LE100

Low harmonic distortion single channel microphone preamp

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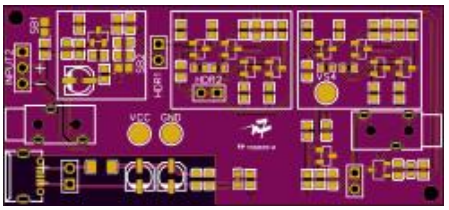
rev 1-1/2022

General description



The LE100 preamp is a multistage transistor based microphone amplifier. It is built around the BC848 NPN transistor and is designed to boost a microphone signal to a suitable level for an ADC converter.

The main advantages over a fully integrated solution like an IC are the customizability and simplicity of this solution. It is also a great learning opportunity to get familiar with transistor amplifiers, which is why there are multiple probe points and jumpers to provide per-stage debugging.

Features

- < 0.5% harmonic distortion
- 182Hz - 2.9MHz frequency range, with optional low pass filter
- 43dB gain
- micro-usb 5.0V power input
- 3.5mm jack input/output
- Compatible with condenser & dynamic microphones

Applications

- Electret condenser microphones
- Dynamic microphones
- Ultrasonic receivers
- General purpose amplifier

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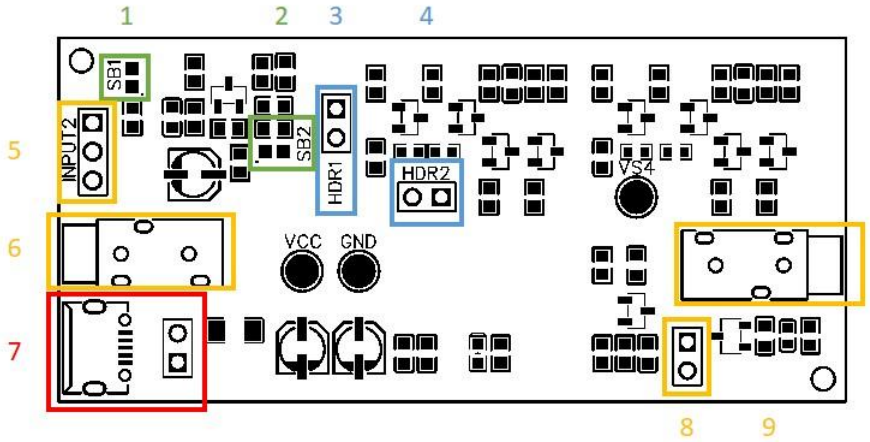
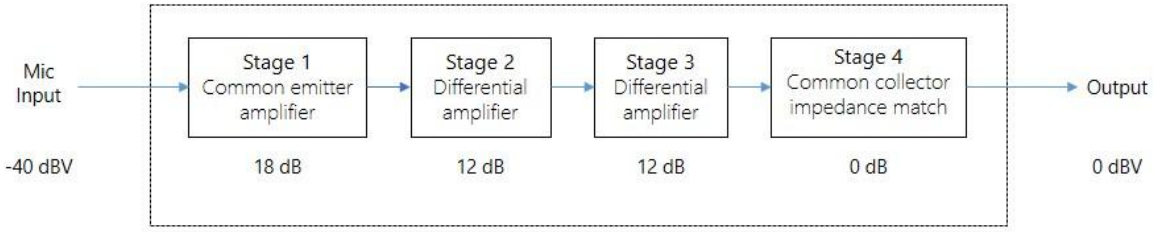
Functional specifications

1. Board layout



Id	Component	Description	
1	Solder bridge SB1	Closing this connection will pull the microphone + signal to Vcc through a 1k resistor (required for electret microphones)	
2	Solder bridge SB2	Enables the built-in low pass filter	
3	Header HDR1	Can be used to insert a potentiometer between stage 1 and 2 to provide variable gain control. Place a jumper if not used	
4	Header HDR2	Disconnects stage 2 from stage 3. Mainly for debugging purposes. Place a jumper if not used	
5	Microphone input	3 pin microphone input	
6	Microphone input	3.5mm jack microphone input. Connected to left chanel	
7	Power input	Power can be provided through micro-usb or through the pin header	
8	Preamp output	2 pin preamp output	
9	Preamp output	3.55 jack preamp output. Connected to left chanel	

2. Functional diagram

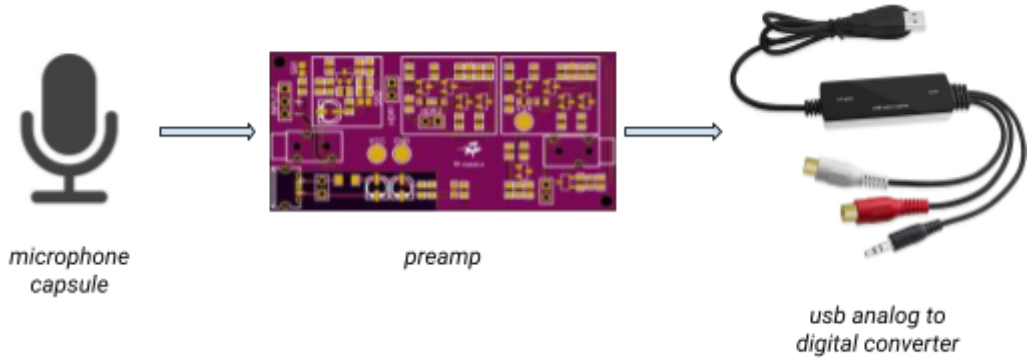


- The first stage is a **common emitter** circuit that provides a good input impedance for the microphone and boosts the signal. However a common emitter structure cannot provide all the gain necessary while maintaining acceptable harmonic distortion performance.

- Stage 2 and 3 are two identical **differential amplifiers** that boost the signal to the desired level. Differential amplifiers have excellent harmonic distortion performance even at higher input levels and gain, but their input and output impedances are not suited to be connected directly to the input nor output.

- The last stage is a **common collector circuit** to provide a low output impedance.

3. Typical application



Note : The upcoming LE110 will have a built-in usb audio controller that will provide a fully integrated solution. A headphone amplifier stage will also be added in order to provide live feedback.

Electrical specifications

Note : *All parameters are from a pspice simulation and circuit analysis. Real measurements are to be done.*

1. Recommended operation conditions

Parameter	Symbol	Min	Typ	Max	Unit
Supply voltage	Vcc	4.8	5.0	5.2	V
Operating temperature	T	0	-	70	°C

2. DC characteristics

Parameter	Symbol	Min	Typ	Max	Unit
Current consumption	I	-	15	50	mA

Vcc = 5V unless specified otherwise

3. AC characteristics

Parameter	Symbol	Min	Typ	Max	Unit
Gain	G		42		dB
Total harmonic distortion	TDH		0.5		%
Cutoff frequency (-3dB, LP disabled)		182 Hz		2.9 MHz	Hz
Cutoff frequency (-3dB, LP enabled)		182 Hz		100 kHz	Hz
Power supply noise rejection					dB

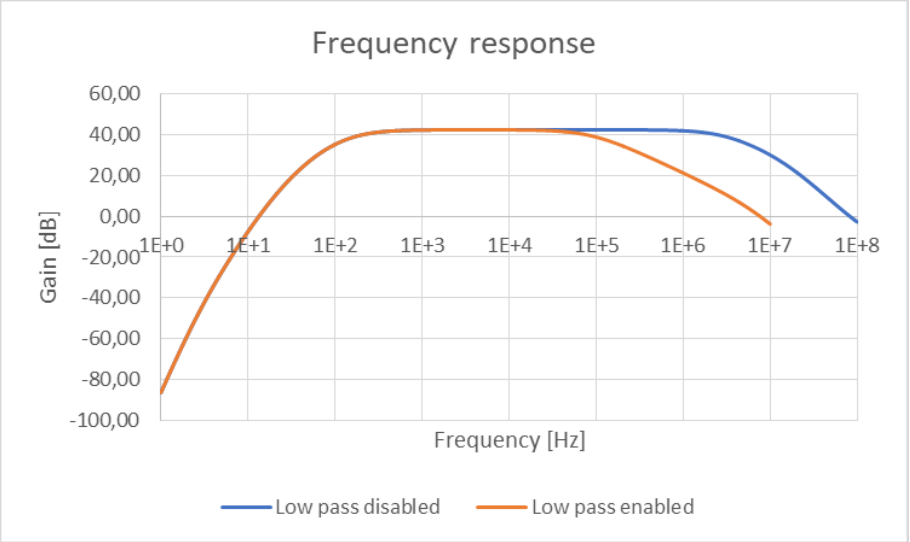
testing frequency = 1kHz unless specified otherwise

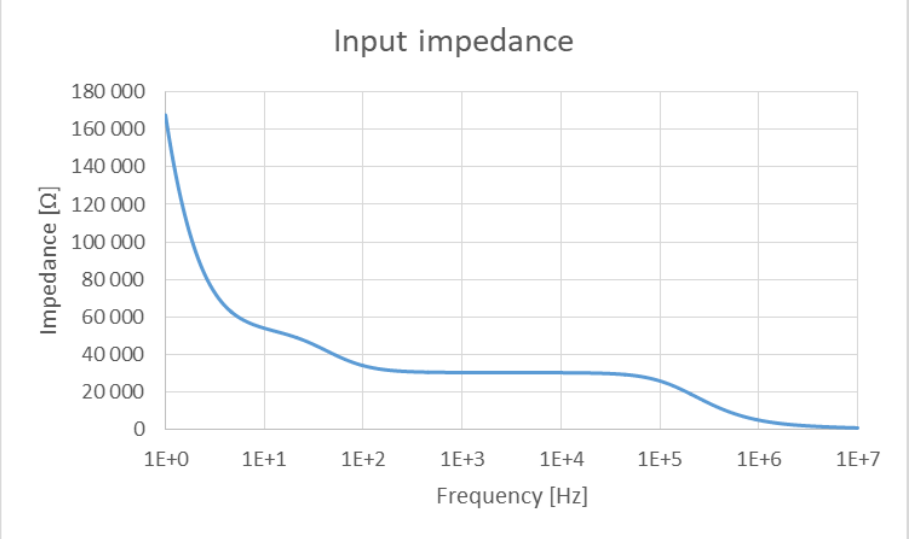
4. Input/Output characteristics

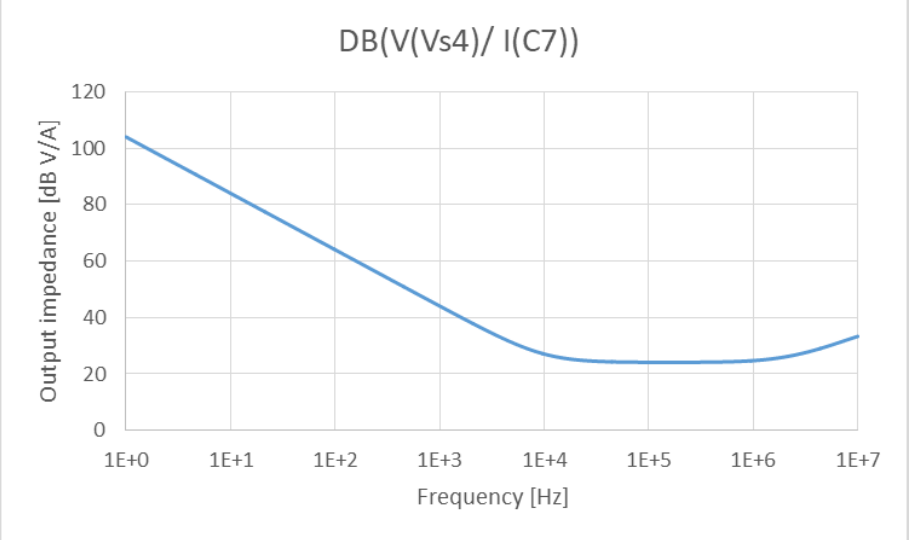
Parameter	Symbol	Min	Typ	Max	Unit
Input impedance @ 1kHz	Ze		30		kΩ
Output impedance @ 1kHz	Zs		162		Ω
Input dynamic range				10	mV
Output dynamic range				1000	mV

testing frequency = 1kHz unless specified otherwise

5. AC Response

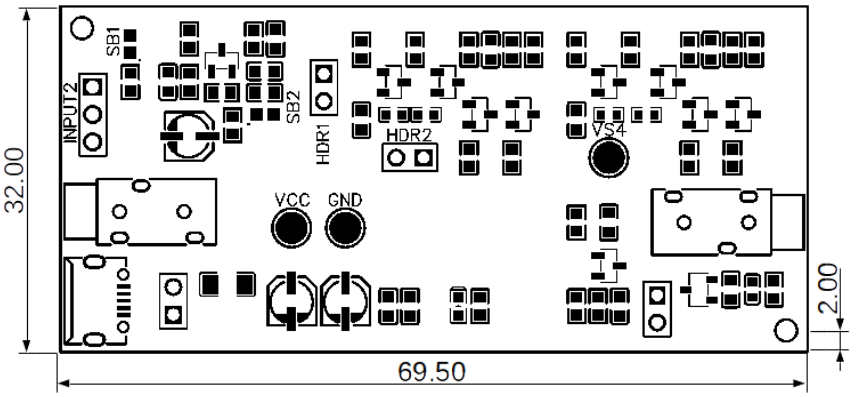


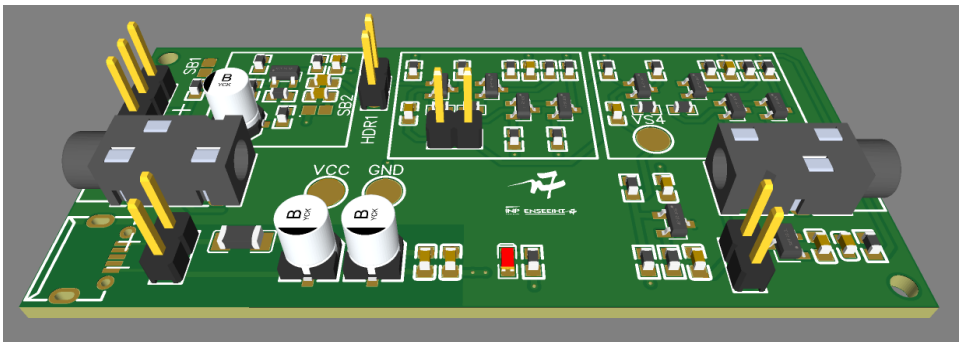




Bill of material

ID	Designator	Value	Footprint	Coef
1	C1,C2,C3,C6,C12,C13,C15,C16,C19	1u	C0603	9
2	C4,C5,C14	10u	CAP-D4.0-H5.5	3
3	C7,C9	100n	C0603	2
4	C8,C22	10n	C0603	2
5	C11	1n	C0603	1
6	HDR1,HDR2,OUT2,PWR_2	HDR-M-2.54_1x2	HDR-M-2.54_1X2	4
7	INPUT1,OUT1	Headphone jack	AUDIO-TH_PJ-3200	2
8	INPUT2	HDR-M-2.54_1X3	HDR-M-2.54_1X3	1
9	L1	10u	L1206	1
10	LED1	LED-0603	LED0603	1
11	PWR_1	micro USB Female	MICRO-USB	1
12	R1,R3,R4,R16,R23,R24,R26,R27	1k	R0603	8
13	R2,R7,R20,R25	10k	R0603	4
14	R5,R6,R21,R22	100	R0603	4
15	R8,R19,RE2	220	R0603	3
16	R9,R10,R17,R18,RC1	2.2k	R0603	5
17	R14,RB2	100k	R0603	2
18	R15	180k	R0603	1
19	RB1	150k	R0603	1
20	RE1	1.2k	R0603	1
21	T1,T2,T3,T4,T5,T7,T8,T9,T10,T11	BC848C	SOT-23	10
22	U1	LM4040DIM3-2.5	SOT-23-3	1





3d render of the pcb