



Future of Digital Audio

PS8535 Datasheet (Ver1.00)

**Stereo USB Streaming Audio Processor with
Stereo Speaker Amplifier**

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High-Fidelity Full-Digital Amplifier for USB Speakers

Stereo USB Streaming Audio Processor with Stereo Speaker Amplifier

Introduction

The PS8535 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.

Built-in USB interface supports both 5V power supply and adaptive isochronous transfer for playback, so no external power source is required. On-chip full-digital stereo speaker amplifier is rated at 1 watt per channel with 96% efficiency.

The PS8535 fully supports sound processing including five-band equalizer, dynamic range control(DRC), mute, volume and auto gain limiter. The equalizer setting may be selected from a large set of preset equalizer pool optimized for the most popular speakers in the market. The PS8535 also provides button control for bass and treble tone, dynamic range control, volume and mute controls.

Through the on-chip I²S interface, the PS8535 may also receive additional digital sources. I²C control bus and GPIO allows full compatibility and easy configuration.

Advantages

- ✓ Outstanding sound quality from patented full digital amplifier.
- ✓ No additional active components for USB speakers required.
- ✓ Sophisticated on-chip sample rate converter.
- ✓ Sound processing : equalizer, bass, treble, DRC, etc.
- ✓ Easy speaker tuning and user sound effects control
- ✓ Supports selectable optimized speaker tuning for both 4Ω and 8Ω speakers

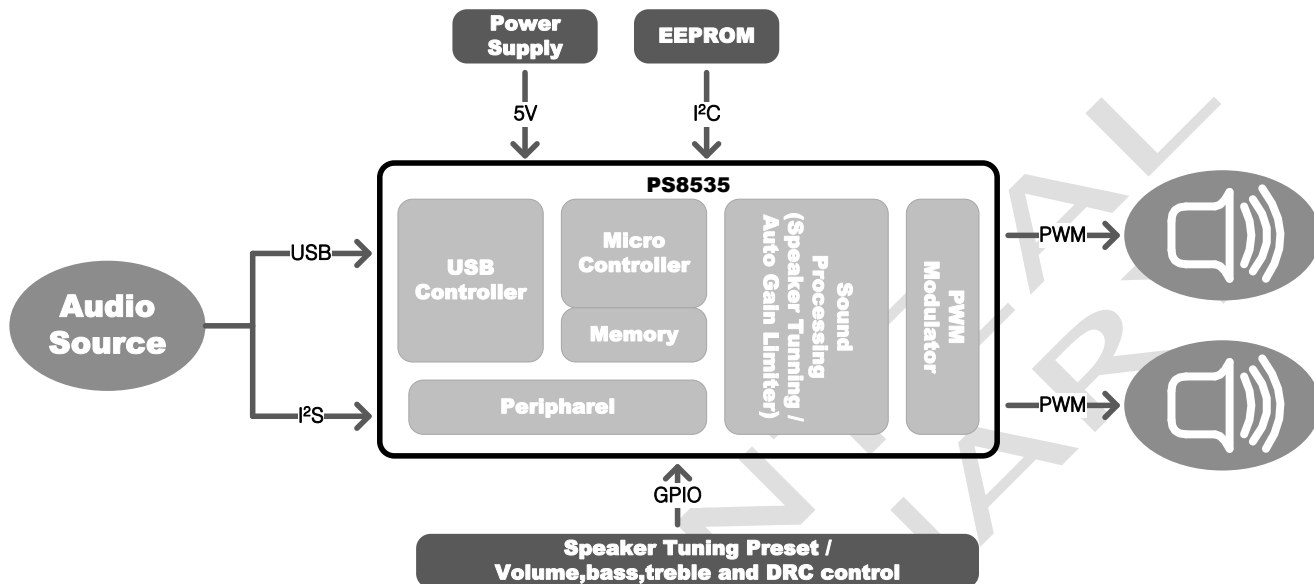
Features

- ✓ On-chip USB interface
 - USB1.1 specification full-speed compatible
 - No required device driver
 - Adaptive isochronous transfer for playback
- ✓ Windows 98/XP/Vista, Mac OS and Linux compatible
- ✓ Single power supply : Bus powered/self powered
- ✓ Multiple functions
 - GPIO (general purpose inputs and outputs)
 - Stereo serial input ports(I²S)
 - I²C control bus
- ✓ Audio source select using a pin : USB/I²S
- ✓ High-performance digital to digital converter
- ✓ 2 channel full-digital stereo BTL driver
- ✓ Independently adaptive sample rate : up to 96kHz
- ✓ On-chip sample rate converter
- ✓ Clipping free processing with on-chip DRC
- ✓ 5-band full parametric equalizer for channel
- ✓ Digital volume control and DRC control
- ✓ Soft volume adjustment & soft mute control
- ✓ Click noise free
- ✓ Easy speaker tuning by preset equalizer with GPIO
- ✓ Equalizer and filter value setting available with EE-PROM
- ✓ GPIO controlled bass, treble, DRC, volume & mute
- ✓ Embedded clock generator (PLL)
- ✓ Vendor-identification, PID, String available with external EEPROM

Applications

- ✓ USB PC 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.
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1 ELECTRICAL SPECIFICATIONS

1.1 Absolute Maximum Ratings

Power Supply Voltage Range, VDD_USB_I.....	-0.5V to 5.5V
Power Supply Voltage Range, VDD33_I, VDD33_USB_I.....	-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_I	4.50		5.00	V
	USB Power	VDD33_USB_I	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_I		TBD		mA
	USB Power	VDD33_USB_I		TBD		mA
	I/O Power	VDD33_I		TBD		mA
	Core Power	VDD18_I		TBD		
	PLL Power	VDD_PLL		TBD		
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 ² S)			8k		48k	Hz

1.4 Digital Electrical Characteristics

PARAMETERS		SYMBOL	MIN.	TYP.	MAX.	UNITS
Input Leakage Current		IL	-10		+10	μA
Tri-State Output Leakage Current		IOZ	-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
Schmitt Threshold Point		VT	1.35	1.47	1.60	V
Pull-down Resistance		RPD	43k	55k	97k	Ω
Pull-up Resistance		RPU	46k	66k	97k	Ω
Output Low Voltage		VOL			0.4	V
Output High Voltage		VOH	2.4			V
Low Level Output Current (@VOL=0.4V)		IOL	4.9	7.8	9.4	mA
High Level Output Current (@VOH=2.4V)		IOH	5.8	11.7	18.0	mA

1.5 Switching Characteristics – I²S

PARAMETERS	SYMBOL	MIN	TYP	MAX	UNITS
Data Hold Time	$T_{HDIS(I^2S)}$	50			ns
Data Setup Time	$T_{SUIS(I^2S)}$	50			ns
Clock High Time	$T_{HIGH(I^2S)}$	160	360		ns
Clock Low Time	$T_{LOW(I^2S)}$	160	360		ns
Rising Time of MBCK,SBCK	$T_{RISS(I^2S)}$			40	ns
Falling Time of MBCK,SBCK	$T_{FISS(I^2S)}$			40	ns
Delay until Valid Data		40		80	ns

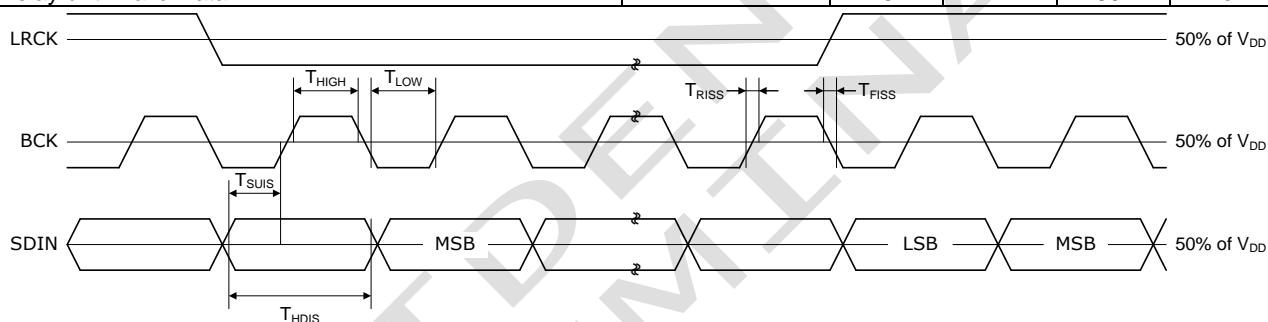
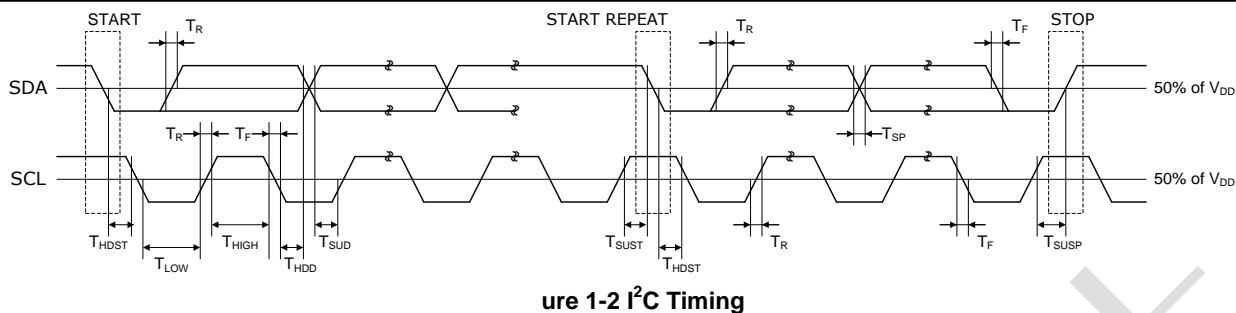


Figure 1-1 I²S Timing

1.6 Switching Characteristics – I²C

PARAMETERS	SYMBOL	MIN	TYP	MAX	UNITS
SCL Clock Frequency				400	kHz
START (REPEAT) Condition Hold Time	$T_{HDST(I^2C)}$	400			ns
Low Period of SCL Clock	$T_{LOW(I^2C)}$	800			ns
High Period of SCL Clock	$T_{HIGH(I^2C)}$	800			ns
Setup Time for START REPEAT Condition	$T_{SUST(I^2C)}$	400			ns
Data Hold Time	$T_{HDD(I^2C)}$	0			ns
Data Setup Time	$T_{SUD(I^2C)}$	100			ns
Rise Time of both SDA and SCL	$T_{RI(I^2C)}$			600	ns
Falling Time of both SDA and SCL	$T_{FI(I^2C)}$			600	ns
Setup Time for STOP Condition	$T_{SUSP(I^2C)}$	400			ns
Bus Free Time between STOP and START Condition		470			ns



Fig

2 PIN INFORMATION

2.1 Pin Assignments

[TOP VIEW]

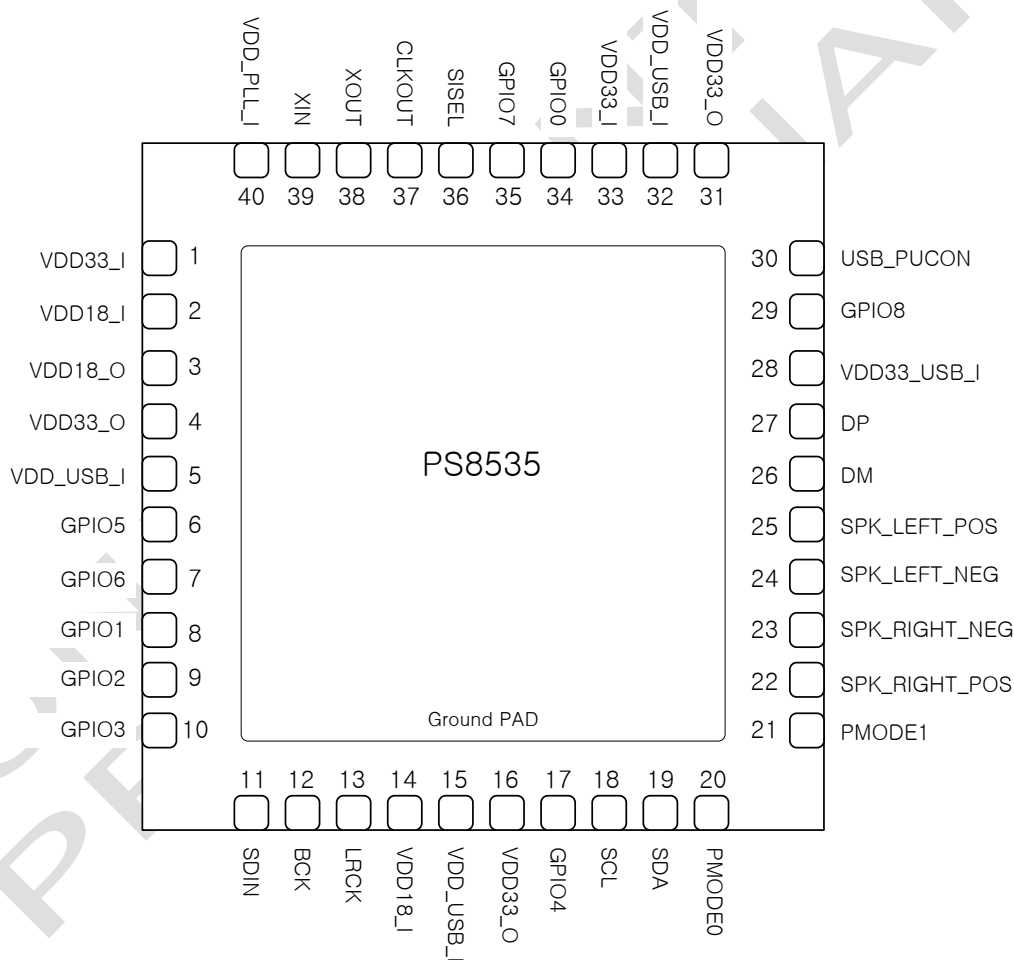


Figure 2-1 Pin Assignments

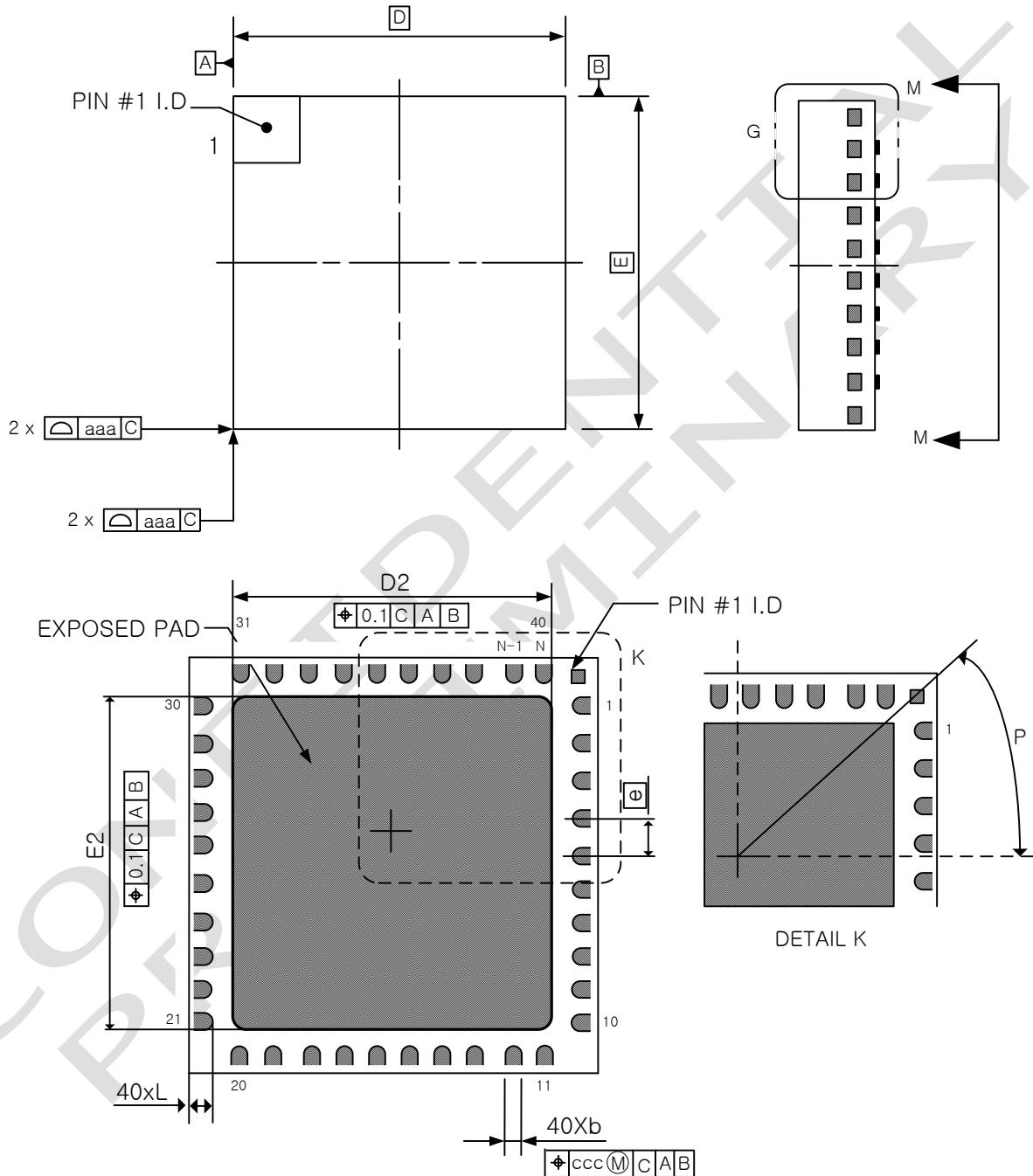
2.2 Pin description

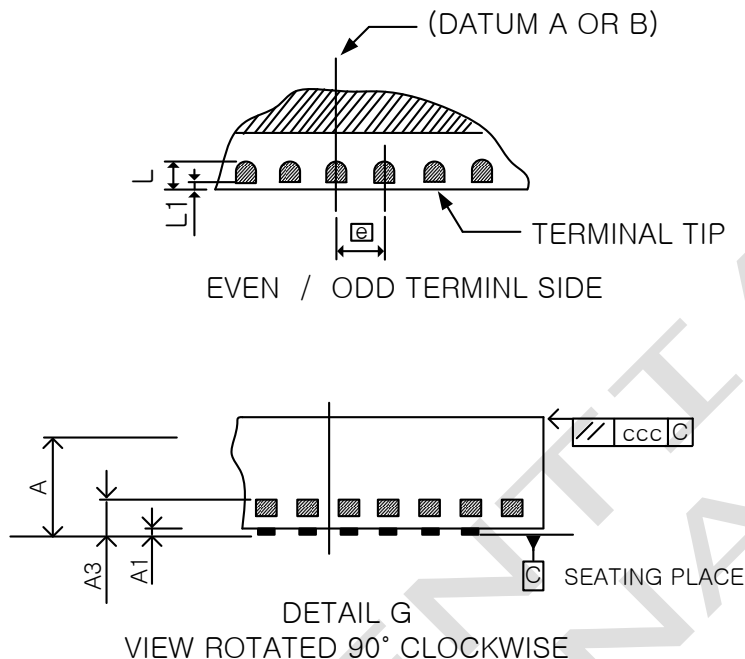
PIN NAME	PIN NO	TYPE	DESCRIPTION
POWER AND GROUND			
VDD33_I	1,33	Power	I/O power supply. 3.3V supply voltage.
VDD33_USB_I	28	Power	USB I/O power supply. 3.3V supply voltage.
VDD18_I	2,14	Power	Core power supply. 1.8V supply voltage.
VDD18_O	3	Power	1.8V output voltage.
VDD33_O	4,16,31	Power	3.3V output voltage.
VDD_USB_I	5,15,32	Power	5V power supply.
VDD_PLL_I	40	Power	PLL power supply. 1.8V 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.
XOUT	38	O	Crystal oscillator output.
CLKOUT	37	O	12MHz output.
PMODE0	20	I	Test pin. Must be set low. (Pull-down)
PMODE1	21	I	Debug mode select pin. (Pull-down)
SISEL	36	I	Audio source input select. (Pull-down)
USB_PUCON	30	O	Boot on flag.
SYSTEM CONTROL INTERFACE			
SCL	18	O	I2C clock. (Pull-up)
SDA	19	I/O	I2C data. (Pull-up)
GPIO0	34	I	Low band tuning / Volume control + (Pull-up)
GPIO1	8	I	Low band tuning / Volume control - (Pull-up)
GPIO2	9	I	Low band tuning / Mute control (Pull-up)
GPIO3	10	I	Low cut tuning / DRC control (Pull-up)
GPIO4	17	I	Low cut tuning (Pull-up)
GPIO5	6	I	Mid band tuning / Bass tone control + (Pull-up)
GPIO6	7	I	Mid band tuning / Bass tone control - (Pull-up)
GPIO7	35	I	Mid band tuning / Treble tone control + (Pull-up)
GPIO8	29	I	Mid band tuning / Treble tone control - (Pull-up)
AUDIO INPUT/OUTPUT INTERFACE			
BCK	12	I	PCM bit clock. (Pull-up)
LRCK	13	I	PCM word clock. (Pull-up)
SDI	11	I	PCM input serial data. (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

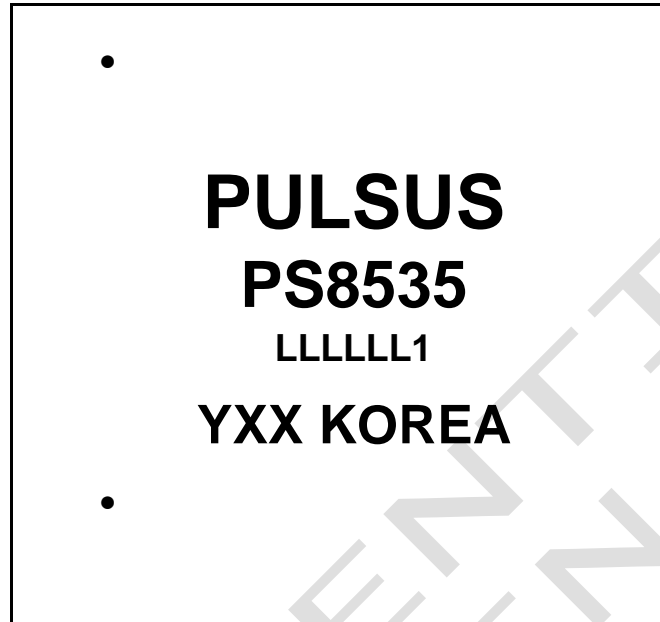
(40-LD eTQFN : 5x5mm , 0.4 mm Pitch)



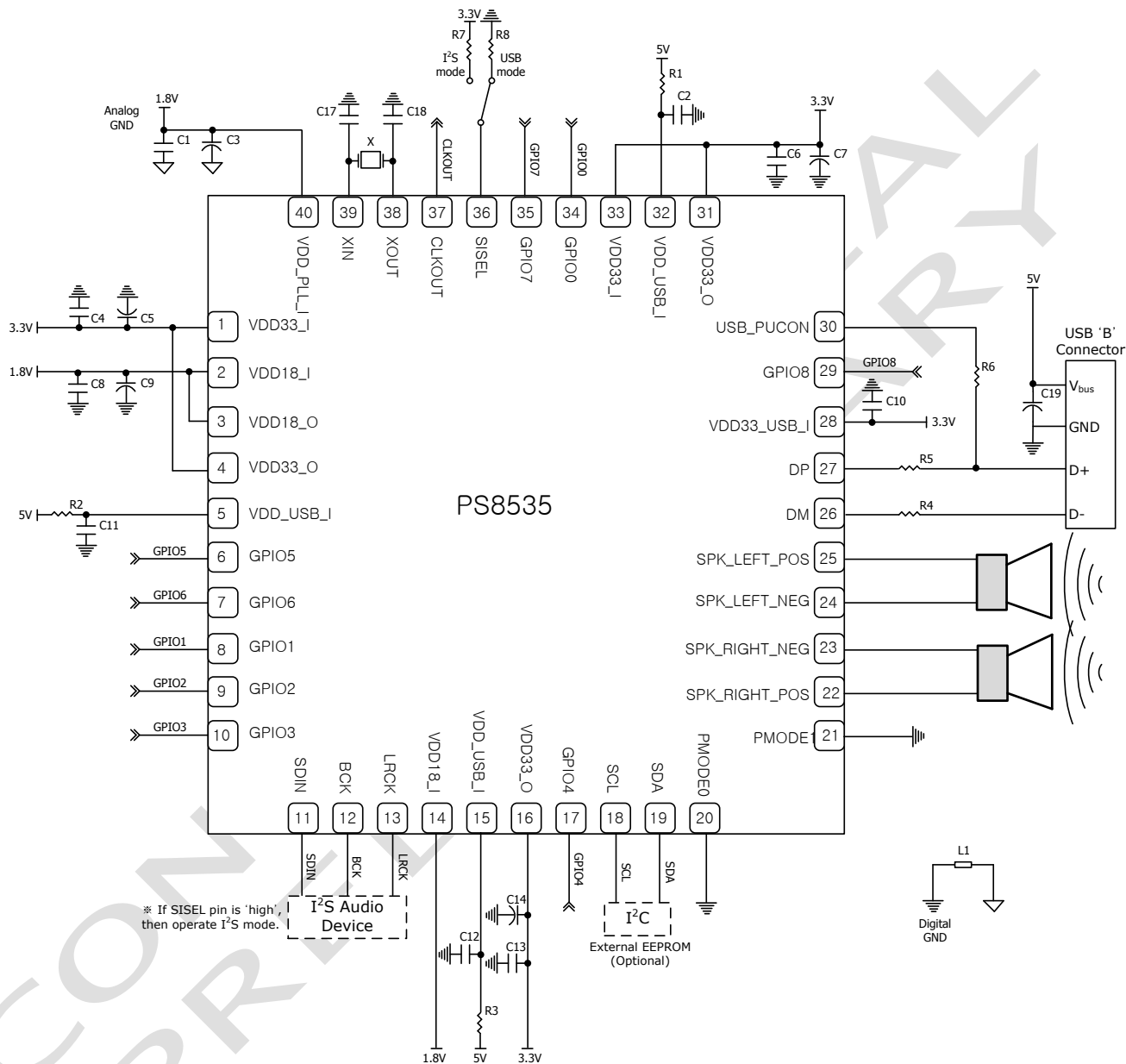


DIM	MIN	NOM	MAX	NOTES		
A	0.80	0.85	0.90	1.0 DIMENSIONING & TOLERANCEING CONFIRM TO ASME Y14.5M-1994. 2.0 ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES. 3.0 DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25mm AND 0.30mm FROM TERMINAL TIP. DIMENSION L1 REPRESENTS TERMINAL 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			Millimeter(mm)	ASME Y14.5M	JEDEC MO-220
ccc	0.10					

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