NS4158 5W Mono Class D Audio Power Amplifier with NCN function

1 Features

- Supply Voltage from 2.2V to 5.25V
- Set the Operation Mode with NCN function by software or hardware.
- Output Power at 10%THD with 5.0VDD supply:
  3.0W(4Ω load).
  3.8W(3Ω *load*)
  5.0W(2Ω *load*)
- 0.2%THD(0.5W output power at 4 Ω Load with 5VDD supply).
- Excellent full bandwidth EMI suppression capability.
- Excellent noise suppression with Power ON/OFF.
- Max efficiency high to 85%.
- High-PSRR to -78dB(217Hz).
- Over-current and Thermal and Input Under-voltage Protection Function
- Available SOP-8 Package

2 Application

- Bluetooth and Wi-Fi speakers.
- Digital products.

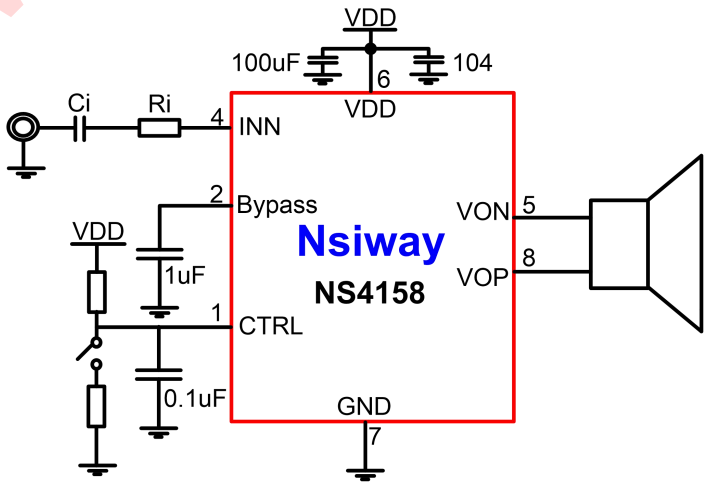
3 Description

NS4158 is a 5W high efficiency mono audio power amplifier with low EMI,filterless and NCN function.The NCN function can detect the distortion of the output signal, dynamically adjust the system gain, not only effectively prevent the damage of the loudspeaker overload output, but also bring a comfortable hearing feeling.In practical applications,the amplifier can be set to operate in NCN mode or normal mode by software or hardware.The software is controlled by one-line pulse,and the hardware is controlled by level.It's very flexible to use.NS4158 uses advanced technology,EMI interference is greatly reduced over the full bandwidth range,which deeply reduces the impact of other compontents.The PWM modulation structure of NS4158 with filterless and built-in feedback resistors,reduces external components,PCB area and system cost. NS4158 can provide 5W of output power to a 2Ω load at 5V operating voltage.

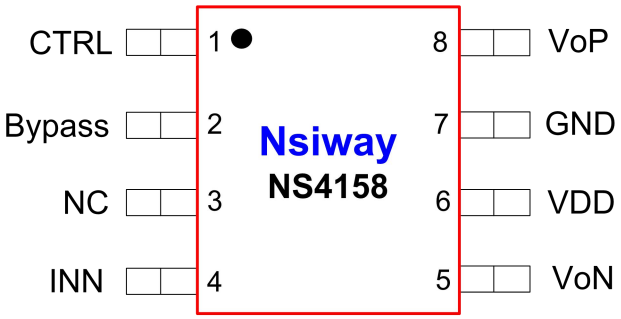
With the internal protection of overcurrent, overheat and undervoltage,it can effectively protect the chip from being damaged under abnormal working conditions.A new circuit design is created and optimized by spread spectrum technology.High efficiency to 85% is better suited to low voltage, high power output audio systems.

NS4158 provides SOP8 package.

4 Typical application



5 Pin configuration



No.	Pins	Description
1	CTRL	Operation Mode control Pin
2	Bypass	bypass capacitor
3	NC	NC
4	INN	Signal input end
5	VoN	Negative output
6	VDD	Power input
7	GND	Power ground
8	VoP	Positive output

6 Limit operating parametes

Name	Parameter
Input Voltage	-0.3V- VDD
ESD Susceptibility	4kV-HBM
Storage Temperature	−65°C to +150°C
Operating Temperature	−40°C to +85°C
Junction Temperature	150°C
Lead Temp(Soldering, in 10s)	260°C
Thermal Resistance	
θJA	20°C/W
θJC	80°C/W

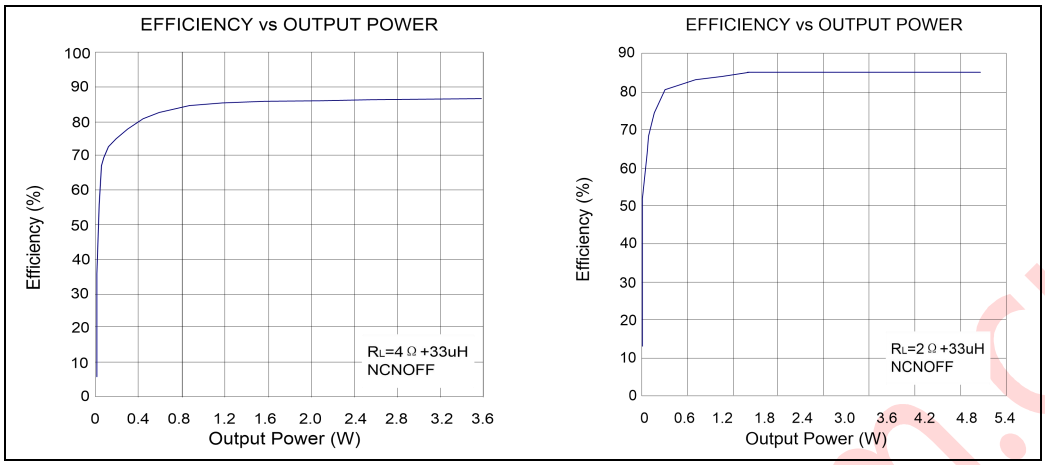
Notes:Over these operating parameters above may result in permanent damages to the chip.Exposure over time at any limit operating conditions may Mayrease the reliability and lifetime of the chip.

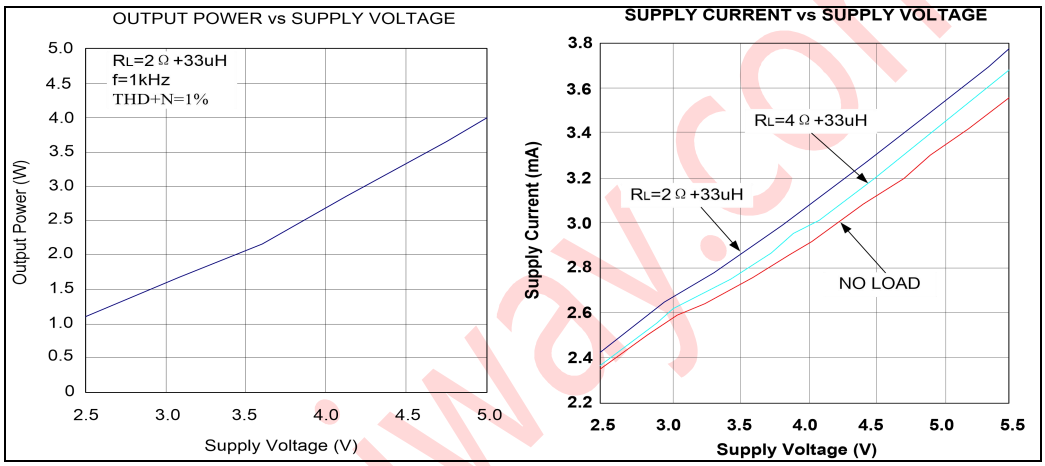
7 Electrical characteristics

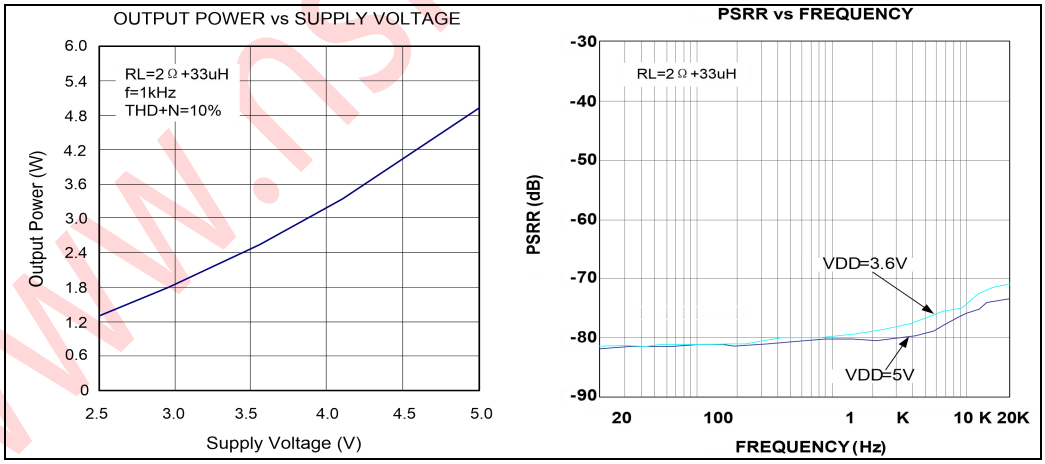
Operating conditions(unless specified)：TA＝25℃，VDD=5.0V.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{DD}	power voltage		3.0		5.25	V
I_{DD}	Quiescent Power Supply Current	V_{DD}=5.0V,V_{INN}＝0V,No load		4		mA
I_{SD}	Shutdown Current			1		μA
V_{OS}	output offset voltage			10	40	mV
R_O	output resistance			3		K
PSRR	Power Supply Rejection Ratio	217Hz			-78	dB
		20KHz			-72	dB
CMRR	Common Mode Rejection Rat o			-70		dB
f_{SW}	modulation frequency	VDD =3.0V to 5.25V		350		kHz
η	efficiency	Po=2.5W,V_{DD}=5V, R_L=4Ω		85		%
V_{IH}	High level input voltage (Software setting mode)	Normal Mode	0.4VDD		V_{DD}	V
		NCN Mode	0.9		V_{DD}	
V_{IL}	Low level input voltage (Software setting mode)	Shutdown	0		0.2	V
T_{HI}	CTRL high level time	Softwar setting mode	1		12	us
T_{LO}	CTRL low level time		1		12	us
T_{OFF}	CTRL turn-off time		100			us
V_{CTRL}	Normal Mode	CTRL threshold (hardware setting mode)	0.4V_{DD}		V_{DD}	V
	NCN Mode		0.9	1/3V_{DD}	0.4V_{DD}	
P_O	Output power （Normal Mode）	THD+N＝1%,f=1KHz RL=2Ω RL=3Ω RL=4Ω		 4.0 3.2 2.6		W
		THD+N＝10%,f=1KHz RL=2Ω RL=3Ω RL=4Ω		 4.8 3.8 3.1		W
THD+N	total distortion + noise	A_{VD}=2,f=1kHz,R_L=4Ω,P_O=0.5W		0.2		%
S/NR	Signal to Noise Ratio	RL＝4Ω,Po＝1.0W		72		dB
T_{AT}	Attack time	V_{DD} =3.6V		20		ms
T_{RL}	Release time	V_{DD} =3.6V		1.5		s
A_{MAX}	Maximum attenuation gain			-10		dB

9 Typical characteristic curves



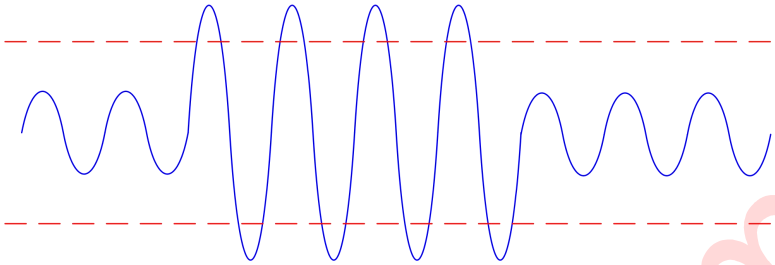




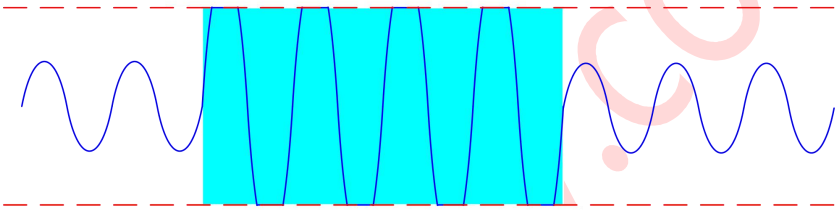
10 Application specifications

10.1 NCN function

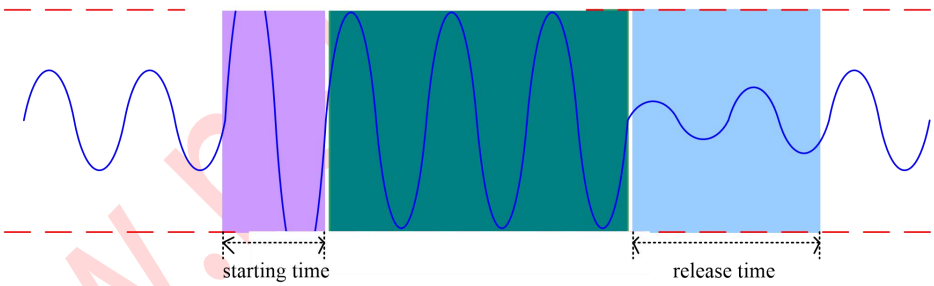
The NS4158 can operate in NCN mode by setting the CTRL pin.The amplifier automatically detects the output clipping distortion and adjusts the gain to prevent distortion. As shown below:



The audio output signal is not limited by the power supply voltage



Audio output signal in normal mode



Audio output signal in NCN mode

10.2 Application parameter settings

Gain calculation:

The gain of NS4158 is set by external input resistance Ri, and the total gain calculation formula is $Avd = \frac{360k\Omega}{Ri + 10k\Omega}$.

Selection of input capacitance Ci and input resistance Ri:

The input capacitor and the input resistor form a high-pass filter.The cut-off frequency is $fc = \frac{1}{2\pi \cdot (Ri + 10k\Omega) \cdot Ci}$. When Ri has been determined, Ci can be calculated according to the cut-off frequency fc.

Selection of bypass capacitor:

Cb determines the stability of NS4158 static operating point, so its value is critical when turning on a burst input signal.The larger the Cb is, the slower the chip output tilts to the static DC voltage (V_{DD}/2), the smaller the opening burst sound is. Cb is set to 1uF to obtain a turn-off function with less "ticking" and "popping".

Power filter capacitor selection:

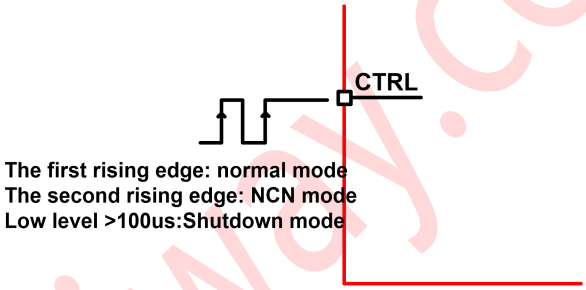
In the amplifier application, the power supply bypass design is very important, especially for the noise performance and power supply voltage suppression performance. The filter capacitor is required to be close to the chip power supply pin. Typical capacitance is 10uF with a ceramic capacitor of 0.1uF.

10.3 Operating mode setting

The NS4158 has two operating modes: normal mode and NCN mode. The chip can be set to operate in different modes by software or hardware.

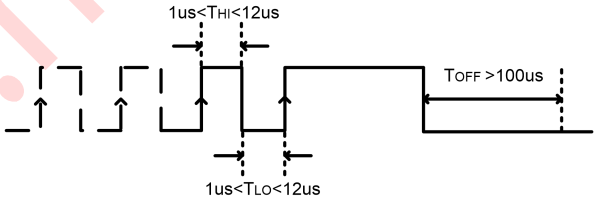
Software setting:

NS4158 supports a one-line pulse through the CTRL pin to control the chip into different operating modes.The first rising edge operates in normal mode.The second rising edge operates in NCN mode.The CTRL pin is lowered and the chip enters shutdown mode for more than 100us.When the chip is operating in shutdown mode,you must reset to re-enter either mode. The schematic diagram is as follows.



Set the NS4158 operating moode using the software

The one-line pulse high level width (T_{HI}) added to the CTRL pin requires 1us<T_{HI}<12us. The low level width (T_{LO}) is required to be 1us<T_{LO}<12us. When entering shutdown mode, the low level hold time (T_{OFF}) is required to be longer than 100us. The sequence diagram is as follows.



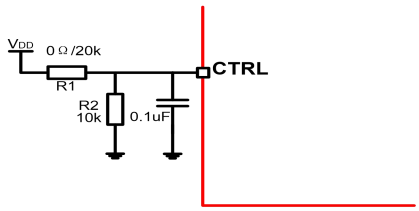
One-line pulse sequence diagram

When the CTRL pin level is stable between 0.9V and 0.4V_{DD},the chip is operating in NCN mode.

Hardware setting:

NS4158 also supports hardware setting operating mode. NS4158 enters different operating modes by the CTRL pin level setting.When the CTRL pin voltage is between 0.4V_{DD} and V_{DD},NS4158 is operating in normal mode.When the CTRL pin voltage is between 0.9V and 0.4V_{DD}, NS4158 is operating in NCN mode.And when the CTRL pin voltage is below 0.2V, NS4158 is operating in shutdown mode.

As shown below. If V_{DD}=5.0V, R_1=0Ω,the CTRL pin level is V_{DD}=5.0V.The chip is operating in normal mode. When R_1= 20K,the CTRL pin level is 1/3V_{DD}=1.7V. The chip is operating in NCN mode.When the CTRL pin level< 0.2V, the chip is operating in shutdown mode.



Set the NS4158 operating moode using the hardware

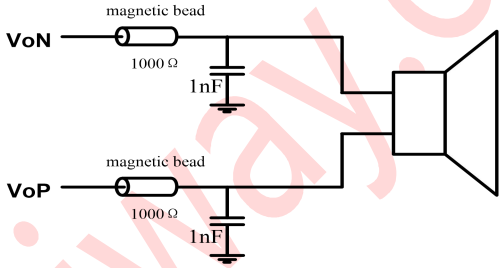
10.4 Magnetic beads and capacitors

NS4158 uses advanced technology to achieve excellent characteristics of low EMI.To give full play to the performance of NS4158,the EMI interference can be minimized in the following aspects:

1. Power amplifier output to the speaker line, the line as short as possible, as wide as possible, and output wiring, the line as far as possible away from sensitive signal lines and circuits.

2. The Mayoupling capacitor of the power supply pin is as close to the chip pin as possible. The power cord and ground wire are best connected by star.

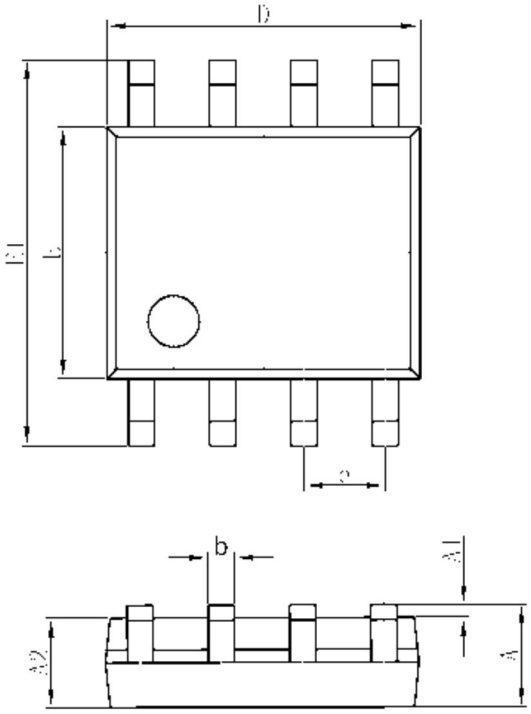
3. When the application environment is harsh due to space limitation, adding magnetic beads and capacitors at the output can effectively suppress EMI interference.Use beads and capacitors as close to the chip pins as possible. The following is the application design reference circuit of NS4158 after adding magnetic beads and capacitors at the output end.



10.5 Protection circuit

When the chip has a short circuit between the output pin and the power supply or ground, or a short circuit between the output fault, the overcurrent protection circuit will turn off the chip to prevent the chip from being damaged. After the short-circuit fault is removed, NS4158 automatically recovers. When the temperature of the chip is too high, the chip is also turned off. After the temperature drops, NS4158 continues to work normally. When the power supply voltage is too low, the chip will also be turned off. After the power supply voltage is restored, the chip will start again.

11 Packaging information



Package dimension drawing of SOP-8

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.100	0.185	0.200
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Note: NSIWAY company has the right to modify the product information and specifications at any time without notice.The right of interpret this manual is belong to NSI company and it is responsible for the final interpretation.