



LTK5313 5W Mono Charge-Pumped Class AB/D Audio Power Amplifier

LTK5313 Features

- **Operating Voltage: 2.8V-5V**
- **Four AGC modes**
- **Integrated Charge-Pumped with Adaptive Control**
- **No External Inductor and Diode Required**
- **Output Power at 10% THD+N**
 - 5W, at $V_{DD}=4.2V$, $R_L=4\Omega$
 - at 1% THD+N
 - 4.2W, at $V_{DD}=4.2V$, $R_L=4\Omega$
- **Thermal and Over-Current Protections**
- **One-Wire Pulse Control**
- **Ultra Low Noise: 90uV**
- **Excellent de-POP function**
- **Space Saving Packages ESOP-10**
- **Lead Free and Green Device Available (RoHS Compliant)**

LTK5313 Applications

- **Bluetooth audio; Smart audio**
- **Loud speaker**
- **Portable multimedia device**
- **Consumer audio equipment**

LTK5313 General Description

The LTK5313 is a mono, filter-free Class-D audio amplifier with capacitor charge-pumped integrated, available in ESOP-10 package.

The built-in charge-pumped converter generates selectable 6.4V supply voltage for the Class-D amplifier. This provides a much louder audio output than a stand-alone amplifier directly connected to the battery. The Automatic Gain Control (AGC) adjusts Class-D gain to prevent heavy clipping.

The LTK5313 also provide AB/D function, this function can completely avoid the FM disturbance when set to AB mode. High PSRR and differential architecture provide increased immunity to noise and RF rectification. In addition to these features, a fast startup time and small package size make the LTK5313 an ideal choice for portable devices.

Moreover, the LTK5313 provides thermal and short circuit protection.

LTK5313 Simplified Application Circuit

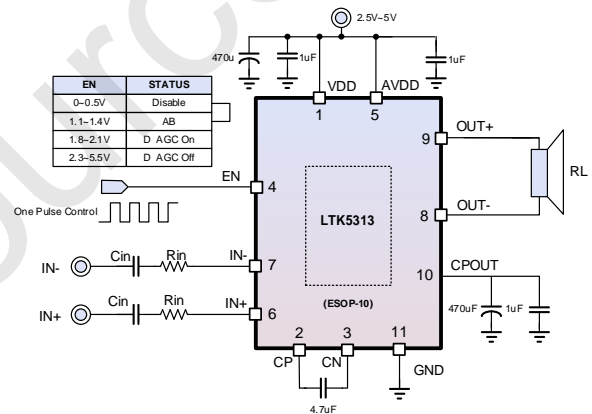


Fig.1 Application Circuit

LTK5313 Order and Marking Information

<p>LTK5313 </p> <p>Assembly Material</p> <p>Handling Code</p> <p>Package Code</p>	<p>Package Code</p> <p>ES: ESOP-10</p> <p>Handling Code</p> <p>TR: Tape & Reel</p> <p>Assembly Material</p> <p>G: Halogen and Lead Free Device</p>
<p>LTK5313 ESP: </p>	<p>X - Data Code</p> <p>Y - Lot Number</p>



LTK5313 Pin Configuration

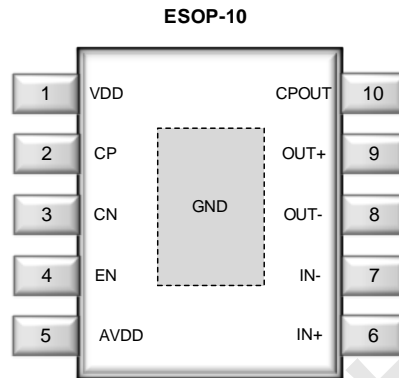


Fig.2 Pin Configuration

LTK5313 Pin Function Description

NO.	NAME	IO	FUNCTION DESCRIPTION
1	VDD	IO	Power for Charge-Pump
2	CP	IO	Flying Positive Connected to External Cap
3	CN	IO	Flying Negative Connected to External Cap
4	EN	I	Shutdown, AGC, AB/D Control
5	AVDD	IO	Input Analog Power Input
6	IN+	I	Positive Audio Input
7	IN-	I	Negative Audio Input
8	OUTP	O	Positive Audio Output
9	OUTN	O	Negative Audio Output
10	CPOUT	O	Charge-Pumped Output Power
11	PGND	IO	Exposed Ground Pad

LTK5313 Absolute Maximum Ratings

SYMBOL	PARAMETER	RATING	UNIT
AVDD	Supply Voltage (VDD to GND)	5V	
VDD	Supply Voltage (VDD to GND)	5V	
T _J	Maximum Junction Temperature	150	°C
T _{STG}	Storage Temperature Range	-65 to +150	
T _{SDR}	Soldering Temperature Range	230	
P _d	Power Dissipation	Internally Limited	W

Note 1. Absolute Maximum Ratings are those values beyond which the life of a device may be impaired. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

LTK5313 Thermal Characteristics



SYMBOL	PARAMETER	VALUE	UNIT
θ_{JA}	Thermal Resistance -Junction to Ambient (Note 2)	160	$^{\circ}\text{C}/\text{W}$

Note 2. Please refer to "Layout Recommendation", the Thermal Pad on the bottom of the IC should soldered directly to the PCB's Thermal Pad area that with several thermal vias connect to the ground plan, and the PCB is a 2-layer, 5-inch square area with 2oz copper thickness.

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LTK5313 Recommended Operating Conditions

Symbol	Parameter		Min.	Max.	Unit
V _{DD}	Supply Voltage		3	5	V
V _{IH}	High Level Threshold Voltage	EN	1.5		
V _{IL}	Low Level Threshold Voltage	EN		0.4	
T _A	Ambient Temperature Range		-40	85	°C
T _J	Junction Temperature Range		-40	125	
R _L	Speaker Resistance		3.5		Ω

LTK5313 Electrical Characteristics

V_{DD}=3.7V, GND=0V, A_v=22dB, T_A= 25°C (unless otherwise noted)

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
I _{DD}	Supply Current	Class D mode			6		mA
I _{DD}	Supply Current	Class AB mode			6		mA
I _{SD}	Shutdown Current	EN=0V				10	μA
F _{OSC1}	Class D Frequency	V _{BAT} =3.7V		450	680	700	kHz
F _{OSC2}	Charge Pump Frequency	V _{BAT} =3.7V		1000	1200	1300	kHz
R _{DS(ON)}	Static Drain-Source On-State Resistance (PMOSFET+NMOSFET)	P _{VDD} =6.4V, I _L =1A	NMOSFET		120		mΩ
		P _{VDD} =6.4V, I _L =1A	PMOSFET		150		
η	Efficiency	P _O =1W, R _L =4Ω+33μH			80		%
		P _O =4.7W, R _L =4Ω+33μH			79		
R _L =4Ω							
THD+N	Total Harmonic Distortion Pulse Noise	THD+N=1%, f _{in} =1kHz, V _{BAT} =4.2V, P _{VDD} =6.4V	R _L =4Ω		4.2		W
			R _L =8Ω		2.5		
		THD+N=10%, f _{in} =1kHz, V _{BAT} =4.2V, P _{VDD} =6.4V	R _L =4Ω		5.0		
			R _L =8Ω		2.82		
V _{OS}	Output Offset Voltage	R _L =4Ω			20		mV
V _n	Noise Output Voltage	With A-weighted Filter, R _L =4Ω			90		μVrms
S/N	Signal to Noise Ratio	With A-weighted Filter P _O =2W, R _L =4Ω			80		dB
PSRR	Power Supply Rejection Ratio	R _L =4Ω, f _{in} =217Hz, V _{rr} =0.2Vpp			-80	-60	
Att _{shutdown}	Shutdown Attenuation	f _{in} =1kHz, R _L =8Ω, V _{in} =1Vpp			-115	-90	



LTK5313 Characteristic curve test condition (TA=25°C)

Description	Test Conditions	Serial No.
Output Power VS THD+N	RL=4Ω+33uH, Class D	Fig.3
Output Power VS THD+N	RL=4Ω+33uH, Class AB	Fig.4
Efficiency VS Output Power	VBAT=3.7V, RL=4Ω+33uH	Fig.5
Input Voltage VS Maximum Output Powe	RL=4Ω+33uH THD+N=10%	Fig.6
Frequency Response	VBAT=3.8V, RL=4Ω+33uH	Fig.7
Frequency VS THD+N%	VBAT=3.8V, RL=4Ω+33uH Po=1W	Fig.8

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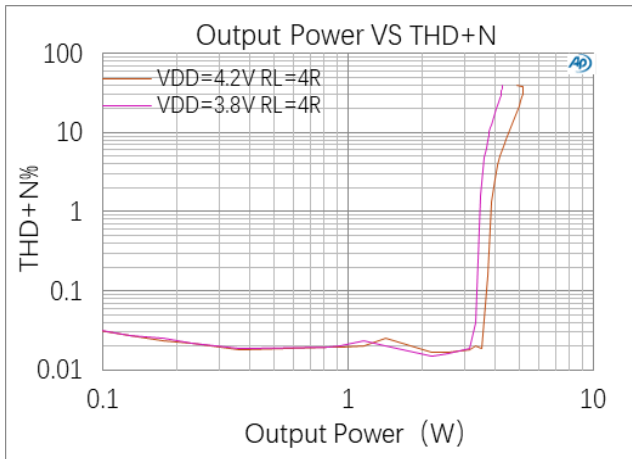


Fig.3 Output Power VS THD+N

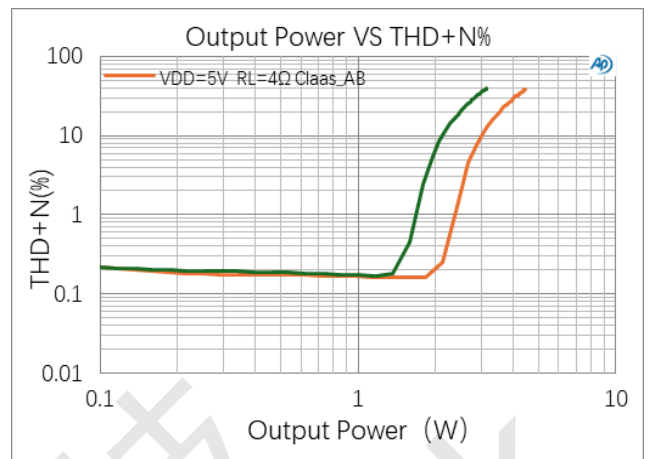


Fig.4 Output Power VS THD+N

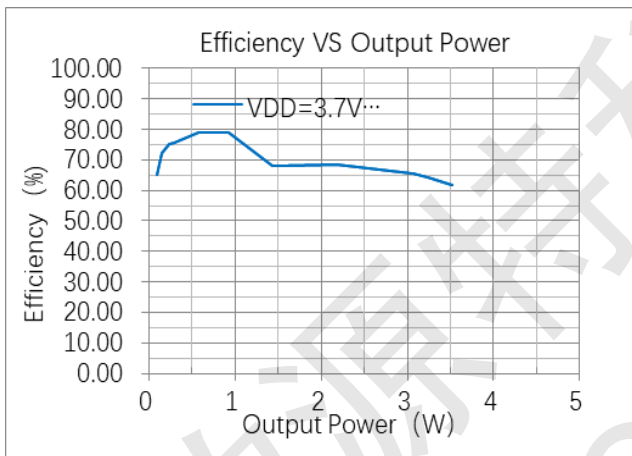


Fig.5 Efficiency VS Output Power

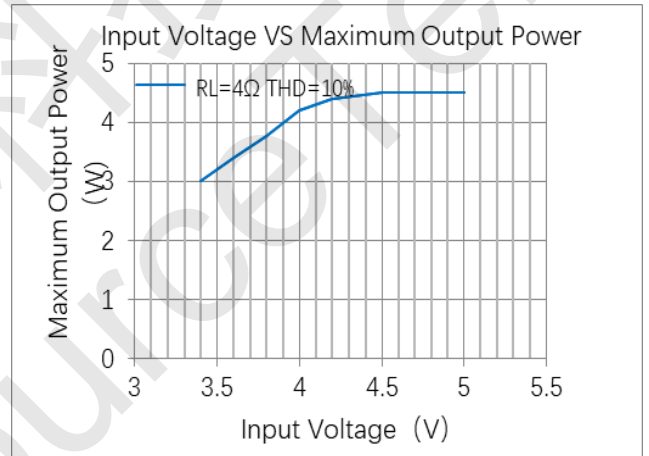


Fig.6 Input Voltage VS Maximum Output Power

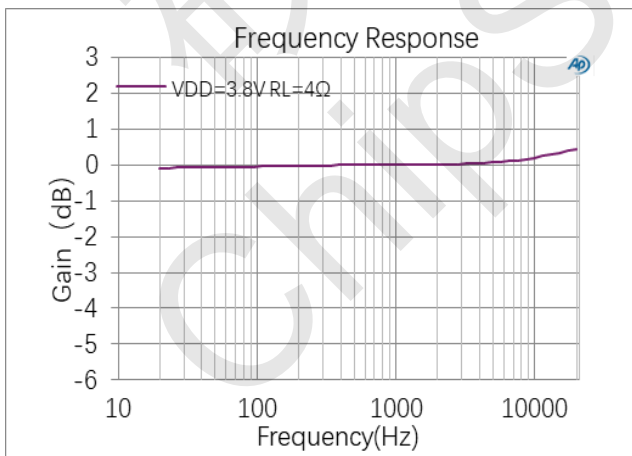


Fig.7 Frequency Response

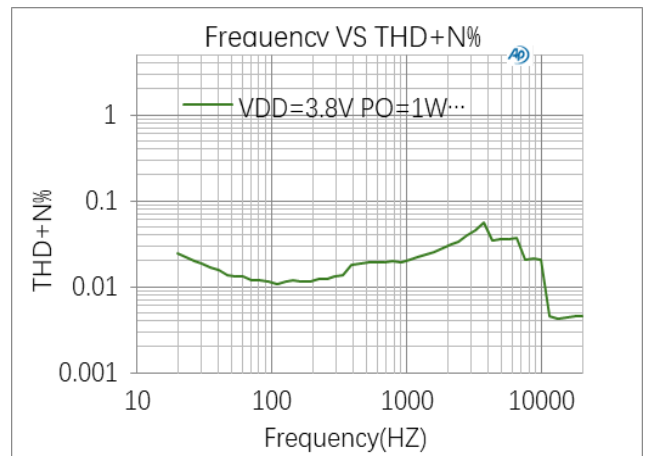


Fig.8 Frequency VS THD+N%



LTK5313 Application Information

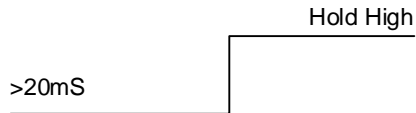
EN Pin Control

LTK5313 has two modes of control: Software control (pulse control) & Hardware control (level control).

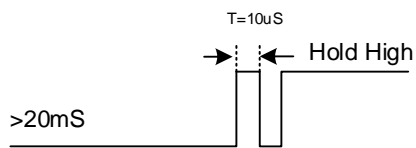
Software control:

Different rise edge of pulse controls different mode functions.

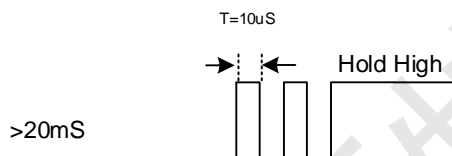
1st edge Class D AGC off;



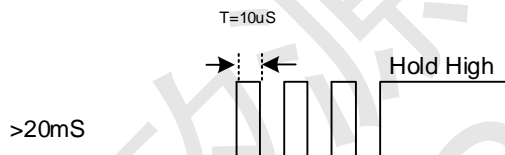
2nd edge AGC1 (THD<6%)



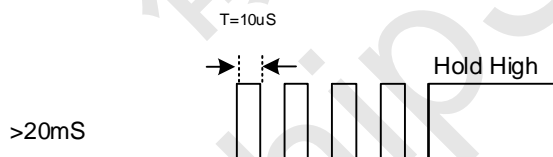
3rd edge AGC2 (THD<5%)



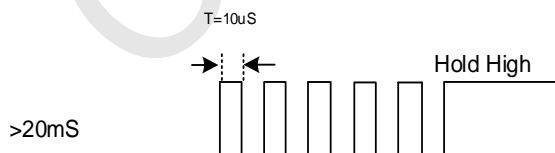
4th edge AGC3 (THD<3%)



5th edge AGC4 (THD<2%)



6th edge Class AB mode



Hardware control:

Different levels of EN controls Class AB & D functions



V(EN)	Status
<0.5V	Shut Down
0.9V-1.3V	Class AB mode
1.6V-2.1V	Class D AGC On
2.5V-VDD	Class D AGC Off

Input Resistor, Rin

The LTK5313's input resistor is fixed, and the value is 20k, the input resistance have wide variation (+/-5%) caused by manufacture.

The gain can also be set by the external resistors Rin.

$$A_V = \frac{480k}{20k + R_{IN}}$$

The 6.5k is the internal input resistor, and the Rin is the external input resistor. Different feedback resistor is set according to Class D or Class AB mode. For fully differential operating, The Rin match is very important for CMRR, PSRR and harmonic distortion performance. It's recommended use 1% tolerance resistor or better.

Input Capacitor, Ci

In the typical application an input capacitor, Ci, is required to allow the amplifier to bias the input signal to the proper DC level for optimum operation. In this case, Ci and the input impedance Ri form a high-pass filter with the corner frequency determined in the follow equation:

$$f_{C(\text{highpass})} = \frac{1}{2\pi R_i C_i} \quad (3)$$

The value of Ci is important to consider as it directly affects the low frequency performance of the circuit. Where Ri is 25kΩ (minimum) and the specification calls for a flat bass response down to 20Hz. Equation is reconfigured as follow:

$$C_i = \frac{1}{2\pi R_i f_c} \quad (4)$$

To consider input resistance variation, the Ci is 0.1μF so one would likely choose a value in the range of 0.1μF to 0.47μF. A further consideration for this capacitor is the leakage path from the input source through the input network (Ri + Ri, Ci) to the load. This leakage current creates a DC offset voltage at the input to the amplifier that reduces useful headroom, especially in high gain applications. For this reason, a low-leakage tantalum or ceramic capacitor is the best choice. When polarized capacitors are used, the positive side of the capacitor should face the amplifier input in most applications as the DC level there is held at VDD/2, which is likely higher than the source DC level. Please note that it is important to confirm the capacitor polarity in the application.

Ferrite bead selection

If the traces from LTK5313 to speaker are short, the ferrite bead filters can reduce the high frequency radiated to meet the FCC & CE required.

A ferrite that has very low impedance at low frequencies and high impedance at high frequencies (above 1 MHz) is recommended.

Output Low-Pass Filter

If the traces from LTK5313 to speaker are short, it doesn't require output filter for FCC & CE standard.

A ferrite bead may need if it's failing the test for FCC or CE tested without the LC filter. The figure 9 is the sample for added ferrite bead; the ferrite show choosing high impedance in high frequency.

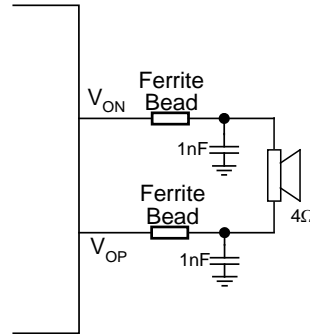


Fig.9 Ferrite bead output filter

Figures 10 and 11 are examples for added the LC filter (Butterworth), it's recommended for the situation that the trace from amplifier to speaker is too long and need to eliminate the radiated emission or EMI.

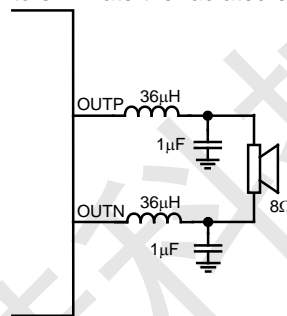


Fig.10 LC output filter for 8Ω speaker

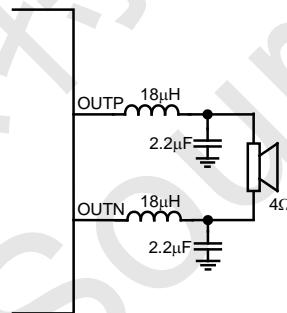


Fig.11 LC output filter for 4Ω speaker

Fig.10 and 11's low pass filter cut-off frequency are 25kHz (F_c).

$$f_{C(\text{lowpass})} = \frac{1}{2\pi\sqrt{LC}} \quad (6)$$

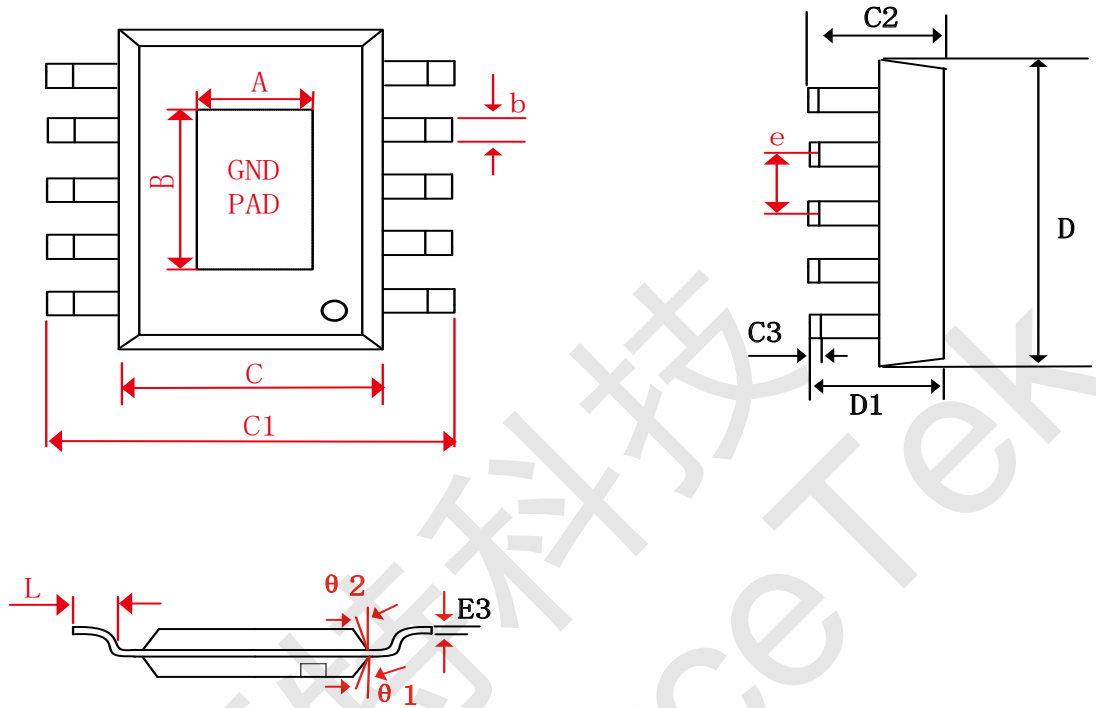
Power-Supply Decoupling Capacitor, CS

The LTK5313 is a high-performance CMOS audio amplifier that requires adequate power supply decoupling to ensure the output total harmonic distortion (THD) is as low as possible. Power supply decoupling also prevents the oscillations causing by long lead length between the amplifier and the speaker.

The optimum decoupling is achieved by using two different type capacitors that target on different type of noise on the power supply leads. For higher frequency transients, spikes, or digital hash on the line, a good low equivalent-series-resistance (ESR) ceramic capacitor, typically 0.1μF placed as close as possible to the device VDD pin for works best. For filtering lower frequency noise signals, a large aluminum electrolytic capacitor of 10μF or greater placed near the audio power amplifier is recommended.



LTK5313 Package Information



Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min	Nom	Max	Min	Nom	Max
A	2.31	2.40	2.51	0.091	0.094	0.098
B	3.20	3.30	3.40	0.126	0.129	0.132
b	0.33	0.42	0.51	0.013	0.017	0.020
C	3.8	3.90	4.00	0.15.50	0.15.54	0.15.57
C1	5.8	6.00	6.2	0.228	0.235	0.244
C2	1.35	1.45	1.55	0.053	0.058	0.061
C3	0.05	0.12	0.15.5	0.004	0.007	0.010
D	4.70	5.00	5.1	0.185	0.190	0.200
D1	1.35	1.60	1.75	0.053	0.06	0.069
e	1.270(BSC)			0.050(BSC)		
L	0.400	0.83	1.27	0.016	0.035	0.050