXER LOOP BACK FILTER
65	DACL	I	31	LEFT D/A CONVERTER LOW-PASS SMOOTH FILTER
66	DACR	I	48	RIGHT D/A CONVERTER LOW-PASS SMOOTH FILTER
67	FMDAL	O	36	FM D/A LOW-PASS SMOOTH FILTER LEFT
68	FMDAR	O	43	FM D/A LOW-PASS SMOOTH FILTER RIGHT

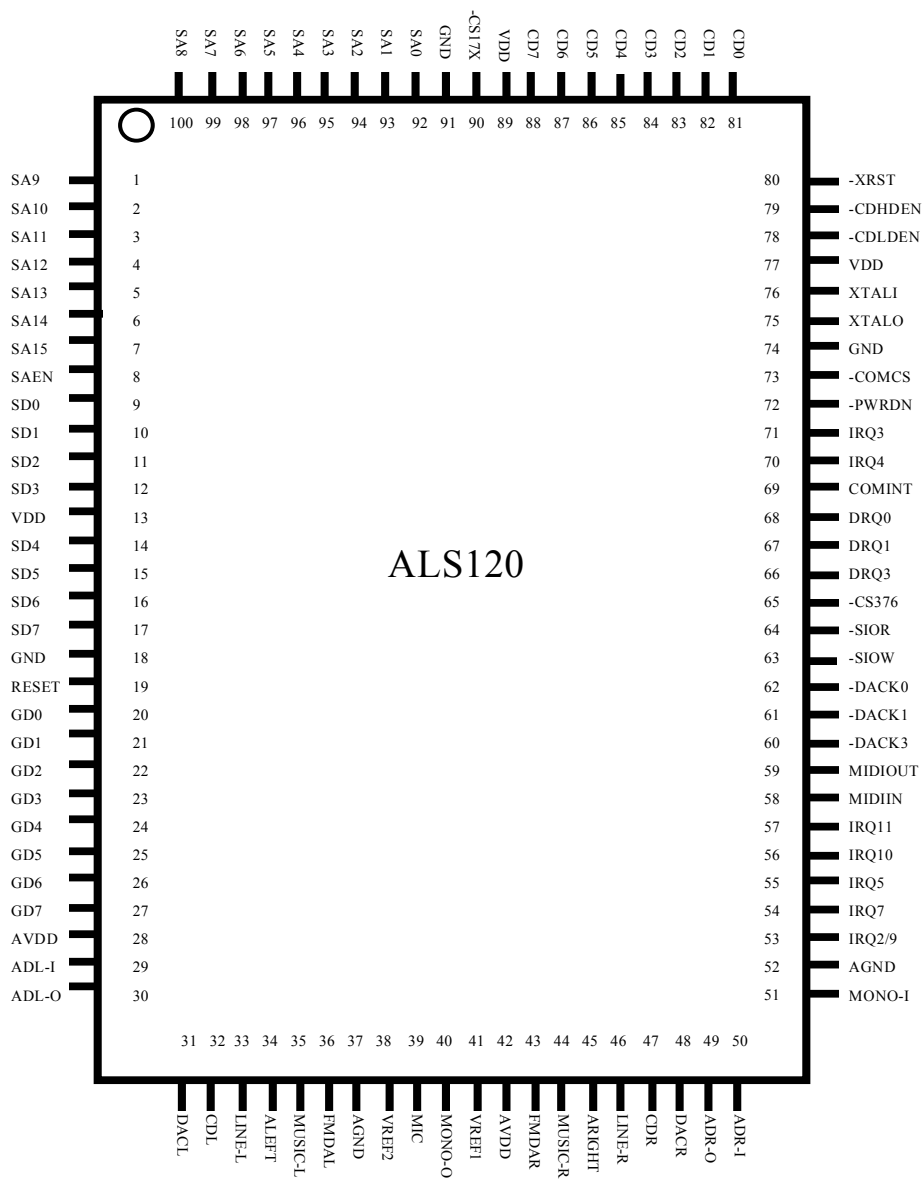
**EXTERNAL GAME PORT, CD-ROM, AND EXPANSION**

Item	Pin Name	Type	Pin No.	Description
69	GD0	I/O	20	GAME PORT A TIMER X
70	GD1	I/O	21	GAME PORT A TIMER Y
71	GD2	I/O	22	GAME PORT B TIMER X
72	GD3	I/O	23	GAME PORT B TIMER Y
73	GD4	I	24	GAME PORT A BUTTON A
74	GD5	I	25	GAME PORT A BUTTON B
75	GD6	I	26	GAME PORT B BUTTON A
76	GD7	I	27	GAME PORT B BUTTON B
77	-CS17X	I/O	90	IDE CD-ROM I/O PORT 170-177h
78	-CS376	I/O	65	IDE CD-ROM I/O PORT 376-377h
79	-CDLDEN	I/O	78	IDE CD-ROM LOW BYTE DATA ENABLE
80	-CDHDEN	O	79	IDE CD-ROM HIGH BYTE DATA ENABLE
81	CD0	I/O	81	IDE CD-ROM DATA BUS BIT 0
82	CD1	I/O	82	IDE CD-ROM DATA BUS BIT 1
83	CD2	I/O	83	IDE CD-ROM DATA BUS BIT 2
84	CD3	I/O	84	IDE CD-ROM DATA BUS BIT 3
85	CD4	I/O	85	IDE CD-ROM DATA BUS BIT 4
86	CD5	I/O	86	IDE CD-ROM DATA BUS BIT 5
87	CD6	I/O	87	IDE CD-ROM DATA BUS BIT 6
88	CD7	I/O	88	IDE CD-ROM DATA BUS BIT 7
89	-XRST	O	80	CD-ROM OR FM RESET
90	-PWRDN	I/O	72	POWER DOWN

**POWER**

Item	Pin Name	Type	Pin No.	Description
91	VDD	P	13	DIGITAL VCC, 5 OR 3.3 VOLT
92	VDD	P	77	DIGITAL VCC, 5 OR 3.3 VOLT
93	VDD	P	89	DIGITAL VCC, 5 OR 3.3 VOLT
94	AVDD	P	28	ANALOG VCC, 5 OR 3.3 VOLT
95	AVDD	P	42	ANALOG VCC, 5 OR 3.3 VOLT
96	GND	P	18	DIGITAL GROUND
97	GND	P	91	DIGITAL GROUND
98	GND	P	74	DIGITAL GROUND
99	AGND	P	37	ANALOG GROUND
100	AGND	P	52	ANALOG GROUND

**FIGURE 3.1      ALS120 PIN DIAGRAM**



## 4.0 Electrical Specification

### Analog Characteristics

Assumptions:

- Ambient temperature  $\square$  TA  $\square$  -----25  $\square$
- Voltage, Analog  $\square$  VA  $\square$  ----- +5.0
- Voltage, Digital  $\square$  VD  $\square$  -----+5.0
- Voltage, Filtered Digital  $\square$  VFD  $\square$  ----- +5.0
- Input levels:
  - Logical 0 -----0 V
  - Logical 1 -----VD
- Input signal -----1kHz sine wave
- Sample frequency  $\square$  FS1  $\square$  ----- 48kHz
- Sample frequency  $\square$  FS2  $\square$  ----- 8kHz
- Measurement bandwidth  $\square$  16-bit linear coding  $\square$  20Hz to 20kHz

Parameter	Min.	Type	Max.	Units
<b>Analog Input Characteristics-Minimum Gain Setting(0 dB);unless otherwise specified</b>				
ADC Resolution	-	16	-	Bits
Instantaneous Dynamic Range $\square$ IDR $\square$	-	80	-	dB
Total Harmonic Distortion $\square$ THD $\square$	-	0.04	-	$\square$
Inter-Channel Isolation	-	70	-	dB
Left/Right Channel Separation	-	76	-	dB
Inter-Channel Gain Mismatch	-	-	0.5	dB
			0.5	dB
Programmable Input Gain Span	12.0	12.0	-	dB
Gain Step Size $\square$ 32 levels $\square$	1.3	1.5	1.7	dB
ADC Offset Error	-	10	100	LSB
Full Scale Input Voltage (MGE=1) Mic Inputs	0.26	0.28	0.31	Vpp
				Vpp
Line, CD-Audio, Music Inputs	2.6	2.8		Vpp

(Table continued form previous page.)					
Gain Drift		-	100	-	ppm/□
Input Resistance		47	-	-	kΩ
Input Capacitance		-	-	15	pF
<b>Analog output Characteristics-Minimum attenuation(1 dB);unless otherwise specified</b>					
DAC Resolution		16	-	-	Bits
Total Dynamic Range(TDR)	All Outputs	-	95	-	dB
Instantaneous Dynamic Range(IDR)	All Outputs	-	80	-	dB
Total Harmonic Distortion(THD)		-	0.04	-	□
Inter-Channel Isolation	Line Out	-	70	-	dB
Inter-Channel Gain Mismatch	Line Out	-	-	0.2	dB
Voltage Reference Output-VREF		-	2.00	-	V
Voltage Reference Output Current-VREF		-	1.5	-	mA
DAC Programmable Attenuation Span		46.5	46.5	-	dB
DAC Attenuation Step Size	0dB to -81dB	1.3	1.5	1.7	dB
	-82.5dB to -94.5dB	1.0	1.5	2.0	dB
DAC Offset Voltage		-	10	30	mV
Full Scale Output Voltage	OLB=0	1.8	2.0	2.25	Vpp
	OLB=1 OUT, MOUT	2.6	2.9	3.2	Vpp
Gain Drift		-	100	-	ppm/□
Deviation From Linear Phase		-	-	10	degrees
Mute Attenuation(0 dB)		-	80	-	dB
Total Out-of-Band Energy	0.6xFS1 to 100kHz	-	-	-45	dB
Audible Out-of-Band Energy	0.6xFS2 to 22kHz		-	-70	dB
Signal To Noise Ratio		76	-	-	dB
Output Power Rating-Main Out(4Ωspeakers)		-	-	2	W/chnl
<b>Power Supply</b>					
Power Supply Current	Digital , Operating	-	61	110	mA
	Analog, Operating	-	41	60	mA
	Total	-	102	170	mA
	Digital, Power Off	-	100	300	μA



Analog, Power Off	-	100	300	μA
Power Supply Rejection	1kHz	40		dB

Note: These values are based on characterizations, not on production testing.

## Mixers

Assumptions:

- Ambient temperature □ TA □ ----- 25 □
- Voltage, Analog □ VA □ ----- +5.0
- Voltage, Digital □ VD □ ----- +5.0
- Voltage, Filtered Digital □ VFD □ ----- +5.0
- Input levels:
  - Logical 0 ----- 0 V
  - Logical 1 ----- VD
- Input signal ----- 1kHz sine wave

Parameter		Min.	Type	Max.	Units
Mixer Gain Range Span	Line, CD-ROM, Music	45	46.5	-	dB
	Monaural	42	45	-	dB
	Master	42	45	-	dB
Step Size	Line, CD-ROM, Music	1.3	1.5	1.7	dB
	Monaural	1.3	1.5	1.7	dB
	Master	1.3	1.5	1.7	dB

Note: These values are based on characterizations, not on production testing.

## Maximum Ratings

Assumptions:

- Analog Ground □ AGND □ -----0 V
- Digital Ground □ DGND □ -----0 V
- Signal Ground □ SGND □ -----0 V
- All voltages measured with respect to: -----0 V

Parameter	Min.	Max.	Units
Power supplies			
Digital(VD)	-0.3	6.0	V
Filtered Digital(VFD)	-0.3	6.0	V
Analog(VA)	-0.3	6.0	V
Total Power Dissipation (Supplies, Inputs, Outputs)	-	1.0	W
Input Current per Pin (Except Supply Pins)	-10.0	+10.0	mA
Output Current per Pin (Except Supply Pins)	-50	+50	mA
Analog Input Voltage	-0.3	VA+0.3	V
Digital Input Voltage	-0.3	VD+0.3	V
Operating Temperature Range	0	+70	□
Storage Temperature	-50	+125	□
Electrostatic Protection (ESD)c=100pf, R=1.5KΩ	2000	-	V

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

## Timing Parameters

Assumptions:

- Ambient temperature  $T_A$  ----- 25°
- Voltage, Analog  $V_A$  ----- +5.0
- Voltage, Digital  $V_D$  ----- +5.0
- Input levels:
- Logical 0 ----- 0 V
- Logical 1 -----  $V_D$
- Outputs loaded with: ----- 30pF

Parameter	Symbol	Min.	Max.	Units
OSC(14.31 MHz) Frequency	tOSCP	14.000	14.500	MHz
OSC High Width	tOSCH	32	40	ns
OSC Low Width	tOSCL	32	40	ns
SYSCLK Frequency	-	8	9	MHz
SYSCLK High Width	-	50	70	ns
SYSCLK Low Width	-	55	70	ns
-IOR/-IOW Command Width	tCMD	120	-	ns
Write Data Setup To -IOW Rising	tWDS	30	-	ns
Write Data Hold From -IOW Rising	tWDH	15	-	ns
Read Access Time	tRAC	20	50	ns
Address Setup To -IOR/-IOW Falling	tAS	50	-	ns
Address Hold From -IOR/-IOW Rising	tAH	30	-	ns
-DACK Setup To -IOR/-IOW Falling	tDKS	40	-	ns
-DACK Hold From -IOR/-IOW Rising	tDKH	160	-	ns
SD Hold Form -IOR Rising	tDH	0	20	ns
XTAL Frequency	-	-	14.318	MHz
XTAL High Time	-	18	-	ns
XTAL Low Time	-	18	-	ns
Sample Frequency	-	3.918	50	kHz
DRQ Hold Form -IOR/ -IOW Falling	tDRH	0	25	ns

Note: These values are based on characterizations, not on production testing.

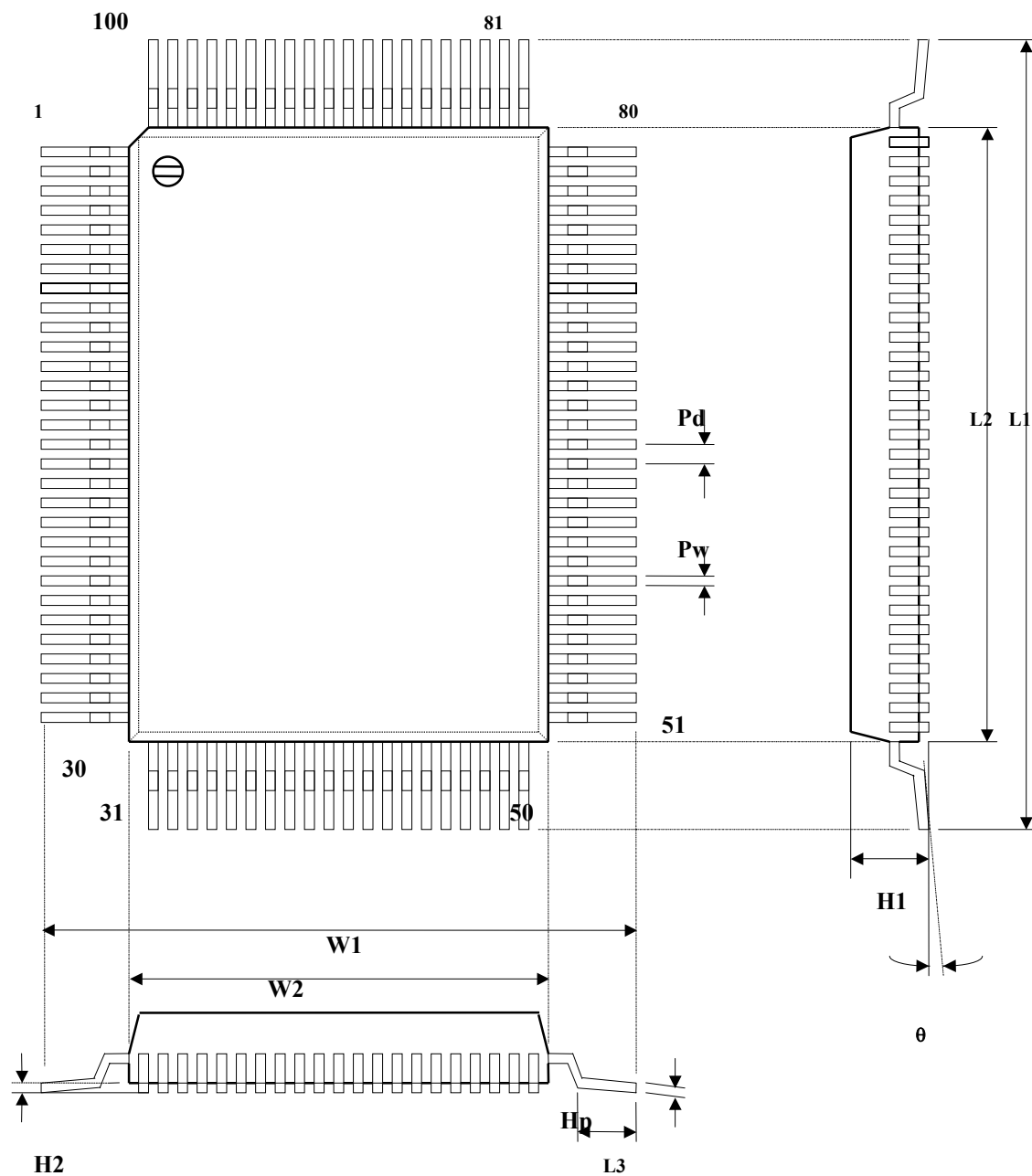
## Operating Environment

Assumptions:

- Analog Ground □ AGND □ ----- 0 V
- Digital Ground □ DGND □ ----- 0 V
- Signal Ground □ SGND □ ----- 0 V
- All voltages measured with respect to: ----- 0 V

Parameter		Min.	Type	Max.	Units
Power supplies	Digital(VD)	4.75	5.0	5.25	V
	Filtered Digital(VFD)	4.75	5.0	5.25	V
	Analog(VA)	4.75	5.0	5.25	V
Operating Ambient Temperature(TA)		0	25	70	□

## 5.0 ALS120 Physical Description

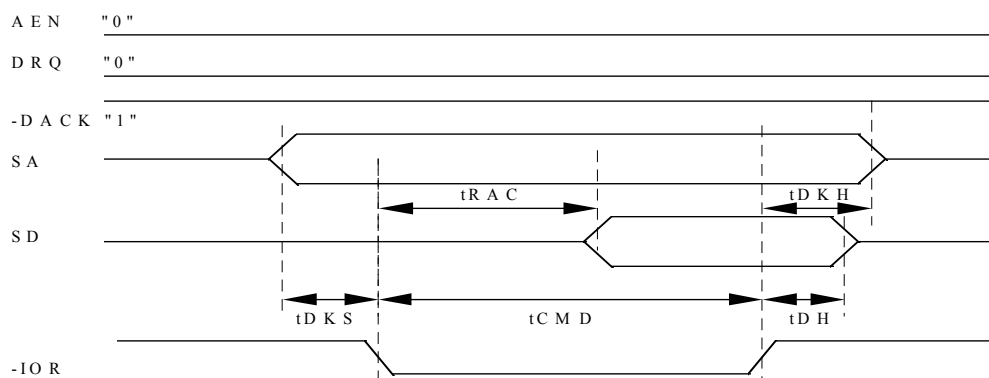


Unit: mm

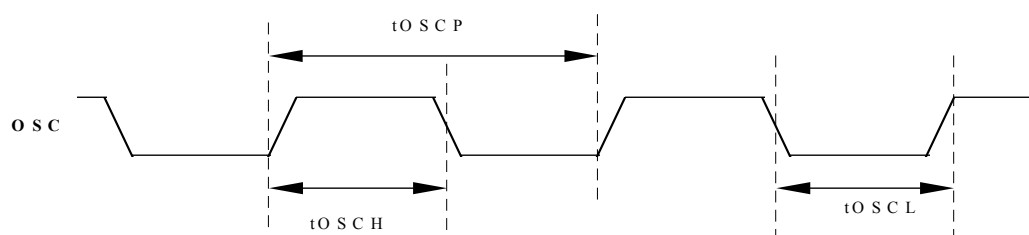
Symbol	Min.	Typ.	Max.
L1	24.45	24.80	25.12
L2	19.75	20.00	20.25
L3	1.00	1.20	1.40
W1	18.45	18.80	19.15
W2	13.75	14.00	14.25
H1	2.70	3.00	3.30
H2	0.11	0.51	0.91
Hp	0.04	0.15	0.26
Pw	0.50	0.65	0.80
Pd	0.18	0.30	0.42
θ	0°	5°	10°

## Timing Characteristics

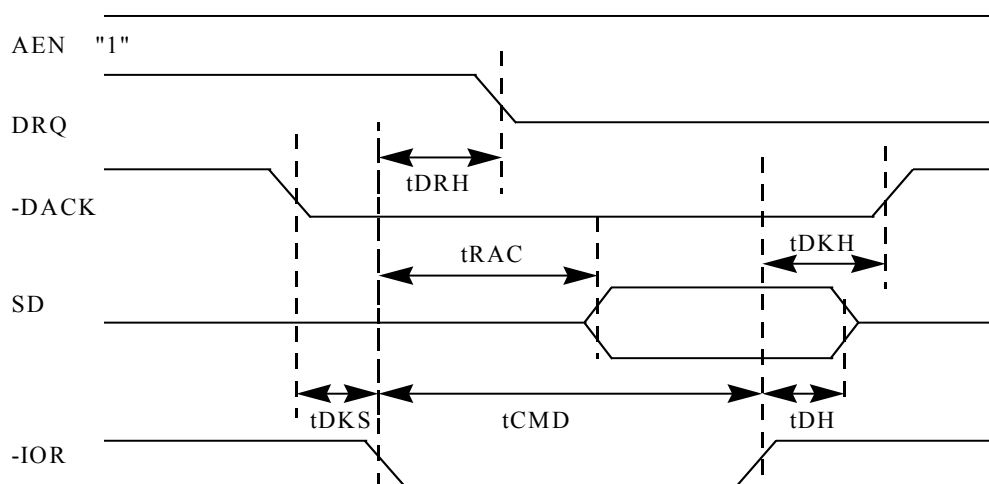
### Register/C D /F M /M ixer/Sound/ Port I/O Read Cycle



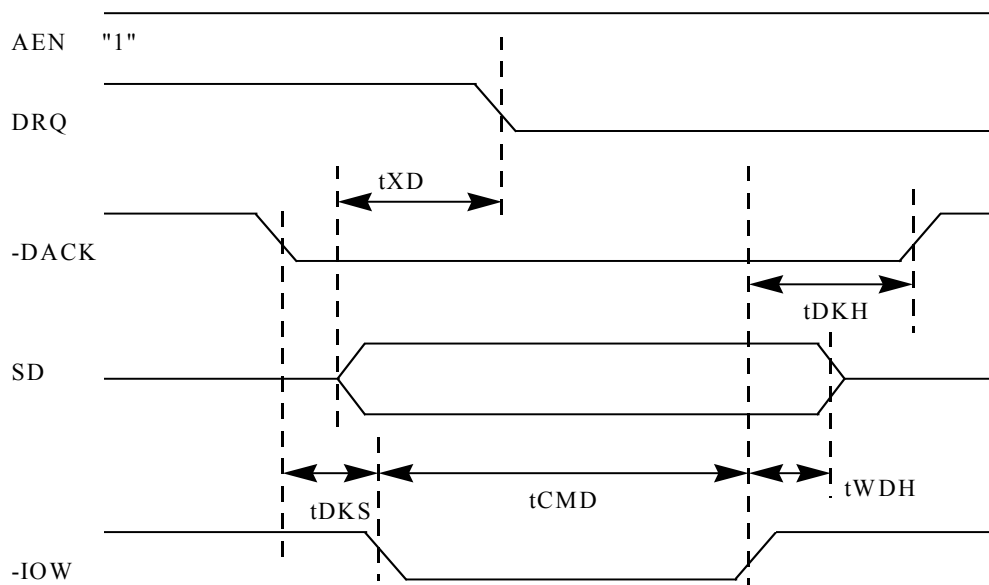
### Clock Timing



## DMA Read/Capture



## DMA Write/Playback Cycle





## 6.0 ALS120 Design Example

ALS120 ISA SOUND SYSTEM

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BILL OF MATERIALS

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ITEM	QUANTITY	REFERENCE	PART
1	9	BC1,BC2,BC3,C45,C46, C61,C62,C77,C78	10U 10UF RAD ELECT CAP
2	1	CN1	DB15 D-SUB 15 PIN FEMALE
3	1	C1	100P 100PF 0805 SMD CAP
4	2	C2,C3	4.7P 4.7PF 0805 SMD CAP
5	9	C4,C5,C9,C17,C29,C51, C52,C60,C76	0.1U 0.1UF 0805 SMD CAP
6	10	C6,C8,C10,C30,C42,C55, C56,C57,C58,C63	100U 100UF RAD ELECT CAP
7	3	C7,C64,C65	0.22U 0.22UF 0805 SMD CAP
8	12	C11,C12,C13,C14,C15, C16,C70,C71,C72,C73, C74,C75	1000P 1000PF 0805 SMD CAP
9	1	C18	220U 220UF RAD ELECT CAP

10	8	C23,C24,C31,C32,C33, C34,C35,C36	0.47U	0.47UF 0805 SMD CAP
11	7	C37,C38,C39,C40,C43, C44,C47	0.01U	0.01UF 0805 SMD CAP
12	3	C59,C66,C67	470U	470UF RAD ELECT CAP
13	1	JP1	2x1	2 PIN 0.1" HEADER(SPKR)
14	1	JP6	IDE	4 PIN 0.1" HEADER(AUDIO)
15	1	JP7	MITSUMI	4 PIN 2MM HEADER
16	1	J14	13X2	13X2 DUAL ROW HEADER
17	4	PH4,J15,J16,J17	PHONEJACK	SJ-100 5 PIN
18	1	J21	20X2	20X2 DUAL ROW HEADER
19	3	L1,L2,L3		FERRITE BEAD
20	1	RN1	2.2KX4	2.2K OHM 8PIN ISO SIP RES NET
21	1	R1	1.8M	1.8 M OHM 0805 SMD RES
22	4	R2,R8,R9,R43	47	47 OHM 0805 SMD RES
23	16	R3,R4,R46	33	33 OHM 0805 SMD RES
**R22,R61,R62,R63,R64,R65,R66,R67, **SEE NOTE				
R68,R70,R71,R72,R73				

24	2	R6,R5	150K	150K OHM 0805 SMD CAP
25	1	R7	2.7K	2.7K OHM 0805 SMD CAP
26	1	R10	1K	1K OHM 0805 SMD CAP
27	1	R11	470	470 OHM 0805 SMD CAP
28	4	R12,R13,R16,R17	1M	1M OHM 0805 SMD CAP
29	3	R44,R45	4.7K	4.7K OHM 0805 SMD CAP
		**R14		**SEE NOTE
30	1	R15	33K	33K OHM 0805 SMD CAP
31	1	R18	R	RESERVED
32	1	R19	100	100 OHM 0805 SMD CAP
33	6	R23,R24,R33,R34,R37,R38	680	680 OHM 0805 SMD CAP
34	2	R26,R25	820	820 OHM 0805 SMD CAP
35	7	R27,R28,R29,R30,R31, R32,R69	100K	100K OHM 0805 SMD CAP
36	2	R35,R36	10K	10K OHM 0805 SMD CAP
37	5	R42,R55,R56,R58,R59	1.2K	1.2K OHM 0805 SMD CAP
38	1	**R47	12K	12K OHM 0805 SMD CAP
				**SEE NOTE
39	2	R57,R60	2K	2K OHM 0805 SMD CAP

## ALS120

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40	1	U1	LM7809CT	TO-220 9V VOLTAGE REGULATOR
41	1	U2	LM7805CT	TO-220 5V VOLTAGE REGULATOR
42	1	U4	ALS120	AVANCE SOUND CHIP
43	1	U8	TEA2025B	16 PIN DIP AMPLIFIER
44	1	**U10	KM93C46	1K BIT EEPROM **SEE NOTE
45	2	U13 **U12	74LS245	20 PIN SOIC **SEE NOTE
46	1	Y1	14,318MHZ	SERIES CRYSTAL