4-Channel Input Audio Processor

General Description

ET2314 is a four-channel input digital audio processor utilizing CMOS Technology. Volume, Bass, Treble and Balance are incorporated into a single chip. Loudness Function and Selectable Input Gain are also provided to build a highly effective electronic audio processor having the highest performance and reliability with the least external components. All functions are programmable using the I^2C Bus. The pin assignments and application circuit are optimized for easy PCB layout and cost saving advantage for audio application.

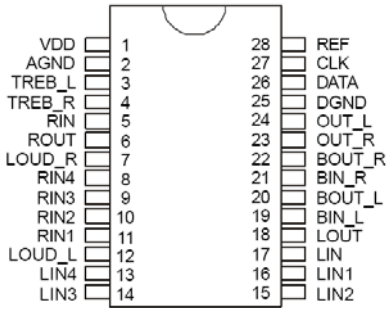
Features

- CMOS Technolog
- Least External Components
- Treble and Bass Control
- Loudness Function
- 4 Stereo Inputs with Selectable Input Gain
- Input/Output for External Noise Reduction System/Equalizer
- 2 Independent Speaker Controls for Balance Control
- Independent Mute Function
- Volume Control in 1.25 dB/step
- Low Distortion
- Low Noise and DC Stepping
- Controlled by I^2C Bus Micro-Processor Interface
- Package: SOP28

Applications

- Car Stereo (Audio)
- Hi-Fi Audio System

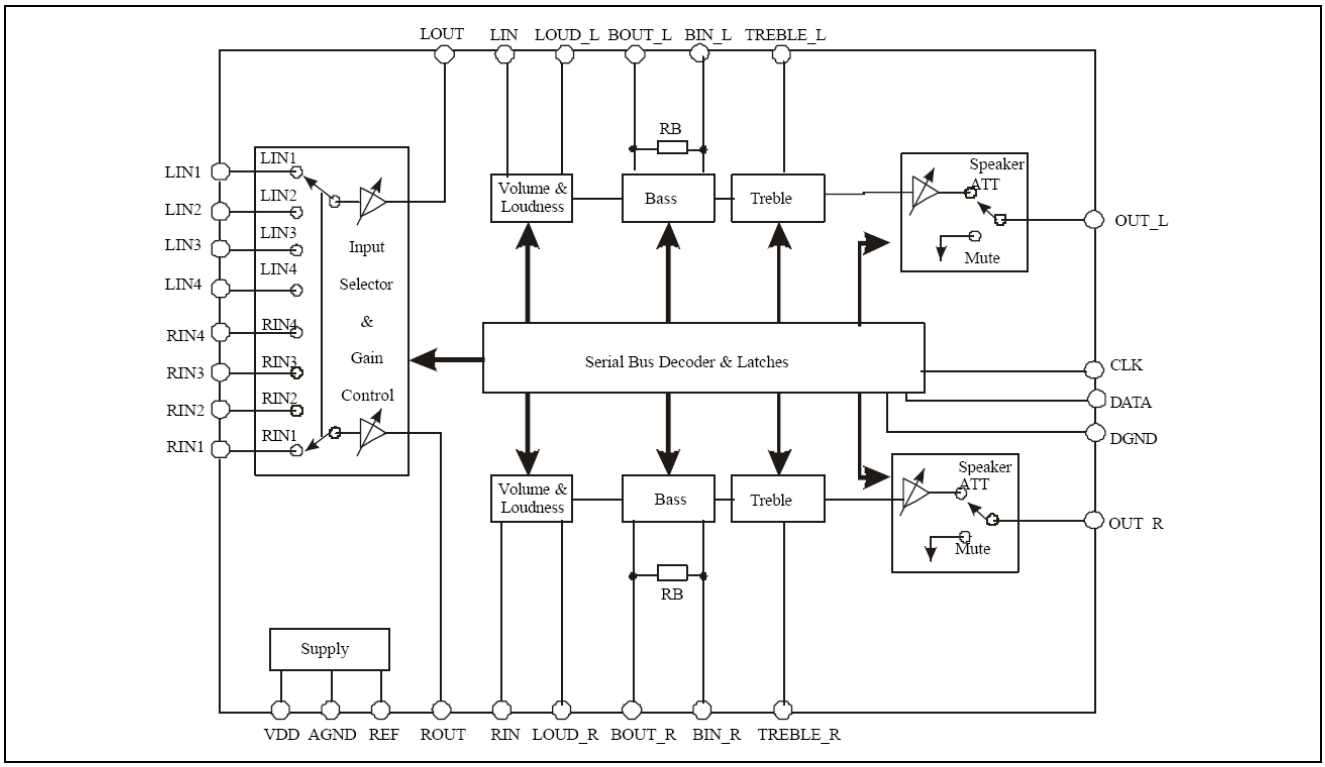
Pin Configuration



Pin Function

Pin NO	Pin Name	I/O	Description
1	VDD	-	Supply Input Voltage
2	AGND	-	Analog Ground
3	TREB_L	I	Left Channel Input for Treble Controller
4	TREB_R	I	Right Channel Input for Treble Control
5	RIN	I	Audio Processor Right Channel Input
6	ROUT	O	Gain Output and Input Selector for Right Channel
7	LOUD_R	I	Right Channel Loudness Input
8	RIN4	I	Right Channel Input 4
9	RIN3	I	Right Channel Input 3
10	RIN2	I	Right Channel Input 2
11	RIN1	I	Right Channel Input 1
12	LOUD_L	I	Left Channel Loudness Input
13	LIN4	I	Left Channel Input 4
14	LIN3	I	Left Channel Input 3
15	LIN2	I	Left Channel Input 2
16	LIN1	I	Left Channel Input 1
17	LIN	I	Audio Processor Left Channel Input
18	LOUT	O	Gain Output and Input Selector for Left Channel
19	BIN_L	I	Left Channel Input for Bass Controller
20	BOUT_L	O	Left Bass Controller Output Channel
21	BIN_R	I	Right Channel Input for Bass Controller
22	BOUT_R	O	Right Channel Output for Bass Controller
23	OUT_R	O	Right Speaker Output
24	OUT_L	O	Left Speaker Output
25	DGND	-	Digital Ground
26	DATA	I	Control Data Input
27	CLK	I	Clock Input for Serial Data Transmission
28	REF	-	Analog Reference Voltage (1/2 VDD)

Block Diagram



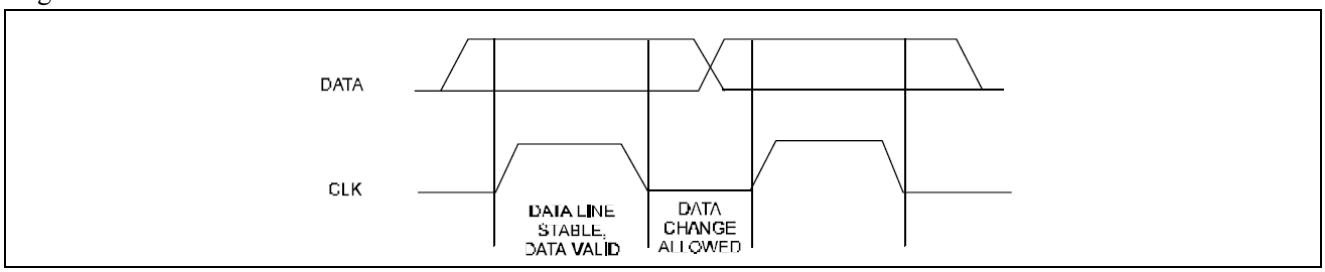
Functional Description

Bus Interface

Data are transmitted to and from the microprocessor to the ET2314 via the DATA and CLK. The DATA and CLK make up the BUS Interface. It should be noted that the pull-up resistors must be connected to the positive supply voltage.

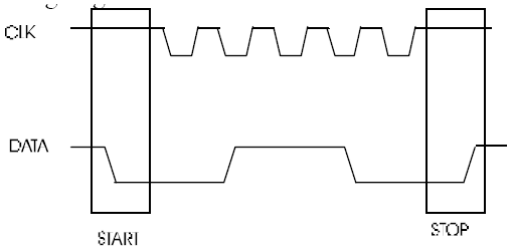
Data Validity

A data on the DATA Line is considered valid and stable only when the CLK Signal is in HIGH State. The HIGH and LOW State of the DATA Line can only change when the CLK signal is LOW. Please refer to the figure below.



Start and Stop Conditions

A Start Condition is activated when 1) the CLK is set to HIGH and 2) DATA shifts from HIGH to LOW State. The Stop Condition is activated when 1) CLK is set to HIGH and 2) DATA shifts from LOW to HIGH State. Please refer to the timing diagram below.

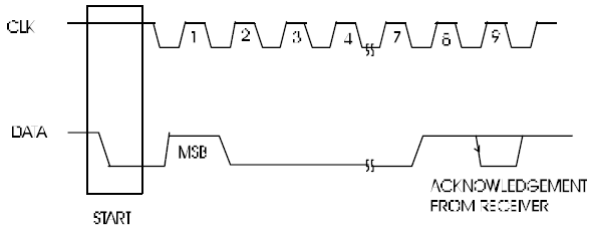


Byte Format

Every byte transmitted to the DATA Line consist of 8 bits. Each byte must be followed by an Acknowledge Bit. The MSB is transmitted first.

Acknowledge

During the Acknowledge Clock Pulse, the master (μP) puts a resistive HIGH level on the DATA Line. The peripheral (audio processor) that acknowledges has to pull-down (LOW) the DATA line during the Acknowledge Clock Pulse so that the DATA Line is in a Stable Low State during this Clock Pulse. Please refer to the diagram below.



The audio processor that has been addressed has to generate an acknowledge after receiving each byte, otherwise, the DATA Line will remain at the High Level during the ninth (9th) Clock Pulse. In this case, the master transmitter can generate the STOP Information in order to abort the transfer.

Transmission without Acknowledge

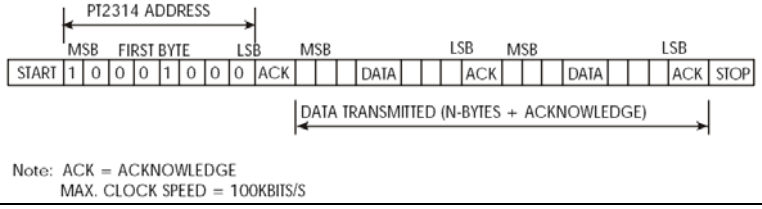
If you want to avoid the acknowledge detection of the audio processor, a simpler μP transmission may be used. Wait one clock and do not check the slave acknowledge of this same clock then send the new data. If you use this approach, there are greater chances of faulty operation as well as decrease in noise immunity.

Interface Protocol

The interface protocol consists of the following:

- A Start Condition
- A Chip Address Byte including the ET2314 address. The 8th Bit of the Byte must be “0”. ET2314 must always acknowledge the end of each transmitted byte.
- A Data Sequence (N-Bytes + Acknowledge)
- A Stop Condition

Please refer to the diagram below:



Note: ACK = ACKNOWLEDGE
MAX. CLOCK SPEED = 100KBITS/S

Software Specification

ET2314 Address

ET2314 Address is shown below.

1 MSB	0	0	0	1	0	0	0 LSB

Data Bytes

MSB							LSB	FUNCTION
0	0	B2	B1	B0	A2	A1	A0	Volume Control
1	1	0	B1	B0	A2	A1	A0	Speaker ATT L
1	1	1	B1	B0	A2	A1	A0	Speaker ATT R
0	1	0	G1	G0	S2	S1	S0	Audio Switch
0	1	1	0	C3	C2	C1	C0	Bass Control
0	1	1	1	C3	C2	C1	C0	Treble Control

where Ax = 1.25 dB steps; Bx = 10 dB steps; Cx = 2 dB steps; Gx = 3.75 dB/steps

Volume

The table below gives a detailed description of the Volume Data Bytes. For example, a volume of -37.5 dB is given by 0 0 0 1 1 1 1 0.

MSB							LSB	FUNCTION
0	0	B2	B1	B0	A2	A1	A0	Volume 1.25 dB steps
					0	0	0	0
					0	0	1	-1.25
					0	1	0	-2.5
					0	1	1	-3.75
					1	0	0	-5
					1	0	1	-6.25
					1	1	0	-7.5
					1	1	1	-8.75
0	0	B2	B1	B0	A2	A1	A0	Volume 10 dB steps
		0	0	0				0
		0	0	1				-10
		0	1	0				-20
		0	1	1				-30
		1	0	0				-40
		1	0	1				-50
		1	1	0				-60
		1	1	1				-70

Speaker Attenuators

The table below gives a detailed description of the speaker attenuators data bytes. For example, an attenuation of 30dB on the Speaker R (Right) is given by: 1 1 1 1 1 0 0 0.

MSB							LSB	FUNCTION
1	1	0	B1	B0	A2	A1	A0	Speaker L
1	1	1	B1	B0	A2	A1	A0	Speaker R
					0	0	0	0
					0	0	1	-1.25
					0	1	0	-2.5
					0	1	1	-3.75
					1	0	0	-5
					1	0	1	-6.25
					1	1	0	-7.5
					1	1	1	-8.75
			0	0				0
			0	1				-10
			1	0				-20
			1	1				-30
			1	1	1	1	1	Mute

Audio Switch Data Byte

The following table shows the detailed description of the Audio Switch Data Bytes. For example, a Stereo 1 Input with Gain of +11.25 dB Loudness ON is given by: 0 1 0 0 0 0 0 0.

MSB							LSB	FUNCTION
0	1	0	G1	G0	S2	S1	S0	Audio Switch
						0	0	Stereo 1
						0	1	Stereo 2
						1	0	Stereo 3
						1	1	Stereo 4
					0			Loudness ON
					1			Loudness OFF
			0	0				+11.25dB
			0	1				+7.5dB
			1	0				+3.75dB
			1	1				0dB

Bass and Treble Data Bytes

The following table shows a detailed description of the Bass and Treble Data Byte. For example a Treble at 12dB is given by : 0 1 1 1 0 0 0 1.

MSB							LSB	FUNCTION
0	1	1	0	C3	C2	C1	C0	Bass
0	1	1	1	C3	C2	C1	C0	Treble
				0	0	0	0	-14

				0	0	0	1	-12
				0	0	1	0	-10
				0	0	1	1	-8
				0	1	0	0	-6
				0	1	0	1	-4
				0	1	1	0	-2
				0	1	1	1	0
				1	1	1	1	0
				1	1	1	0	2
				1	1	0	1	4
				1	1	0	0	6
				1	0	1	1	8
				1	0	1	0	10
				1	0	0	1	12
				1	0	0	0	14

Unit: dB

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Operating Supply Voltage	Vs	10.5	V
Operating Ambient Temperature	Tamb	-20 to 75	℃
Storage Temperature Range	Tstg	-40 to +125	℃

Quick Reference Data

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	Vs	6	9	10	V
Max. Input Signal Handling	V_{CL}	2	2.5		Vrms
Total Harmonic Distortion (V = 1Vrms, f = 1KHz)	THD		0.07	0.15	%
Signal to Noise ratio	S/N		95		dB
Channel Separation (f = 1KHz)	Sc		85		dB
Volume Control 1.25dB step		-75		0	dB
Bass & Treble Control 2dB step		-14		+14	dB
Balance Control 1.25dB step		-37.5		0	dB
Input Gain 3.75 dB step		0		11.25	dB
Mute Attenuation			85		dB

Electrical Characteristics

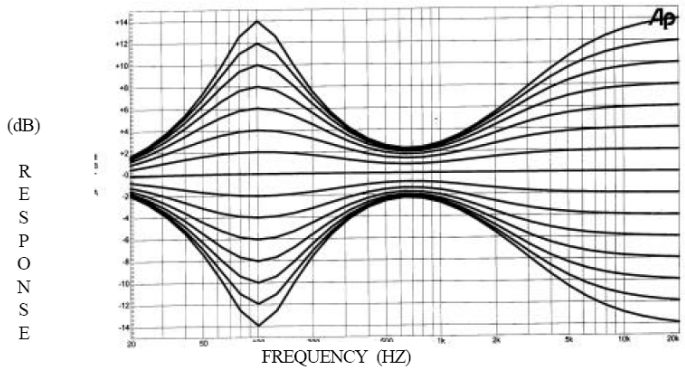
(Unless specified: Tamb = 25℃, Vc=9V, RL=10KΩ, Rg = 600Ω, all controls flat (G=0), f=1KHz)

Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Supply						
Supply Voltage	Vcc		6	9	10	V
Supply Current	Is			30	40	mA
Input Selectors						
Input Resistance	R_{II}	Input 1,2,3	80	100	120	KOhms
Clipping Level	V_{CL}	Av=-8.75 dB ; d=0.3%	2	2.5		Vrms
Input Separation (2)	S_{IN}		80	100		dB
Min. Input Gain	G_{INmin}		-1	0	1	dB
Max. Input Gain	G_{INmax}			11.25		dB
Volume Control						
Input Resistance	R_{IV}		30	40	50	KOhms
Control Range	C_{RANGE}		65	70	75	dB
Min. Attenuation	A_{VMIN}		-1	0	1	dB
Max. Attenuation	A_{VMAX}		65	70	75	dB
Step Resolution	A_{STEP}		0.5	1.25	1.75	dB
Attenuation Set Error	E_A	AV=0 to -20dB	-1.25	0	-1.25	dB
		AV=-20 to –60dB	-3.0	0	2	dB
Speaker Attenuators						
Control Range	C_{RANGE}		35	37.5	40	dB
Step Resolution	S_{STEP}		0.5	1.25	1.75	dB
Attenuation Set Error	E_A				1.5	dB
Output Mute Attenuation	A_{MUTE}		75	85		dB
Bass Control (1)						
Control Range	Gb	Max. Boost/Cut	±12	±14	±16	dB
Step Resolution	B_{STEP}		1	2	3	dB
Internal Feedback Resistance	R_B		34	44	58	KOhms
Treble Control (1)						
Control Range	Gt	Max. Boost/Cut	±13	±14	±15	dB
Step Resolution	T_{STEP}		1	2	3	dB
Audio Outputs						
Clipping Level	V_{OCL}	d=0.3%	2	2.5		Vrms
Output Resistance	R_{OUT}		1.7	1.9	2.1	Ohms
DC Voltage Level	V_{OUT}		4.2	4.5	4.8	V
General						
Output Noise	e_{NO}	BW==20-20KHz, flat		-97		dB
		Output Muted		-92		dB
		All gains=0dB				

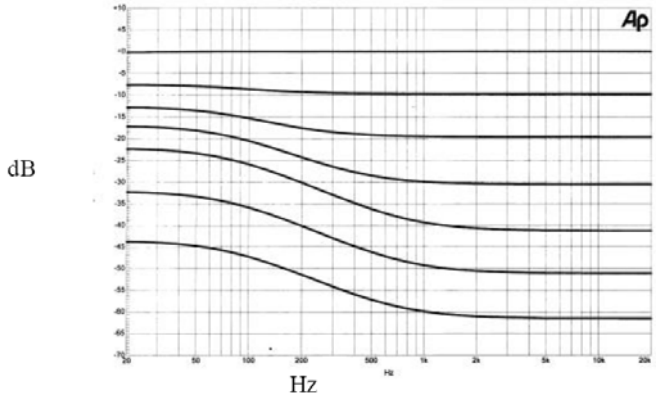
		A Curve All Gains=0dB		-100		dB
Signal to Noise Ratio	S/N	All Gains=0dB Vo=1Vrms		95		dB
Distortion	d	AV=0, VIN=1Vrms AV=-8.75dB,VIN=1Vrms, AV=-8.75dB,VIN=0.3Vrm		0.1 0.07 0.03	0.3 0.15 0.1	% % %
Channel Separation Left/Right	Sc		80	90		dB
Bus Inputs						
Input Low Voltage	V_{IL}				1	V
Input High Voltage	V_{IH}		3			V
Input Current	I_{IN}		-5		+5	uA
Output Voltage SDA Acknowledge	Vo	Io=1.6mA			0.4	V

Note: (1) For the Bass and Treble Response, please, refer to the diagram below. The center frequency and quality of the resonance behavior can be selected by the external circuitry. A standard first order bass response can realized by a standard feedback network.

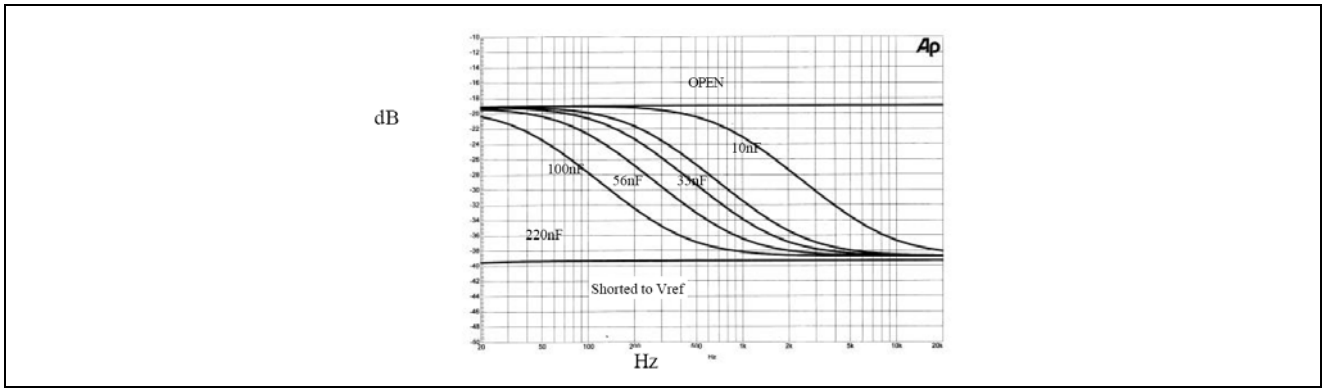
(2) The selected input is grounded thru the 2.2uF capacitor.



Typical Tone Response (with the ext. Components indicated in the test circuit)

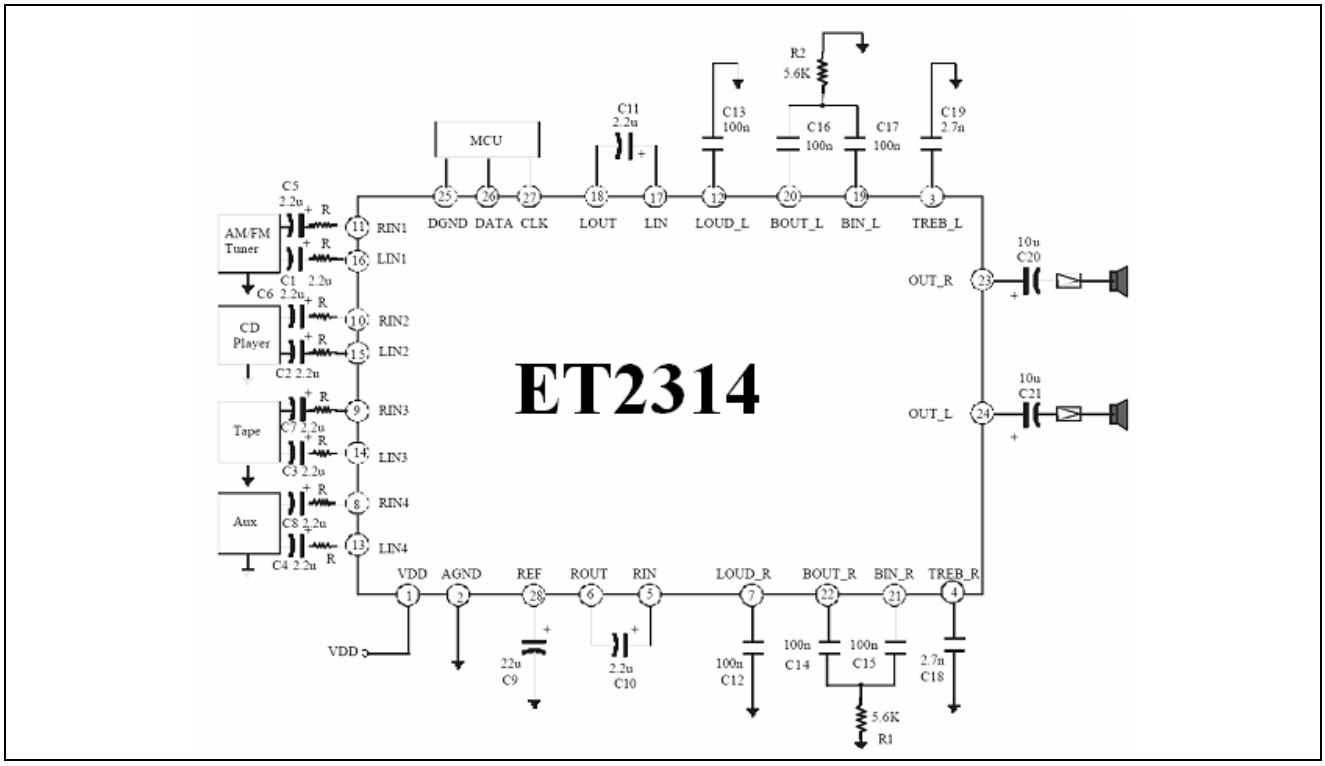


ET2314: Loudness vs Volume Attenuation Frequency Response (C_{10}=C_{11}=100nF)



ET2314 : C_{10}, C_{11} vs Loudness Frequency Response (Volume=-40dB, All other controls are flat)

Application Circuits



Note: 1. It is suggested that you use Mylar Capacitor for capacitors, C12 ~ C19.

2. Resistor (R) Range = 2.0 K Ohms to 3.6 K Ohms

3. Recommended Value of Resistor (R) = 2.4 K Ohms

Package Dimension

SOP28