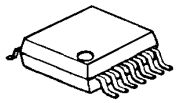
Analog Signal Input Monaural 1.5W Filterless Class D Power Amplifier

■ GENERAL DESCRIPTION

The **NJU8758** is an analog signal input monaural 1.5W filterless class D power amplifier. The **NJU8758** is capable of driving 0.6W at 3.3V or 1.5W at 5.0V into 8ohms without external LC low-pass filters. It includes an output-short protector. The **NJU8758** incorporates BTL amplifier, which eliminate AC coupling capacitors. The **NJU8758** features high power-efficiency by class-D operation, and is suited for security equipment, portable set with speaker, PC, etc.

■ PACKAGE OUTLINE

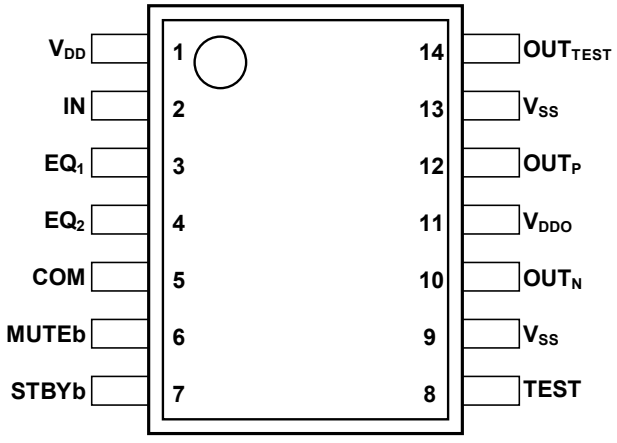


NJU8758V

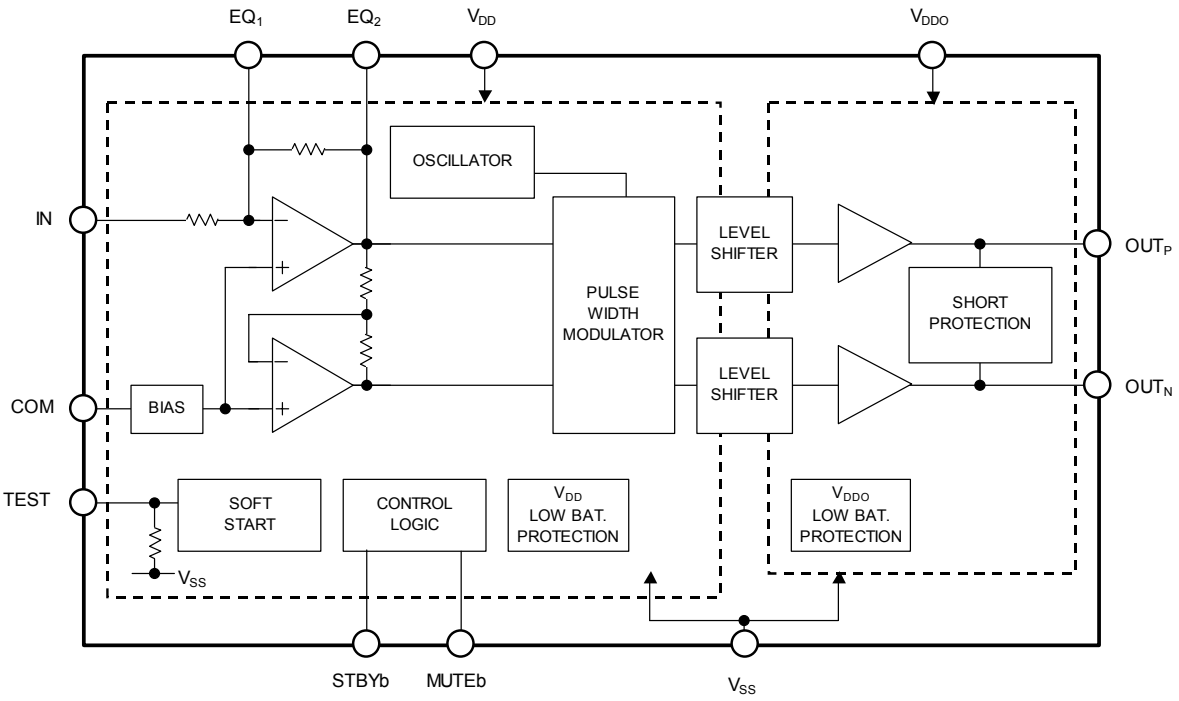
■ FEATURES

- Operating Voltage: 1.8 to 5.5V
- 1.5 W at 5V into 8ohms
- No output filters
- Standby(Hi-Z), Mute Control
- Built-in Pop noise reduction
- EQ for Active filter
- Built-in Low Voltage Detector
- Built-in Short Protector for each channel
- CMOS Technology
- Package Outline: SSOP14

■ PIN CONFIGURATION



■ BLOCK DIAGRAM



■ PIN DESCRIPTION

No	SYMBOL	I/O	FUNCTION
1	V_{DD}	-	Power supply : V_{DD}=3.3V (*1)
2	IN	I	Signal input
3	EQ_1	I/O	for Active filter
4	EQ_2	I/O	for Active filter
5	COM	-	Analog common
6	MUTEb	I	Mute control (*3) MUTEb=Low: MUTE Mode
7	STBYb	I	Standby control (*3) STBYb=MUTEb=Low: Standby Mode
8	TEST	I	TEST terminal for maker (*4)
9	V_{SS}	-	Power GND : V_{SS}=0V (*1)(*2)
10	OUT_N	O	Negative output
11	V_{DDO}	-	Output power supply : V_{DDO} =3.3V (*1)
12	OUT_P	O	Positive output
13	V_{SS}	-	Power GND : V_{SS}=0V (*1)(*2)
14	OUT_{TEST}	O	Short Detect output

*1) The relations of "V_{SS}= 0V" and "V_{DD}= V_{DDO}" must be maintained.
*2) The V_{SS} should be connected at a nearest point to the IC.
*3) The MUTEb and the STBYb must be connected to V_{DD}, when these terminals are not used.
*4) The Test terminal must be connected to V_{SS}.

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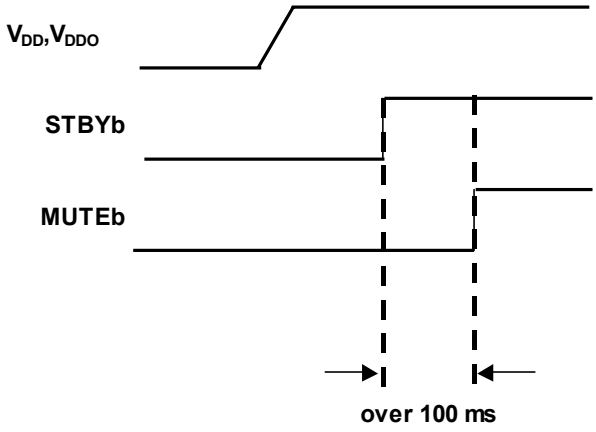
■ FUNCTIONAL DESCRIPTION

(1) Signal Output (OUT_P, OUT_N)
The OUT_P and OUT_N generate PMW output signal.

(2) Standby (STBYb)
By setting the STBYb and MUTEb terminal to “L”, the standby mode is enabled. In the standby mode, the entire functions of the **NJU8758** enter a low-power state, and the output terminals(OUT_P and OUT_N) are in high impedance.

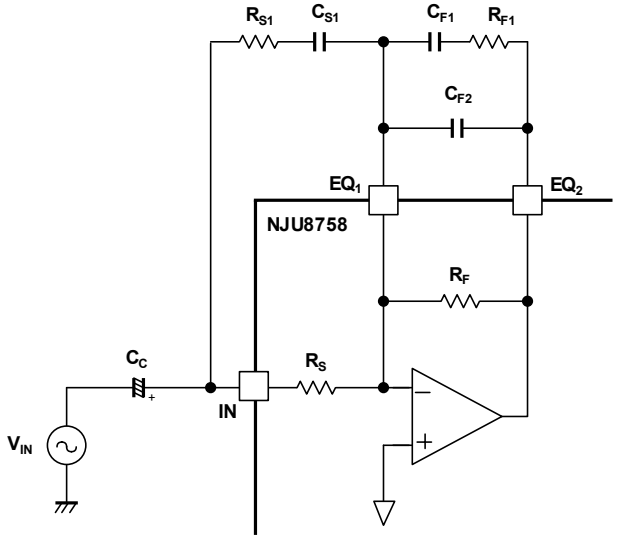
(3) Mute (MUTEb)
By setting the MUTEb terminal to “L”, the Mute function is enabled, and the output terminals(OUT_P and OUT_N) output square wave(Duty: 50%).

The NJU8758 has a built-in circuit for the pop-noise reduction at power-on. However the control with the sequence can realize more effective the pop-noise reduction.



Timing for pop-noise reduction

(4) EQ for Active filter (IN, EQ1, EQ2)
The NJU8758 has EQ1 and EQ2, which is for active filter.
The band-pass filter is calculated as shown below.



R_S=27 kΩ
R_F=32 kΩ

Example: The band-pass filter

$$H(s) = -\frac{\dfrac{1}{\dfrac{1}{R_F} + \dfrac{1}{\left(\dfrac{1}{sC_{F1}} + R_{F1}\right)} + sC_{F2}}}{\dfrac{1}{sC_C} + \dfrac{1}{\dfrac{1}{R_S} + \dfrac{1}{\dfrac{1}{sC_{S1}} + R_{S1}}}}$$

C_{F1}>100 pF

(5) Low Voltage Detector
When the power supply voltage drops down to below V_{DD}(MIN), the internal circuit is halted, and the output terminals(OUT_P and OUT_N) become in high impedance.

(6) Short Protection Circuit
The short protector is enabled in response to following accidents.

Short between OUT_P and OUT_N
Short between OUT_P and V_{SS}
Short between OUT_N and V_{SS}

When the Short Protector enable, the output terminals (OUT_P and OUT_N) become in high impedance, and OUT_{TEST} enable" H"(H=V_{DD}). By setting the STBYb terminal to "L", the **NJU8758** returns to normal operation.

Note 1) The detectable current and the period for the protection depend on the power supply voltage and ambient temperature.
Note 2) The short protector is not effective for a long term short-circuit but for an instantaneous accident. Continuous high-current may cause permanent damage to **NJU8758**.

■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

PARAMETER	SYMBOL	TERMINAL	RATING	UNIT
Supply Voltage	V_{DD} V_{DDO}	V_{DD} V_{DDO}	-0.3 to +7.0 -0.3 to +7.0	V V
Input Voltage	V_{in}	IN, STBYb, MUTEb	-0.3 to V_{DD} + 0.3	V
Operating Temperature	T_a		-40 to +85	°C
Storage Temperature	T_{stg}		-40 to +125	°C
Power Dissipation	P_{DMAX2}	Mounted on two-layer board of based on the EIAJ, T_j = 125°C	450	mW
	P_{DMAX4}	Mounted on four-layer board of based on the EIAJ, T_j = 125°C	570	mW
Thermal Resistance	θ_{ja2}	Mounted on two-layer board of based on the EIAJ, T_j = 125°C	223	°C /W
	θ_{ja4}	Mounted on four -layer board of based on the EIAJ, T_j = 125°C	176	°C /W

Note 3) All voltage are relative to "V_{SS}= 0V" reference.
Note 4) Mounted on two-layer/4-layer board of based on the EIA/JEDEC STD
Note 5) The IC must be used inside of the "Absolute maximum ratings". Otherwise, a stress may cause permanent damage to the LSI.
Note 6) De-coupling capacitors for V_{DD}-V_{SS} and V_{DDO}-V_{SS} should be connected for stable operation.
Note 7) The class-D amplifiers are more power efficient, and dissipate power less than general analog-amplifiers. In theory, the **NJU8758** actualize quite high output-power such as 1.2W at =5V operation with 8ohms load, it looks as if the **NJU8758** exceeds the absolute maximum rating of the power dissipation. However, in practice, the effective output-power of usual music sound is only about 1/10 of its maximum output power, thus it may never exceed the absolute maximum rating.

The maximum power dissipation in the system is calculated, as shown below.

$$P_{DMAX} = \frac{T_{jMAX}[°C] - T_a[°C]}{\theta_{ja}[°C/W]}$$

Pdmax: Maximum Power Dissipation, Tjmax: Junction Temperature = 125°C
Ta: Ambient Temperature, θja: Thermal Resistance of package (SSOP14) = 223°C/W

Power dissipation of the **NJU8758** itself is calculated, as shown below.

$$P_D = \frac{125°C - 50°C}{223°C/W} = 336.3mW$$

■ ELECTRICAL CHARACTERISTICS

(7) DC CHARACTERISTICS

($Ta=25°C$, $V_{DD}=V_{DDO}= 3.3V$, $V_{SS}= 0V$, Input Signal=1kHz, Input Signal Level=200mVrms, Load Impedance=8Ω)

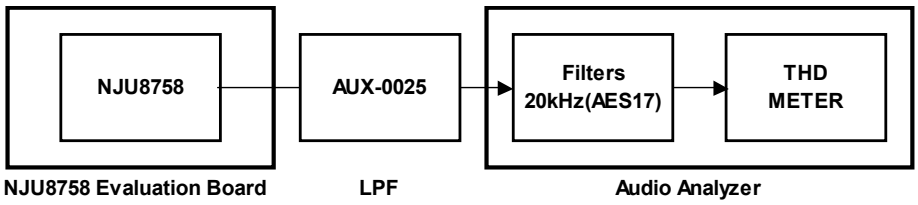
PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{DD},V_{DDO} Supply Voltage	V_{DD}, V_{DDO}		1.8	3.3	5.5	V
Drain-Source On-state Resistance (High-side)	R_{ONH}	OUT_P, OUT_N $V_{OUTP,N} = V_{DDO}$ - 0.1 V	-	0.5	-	Ω
Drain-Source On-state Resistance (Low-side)	R_{ONL}	OUT_P, OUT_N $V_{OUTP,N}$ = 0.1 V	-	0.5	-	Ω
Input Impedance	R_{IN}	IN	-	27	-	kΩ
Operating Current (Standby)	I_{ST}	V_{DD}, STBYb: "L", No Load	-	0.1	0.5	μA
	I_{STO}	V_{DDO}, STBYb: "L", No Load	-	0.1	0.5	μA
Operating Current (No signal input)	I_{DD}	No Load	-	1.5	-	mA
	I_{DDO}		-	1.2	-	mA
Input Voltage	V_{IH}	STBYb, MUTEb	1.5	-	V_{DD}	V
	V_{IL}	STBYb, MUTEb	0	-	0.5	V
Input Leakage Current	I_{LK}	STBYb, MUTEb	-	-	±1	μA
Frequency	f_{OSC}		-	320	-	kHz
Start up Time	T_{ON}	MUTEb: "L"	-	205	-	ms
Voltage Gain	A_V	No Load	-	22.9	-	dB

(8) AC CHARACTERISTICS

(Ta=25°C, V_{DD}= V_{DDL}= V_{DDR}=3.3V, Input Signal=1kHz, Input Signal Level=200mVrms, Load Impedance=8Ω,)

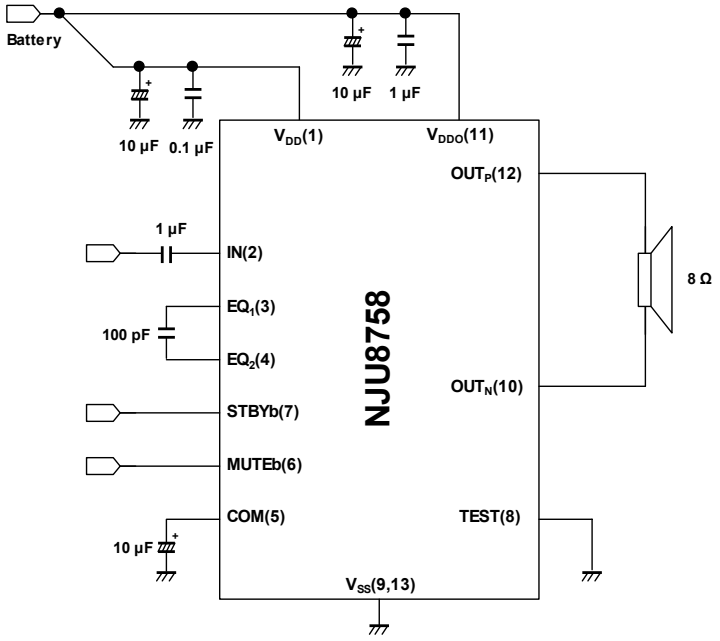
PARAMETER	CONDITIONS	SYMBOL	MIN.	TYP.	MAX.	UNIT
Output Power Efficiency	E_{EFF}	THD+N=10 %	-	80	-	%
THD+N	THD+N	P_O=200 mW	-	0.05	-	%
Output Power	P_O	V_{DD}=V_{DDO}=3.3 V THD+N=10 %	-	0.66	-	W
		V_{DD}=V_{DDO}=5.0 V THD+N=10 %	-	1.5	-	W
S/N	S/N	A-weight V_{DD}=V_{DDO}=5.0 V	-	84	-	dB

Test system of the output THD



Output THD
Test System

■ TYPICAL APPLICATION CIRCUIT



TYPICAL APPLICATION CIRCUIT

Note 8) De-coupling capacitors must be connected between each power supply terminal and GND (V_{DD}-V_{SS}, V_{DDO}-V_{SS}).
Note 9) V_{SS} should be connected at a nearest point to the IC on PCB.
Note 10) IN, EQ1 and EQ2 should be not designed near OUTP and OUTN, which emit PWM noise.
Note 11) The power supply for V_{DDO} requires fast driving response performance such as a switching regulator for better THD.
Note 12) The above circuit shows only application example and does not guarantee the any electrical characteristics. Therefore, please test the circuit carefully to fit your application.
Note 13) The transition time for MUTEB and STBYB signals must be less than 100µs. Otherwise, a malfunction may be occurred.
Note 14) (1) – (12) indicates terminal number.