PULSUS
Future of Digital Audio

PS8235 Datasheet (Ver0.71)

High-fidelity USB Audio Processor Integrated With Stereo Digital Amplifier

2011-08-24

Computer Speakers

High-fidelity USB Audio Processor Integrated With Stereo Digital Amplifier

Introduction

The PS8235 is a highly integrated system-on-chip solution for USB speaker applications. It combines all essential active parts including USB interface, a high-performance stereo PWM modulator, a sophisticated sample rate converter, a stereo speaker amplifier and state-of-art digital signal processing.

Only 5V USB power source is required for embedded LDOs of speaker, IO, and core power source.

The built-in USB interface supports adaptive isochronous transfer for playback. And an embedded asynchronous sample rate converter compensates jitter of a transferred audio source by USB interface.

The built-in sound processor supports easy speaker tuning preset, volume control, mute control, and digital volume boost.

Features

- ✓ On-chip USB interface
  - USB 2.0 specification full-speed compatible
  - No device driver required
  - Adaptive isochronous transfer for playback
- ✓ Windows XP/Vista/7 (WHQL® certified), Mac OS and Linux compatible
- ✓ Single power supply : Bus powered/self powered
- ✓ High fidelity digital to digital converter
- ✓ High-efficiency full-digital stereo BTL driver
- ✓ Independently adaptive sample rate
- ✓ On-chip sample rate converter
- ✓ Clipping free processing
- ✓ Digital volume control and mute control
- ✓ Easy speaker tuning by preset pin-out
  - Low cut HPF preset
  - Auto gain limiter preset
  - Digital volume boost on/off
- ✓ Embedded clock generator (PLL)

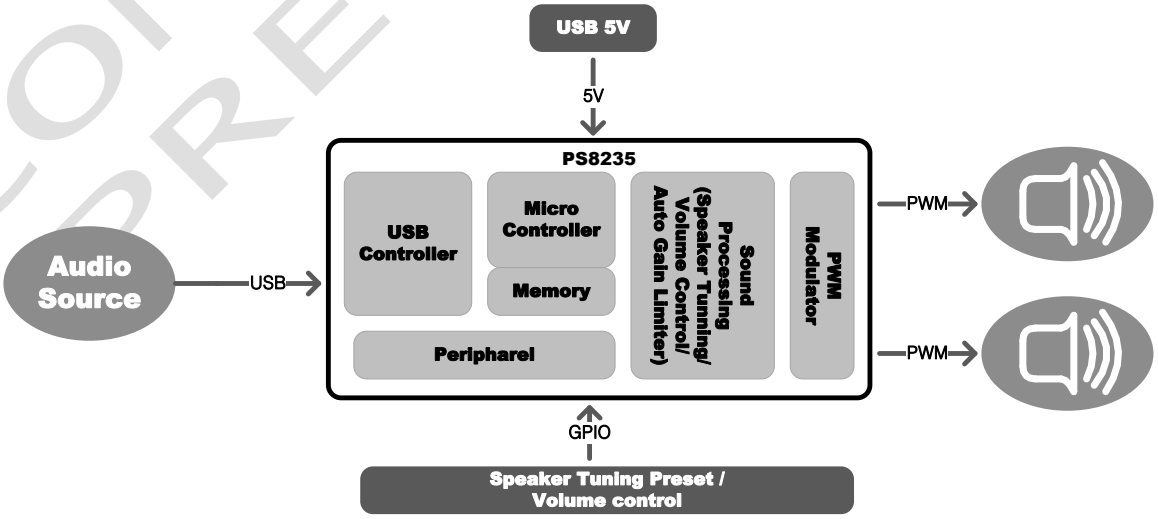
Advantages

- ✓ Lossless full-digital conversion and amplification
- ✓ Single chip solution for USB speakers
  - No additional active components required.
- ✓ Easy speaker tuning preset

Applications

- ✓ Computer speakers
- ✓ USB monitors
- ✓ USB connection consumer audio devices

Block Diagram



REMARK

1. Please consult the most recently issued data sheet before initiating or completing a design.
2. The product status of the device(s) described in this datasheet may have changed since this data sheet was published.
3. Pulsus Technologies, Inc. reserves the right to make changes in the products – including circuits, standard cells, and/or software described or contained herein in order to improve design and/or performance.

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1 ELECTRICAL SPECIFICATIONS

1.1 Absolute Maximum Ratings

Power Supply Voltage Range, VDD_USB.....-0.5V to 5.5V
Power Supply Voltage Range, VDD33_I, VDD33_USB.....-0.5V to 3.6V
Power Supply Voltage Range, VDD18_I, VDD_PLL.....-0.5V to 2.1V
Digital Input Voltage.....-0.5V to 4.0V
Storage Temperature.....-0.5°C to +150°C
Operating Temperature.....-0.5°C to +125°C

※ Stresses exceeding absolute maximum ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

1.2 Recommended Operating Conditions

Recommended Operating Conditions						
PARAMETERS		SYMBOL	MIN.	TYP.	MAX.	UNITS
DC Power Supply	USB Power	VDD_USB	4.50		5.00	V
	USB Power	VDD33_USB	3.00	3.30	3.60	V
	I/O Power	VDD33_I	2.97	3.30	3.63	V
	Core Power	VDD18_I	1.62	1.80	1.98	V
	PLL Power	VDD_PLL	1.62	1.80	1.98	V
Ground		VSS, Ground PAD		0		V
DC Power Supply	USB Power	VDD_USB		50[A]		mA
Ambient Operating Temperature				TBD		°C

1.3 Audio Electrical Characteristics

Audio Electrical Characteristics					
PARAMETERS	SYMBOL	MIN.	TYP.	MAX.	UNITS
Speaker Output Power					
Case 1 : 3.3V, THD+N ≤ 10%, 8Ω				580	mW
Case 2 : 3.3V, THD+N ≤ 1%, 8Ω				460	mW
Case 3 : 3.3V, THD+N ≤ 10%, 4Ω				800	mW
Case 4 : 3.3V, THD+N ≤ 1%, 4Ω				670	mW
Audio Input Sampling Rate (I^2S)		8k		48k	Hz

1.4 Digital Electrical Characteristics

PARAMETERS		SYMBOL	MIN.	TYP.	MAX.	UNITS
Input Leakage Current		IL	-10		+10	μA
High-level Input Voltage	Normal Input	VIH	2.00		5.50	V
	Schmitt Input	VT+	1.40	1.50	1.59	V
Low-level Input Voltage	Normal Input	VIL	-0.30		0.80	V
	Schmitt Input	VT-	0.88	0.94	1.00	V
Pull-down Resistance		RPD	43k	55k	97k	Ω
Pull-up Resistance		RPU	46k	66k	97k	Ω

Table 1 VCM,VCP,MC,LCT0_DRC,LCT1,AGLTH0,AGLTH1 Digital Input Characteristics

[A] Condition : Idle state

PARAMETERS	SYMBOL	MIN.	TYP.	MAX.	UNITS
Static output high voltage	VOH	2.8			V
Static output low voltage	VOL			0.3	V

Table 2. DP,DM Digital Electrical Characteristics

2 PIN INFORMATION

2.1 Pin Assignments

[TOP VIEW]

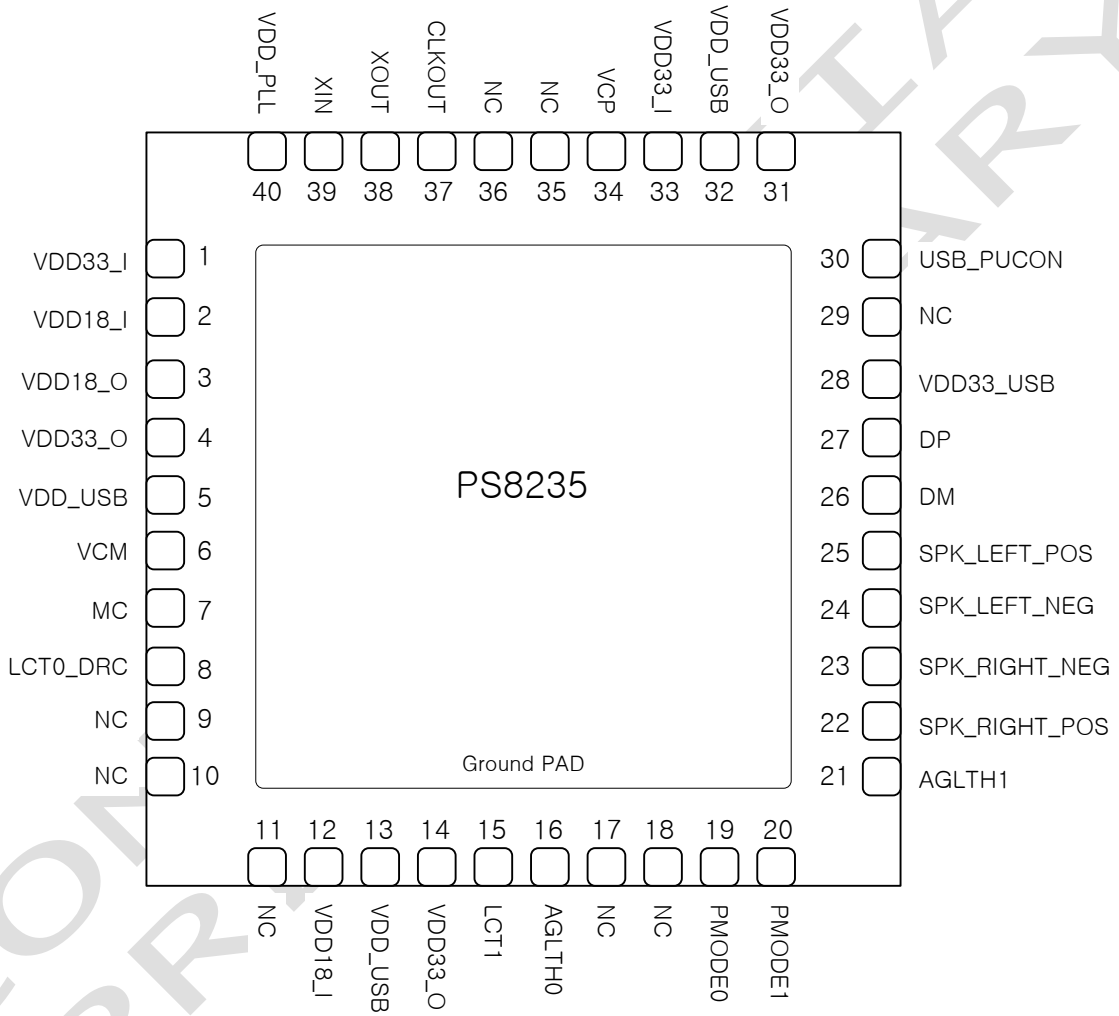


Figure 2-1 Pin Assignments

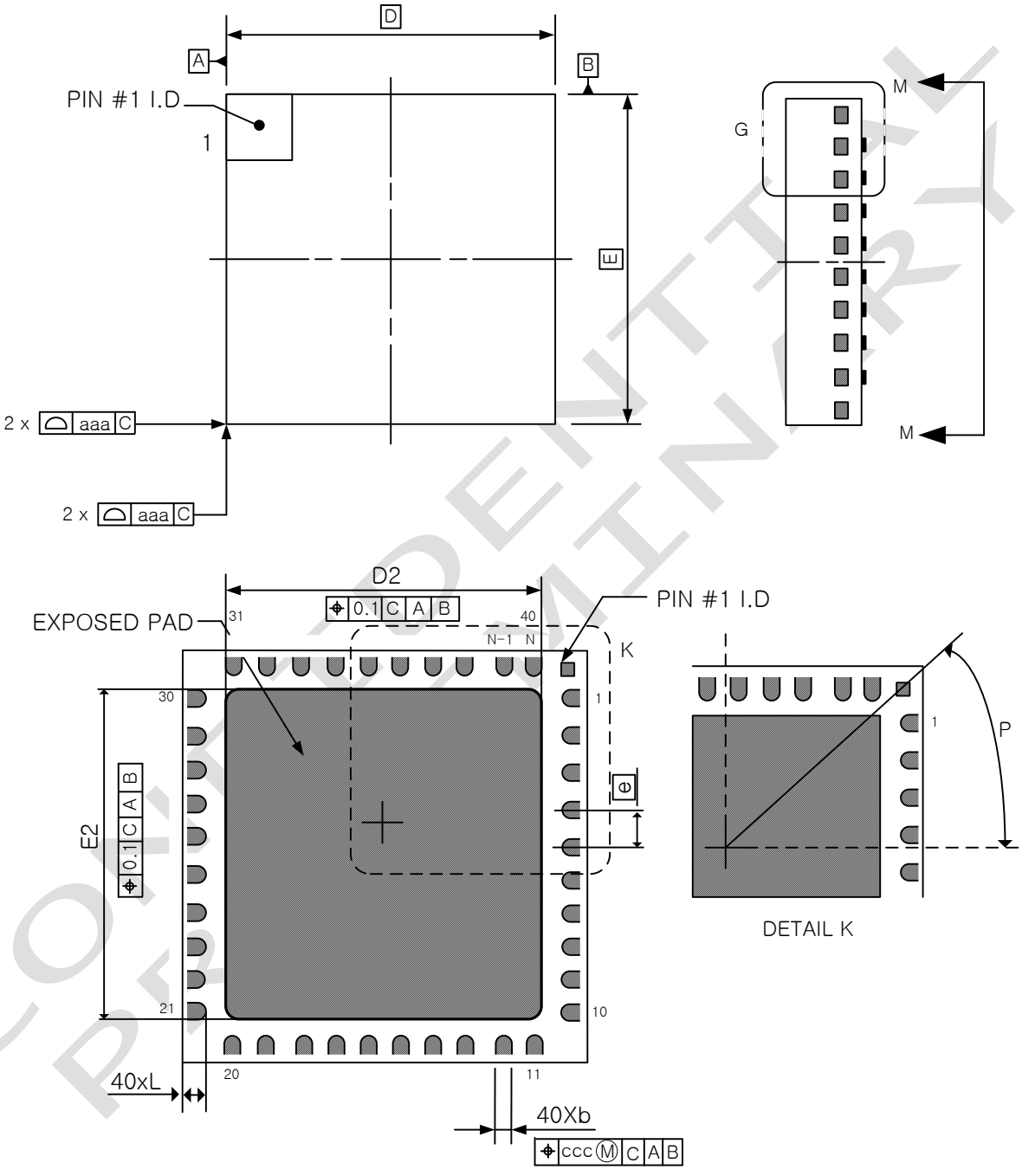
2.2 Pin description

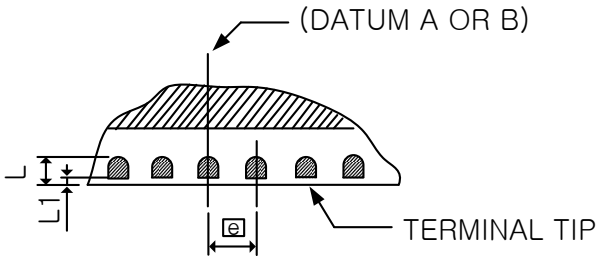
PIN NAME	PIN NO	TYPE	DESCRIPTION
POWER AND GROUND			
VDD33_I	1,33	Power	I/O power supply. 3.3V supply voltage.
VDD33_USB	28	Power	USB I/O power supply. 3.3V supply voltage.
VDD18_I	2,12	Power	Core power supply. 1.8V supply voltage.
VDD18_O	3	Power	1.8V output voltage.
VDD33_O	4,14,31	Power	3.3V output voltage.
VDD_USB	5,13,32	Power	5V power supply.
VDD_PLL	40	Power	PLL power supply. 1.9V supply voltage.
GND_PAD	Bottom	Ground	Ground of all power.
USB INTERFACE			
DM	26	I/O	USB differential input/output minus.
DP	27	I/O	USB differential input/output plus.
SYSTEM SERVICES			
XIN	39	I	Crystal oscillator input. (12MHz)
XOUT	38	O	Crystal oscillator output.
CLKOUT	37	O	12MHz output.
PMODE0	19	I	Test pin. Must be set low.
PMODE1	20	I	Debug mode select pin. Must be set low.
USB_PUCON	30	O	Boot on flag.
NC	9,10,11,17,18,29,35,36	I	No connection.
SYSTEM CONTROL INTERFACE			
VCP	34	I	Volume control + (Internal pull-up)
VCM	6	I	Volume control - (Internal pull-up)
MC	7	I	Mute control (Internal pull-up)
LCT0_DRC	8	I	Low cut tuning / DRC control (Internal pull-up)
LCT1	15	I	Low cut tuning (Internal pull-up)
AGLTH0	16	I	Audio maximum output control (Internal pull-up)
AGLTH1	21	I	Audio maximum output control (Internal pull-up)
SPEAKER OUTPUT			
SPK_RIGHT_POS	22	Analog	Positive BTL driver output of right channel PWM.
SPK_RIGHT_NEG	23	Analog	Negative BTL driver output of right channel PWM.
SPK_LEFT_POS	25	Analog	Positive BTL driver output of left channel PWM.
SPK_LEFT_NEG	24	Analog	Negative BTL driver output of left channel PWM.

3 PACKAGE INFORMATION

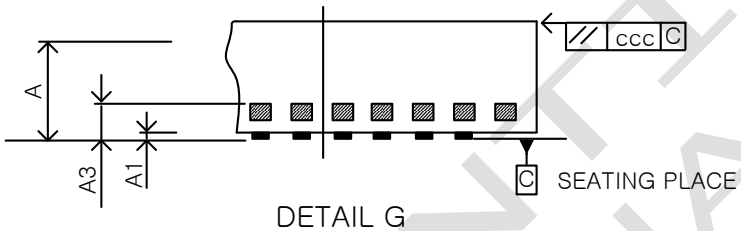
3.1 Package Dimensions

(40-LD eTQFN : 5x5mm , 0.4 mm Pitch)





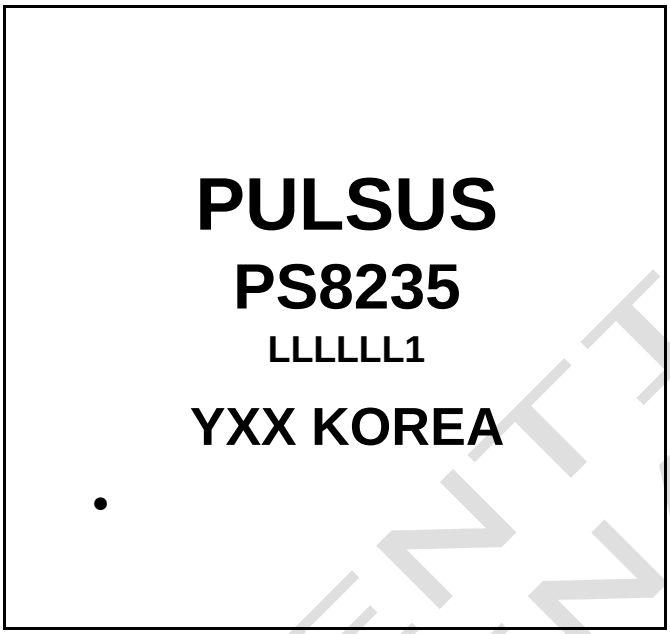
EVEN / ODD TERMINL SIDE



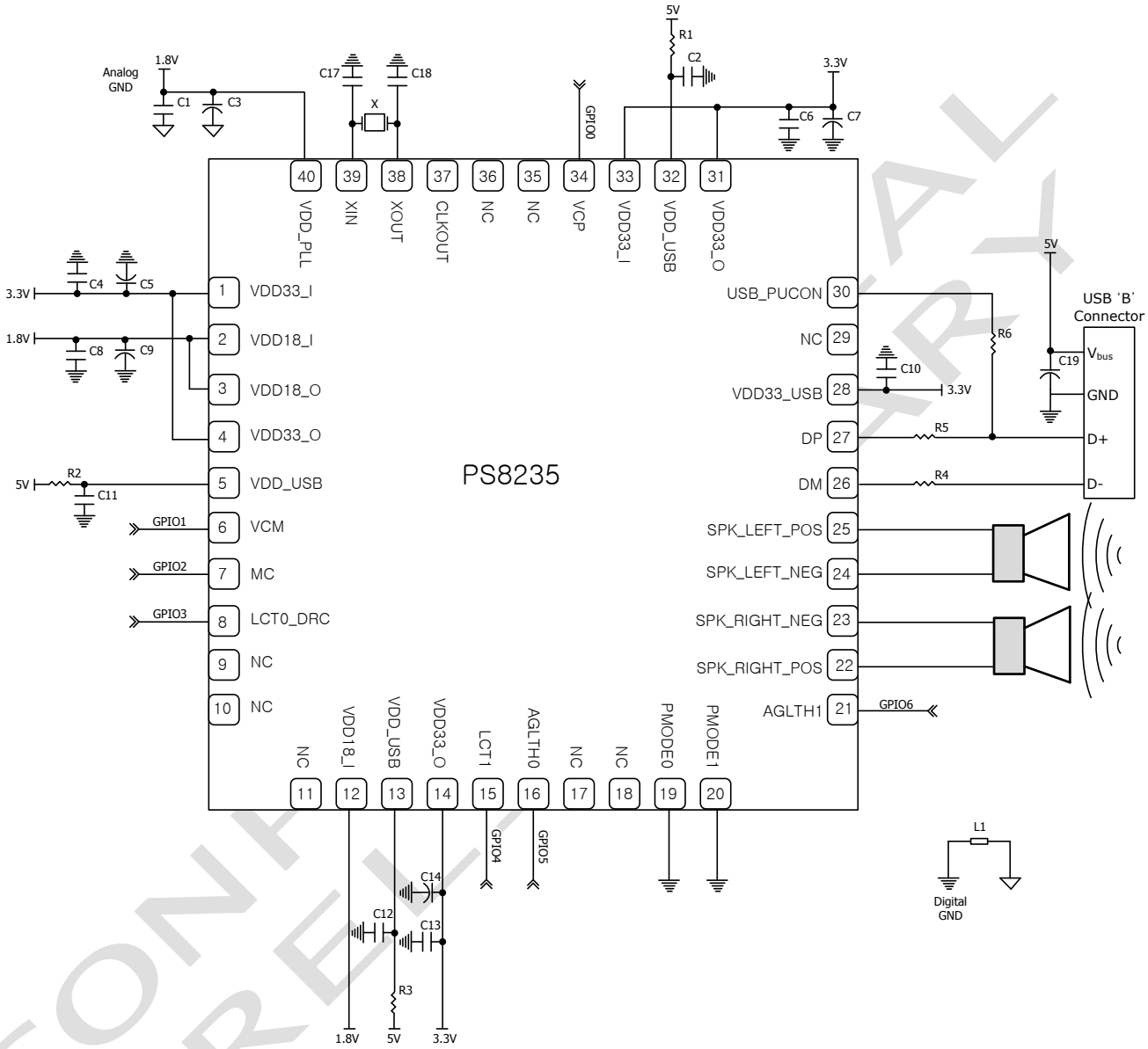
DETAIL G
VIEW ROTATED 90° CLOCKWISE

DIM	MIN	NOM	MAX	NOTES
A	0.80	0.85	0.90	1.0 DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994. 2.0 ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES. 3.0 DIMEMSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25mm AND 0.30mm FROM TERMINAL TIP. DIMENSION L1 REPRESENTS TERMINAL FULL BACK FROM PACKAGE EDGE UP TO 0.1mm IS ACCEPTABLE. 4.0 COPLANARITY APPLIES TO THE EXPOSED HEAT SLUG AS WELL AS THE TERMINAL. 5.0 RADIUS ON TERMINAL IS OPTIONAL
A1	0.00		0.05	
A3	0.203 REF			
b	0.15	0.20	0.25	
D	5.00 BSC			
E	5.00 BSC			
D2	3.70	3.80	3.90	
E2	3.70	3.80	3.90	
e	0.40 BSC			
L	0.30	0.35	0.40	
L1			0.10	
P	45° BSC			UNIT / DIMENSION AND TOLERANCE / REFERENCE DOCUMENT
aaa	0.15			
ccc	0.10			Millimeter(mm) / ASME Y14.5M / JEDEC MO-220

3.2 Marking Information



4 APPLICATION INFORMATION

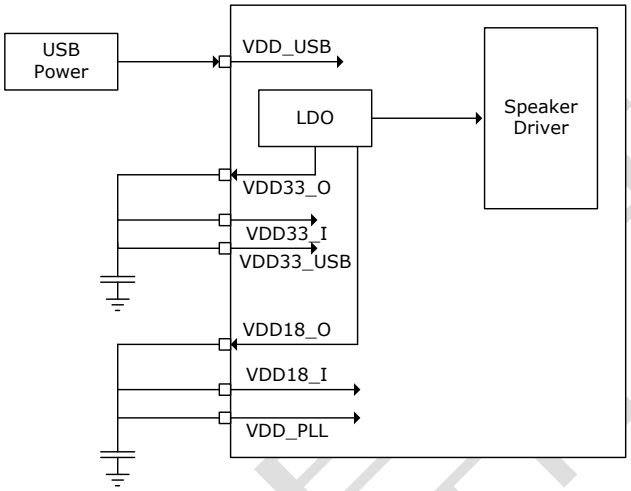


Note
X: 12MHz crystal resonator
C1,C4,C6,C8,C10,C13 : 100nF
C2,C5,C7,C9,C11,C12,C14 : 1uF
C3,C19 : 10uF
C17,C18 : 27pF
R1,R2,R3 : 2Ω
R4,R5 : 27Ω
R6 : 1.5kΩ

5 DETAILED DESCRIPTION

5.1 Power Supply

PS8235 는 USB VBus 전원을 사용하여 구동 할 수 있다. 내부에 speaker 구동용 LDO 와 core 용 LDO, 그리고 IO 용 LDO 가 내장되어 있다.



5.2 Reset Control

POR 을 사용하여 reset 된다.

5.3 Speaker Tuning Preset Control

Speaker tuning preset은 LCT0_DRC, LCT1, AGLTH0, AGLTH1 pin을 사용하여 설정한다. Speaker tuning preset은 Low cut용 HPF 설정, Auto gain limiter threshold 설정이 있다.

설정 방법은 각 pin을 pull-up 혹은 pull-down 하여 설정 한다. 각 preset 설정은 전원이 인가된 이후에 설정된다. 예를 들어 LPF 80Hz filter를 설정 하고자 할 경우 LCT1, LCT0_DRC을 외부에서 Pull-down하면 설정된다.

Low Cut HPF Preset

Low Cut HPF Preset

LCT1	LCT0_DRC	2-order bi-quad low pass filter
Pull-down	Pull-down	LPF 75Hz
Pull-down	Pull-up	LPF 140Hz
Pull-up	Pull-down	LPF 280Hz
Pull-up	Pull-up	Off

Auto Gain Limiter Threshold Preset

Auto gain limiter(AGL)는 출력을 조절하는 용도로 사용된다. AGL 은 설정된 threshold magnitude 로 출력이 scale 된다.

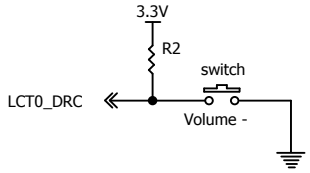
AGL Threshold Preset

AGLTH1	AGLTH0	Auto gain limiter threshold level
Pull-down	Pull-down	-3dB
Pull-down	Pull-up	0dB
Pull-up	Pull-down	4.5dB
Pull-up	Pull-up	9dB

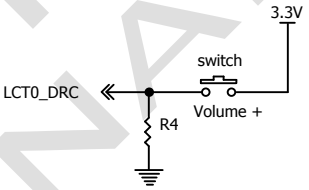
5.4 Switch Controlled Function

Switch controlled function 은 volume up/down control, mute control, DRC control 이 있다. DRC control 의 경우 설정 pin 이 speaker tuning preset 과 같이 사용된다. 그러므로, 아래와 같은 회로를 사용한다.

각 Switch controlled function 은 short key control 과 long key control 을 지원한다.



5-1 LCT0_DRC(pull-up)



5-2 LCT0_DRC(pull-down)

Volume Control

Volume up/down 을 조절한다. volume level 설정은 PC 에서 설정한다.

Mute Control

Mute on/off 를 조절한다.

DRC Control

DRC on/off 를 조절한다. 음압의 부스트 알고리즘을 on/off 한다.

6 APPENDIX

6.1 Volume Control

PS8235 의 volume 은 USB audio class specification 에 맞게 구현되어 있다. PS8235 는 PC host 에 max,min magnitude 를 전달한다.

Maximum Volume Value : +20dB

Minimum Volume Value : -30dB

PC host 에서는 PC 에서 조절되는 volume 값에 따라서 volume value(dB)을 PS8235 에 전달한다. 이 값은 PC OS 마다 다른 값을 가지고 있다. 아래 volume table 은 PC 에서 전달된 volume 값과 PS8235 에 적용되는 volume 값에 대한 matching table 이다.

USB interface DDC volume table

PC volume	DDC volume	PC volume	DDC volume
-29dB	-34.5dB	-4dB	-9dB
-28dB	-33.0dB	-3dB	-9dB
-27dB	-33.0dB	-2dB	-7.5dB
-26dB	-31.5dB	-1dB	-6dB
-25dB	-30.0dB	0dB	-6dB
-24dB	-30.0dB	1dB	-4.5dB
-23dB	-28.5dB	2dB	-3dB
-22dB	-27.0dB	3dB	-3dB
-21dB	-27.0dB	4dB	-1.5dB
-20dB	-25.5dB	5dB	0dB
-19dB	-24.0dB	6dB	0dB
-18dB	-24.0dB	7dB	1.5dB
-17dB	-22.5dB	8dB	3dB
-16dB	-21.0dB	9dB	3dB
-15dB	-21.0dB	10dB	4.5dB
-14dB	-19.5dB	11dB	6dB
-13dB	-18.0dB	12dB	6dB
-12dB	-18.0dB	13dB	7.5dB
-11dB	-16.5dB	14dB	9dB
-10dB	-15.0dB	15dB	9dB
-9dB	-15.0dB	16dB	10.5dB
-8dB	-13.5dB	17dB	12dB

-7dB	-12.0dB	18dB	12dB
-6dB	-12.0dB	19dB	13.5dB
-5dB	-10.5dB	20dB	15dB

6.2 Short Key / Long Key Control

Short Key Control

20msec 이상 key 가 눌려질 경우 short key 로 인식한다.

Long Key Control

Short key 인식 후 200msec 동안 key 가 눌려질 경우 long key 로 인식한다.

6.3 USB_PUCON control

Control data and audio data are transferred to PS8235 via DP and DM. For the USB interface, DP and DM driver output impedance should stay in the range of 28Ω to 44Ω, in order to reduce the transmission line effect. And a 1.5 kΩ register is connected from DP to USB_PUCON.

The following picture shows the external series resistances (Rs) insertion for full-speed mode impedance matchs requirement. The series resister (Rs) of 27Ω can be as a reference value to meet the overall output impedance specification. All data are transferred at full speed (12 MB/s).