PRELIMINARY

Analog Signal Input Class D Amplifier for Piezo Speaker

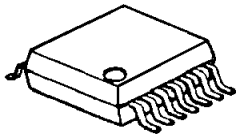
■ GENERAL DESCRIPTION

The **NJU8752/NJU8752B** is an analog signal input monaural class D amplifier for Piezo speaker. The **NJU8752/52B** includes Inversion operational amplifier input circuit, PWM modulator, an output-short protector and a low voltage detector. Input part operates on 3.3V(TYP) as power supply and Output part operates up to 16.0V(MAX). Therefore, it drives Piezo speaker with louder sound and High efficiency.

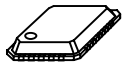
The **NJU8752/52B** incorporates BTL amplifier, which eliminate AC coupling capacitors, capable of driving Piezo speaker with simple external LC low-pass filters.

Class D operation achieves lower power operation for Piezo speaker, thus the **NJU8752/52B** is suited for battery powered applications.

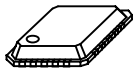
■ PACKAGE OUTLINE



NJU8752V / 52BV



NJU8752BKM1

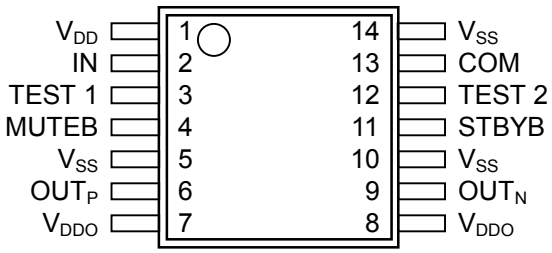


NJU8752BKP4

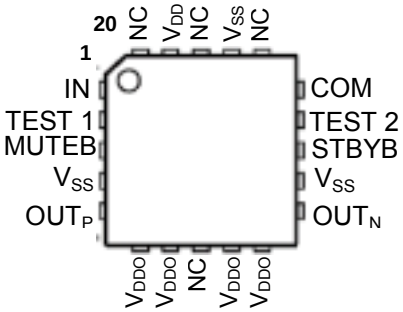
■ FEATURES

- Piezo Speaker Driving
- 1-channel Analog Signal Input, 1-channel BTL Output
- Standby(Hi-Z), Mute Control
- Voltage Gain 31dB(NJU8752)
  20dB(NJU8752B)
- Built-in Low Voltage Detector
- Built-in Short Protector
- Operating Voltage Input: 2.7 ~ 3.6V (NJU8752)
  3.1 ~ 3.6V (NJU8752B)
  Output: 6.0 ~ 16.0V
- C-MOS Technology
- Package Outline SSOP14 (NJU8752 / 52B)
  QFN20 / QFN28 (NJU8752B)

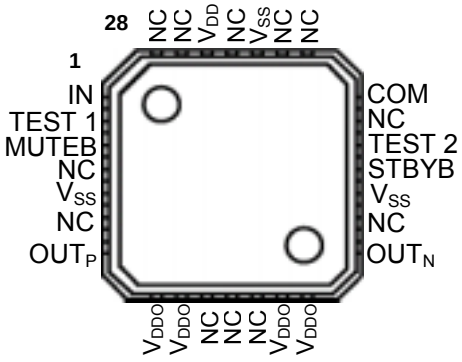
■ PIN CONFIGURATION



SSOP14 (NJU8752V / 52BV)

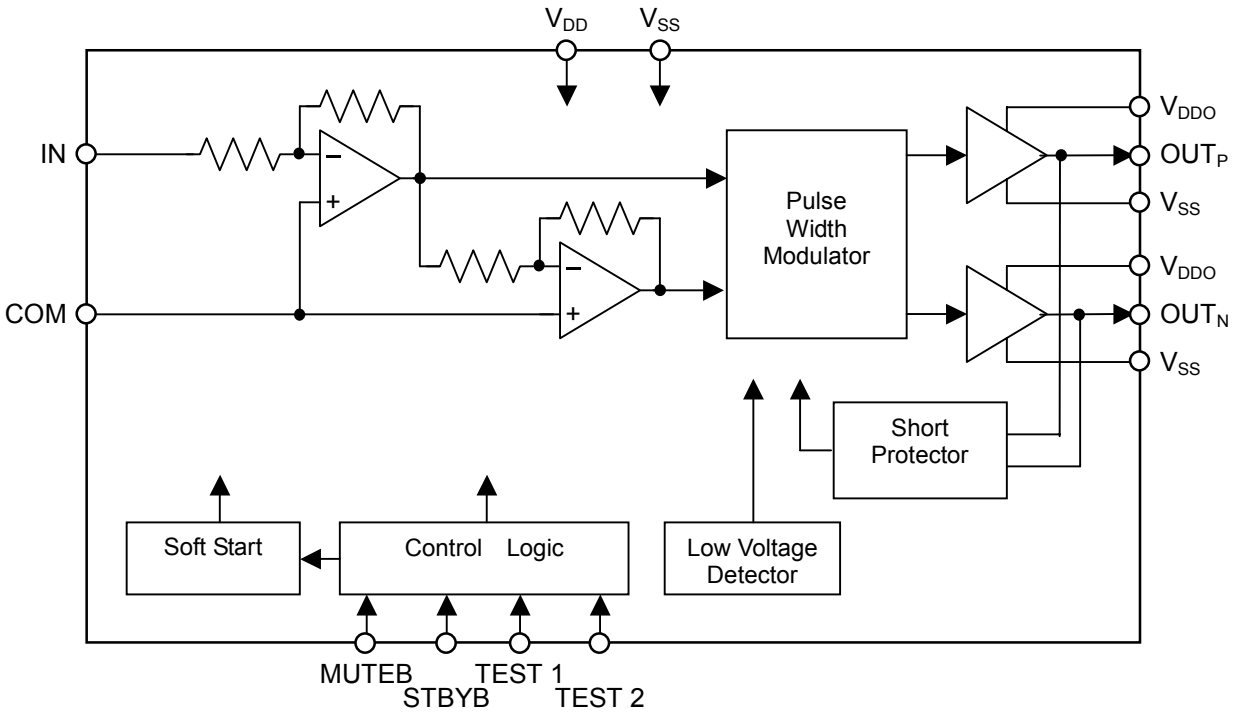


QFN20 (NJU8752BKM1)



QFN28 (NJU8752BKP4)

■ BLOCK DIAGRAM



■ PIN DESCRIPTION

No.			SYMBOL	I/O	Function
SSOP14	QFN20	QFN28			
1	19	26	V_{DD}	–	Power Supply: V_{DD}=3.3V
2	1	1	IN	I	Signal Input
3	2	2	TEST 1	I	Maker test 1 This pin must be connected to GND.
4	3	3	MUTEB	I	Mute Control Low : Mute ON High : Mute OFF
5,10,14	4,12,17	5,17,24	V_{SS}	–	Power GND: V_{SS}=0V
6	5	7	OUT_P	O	Positive Output
7,8	6,7,9,10	8,9,13,14	V_{DDO}	–	Output Power Supply : V_{DDO}=16.0V max.
9	11	15	OUT_N	O	Negative Output
11	13	18	STBYB	I	Standby Control Low : Standby ON High : Standby OFF
12	14	19	TEST 2	I	Maker test 2 This pin must be connected to GND.
13	15	21	COM	–	Analog common
–	8,16,18,20	4,6,10,11, 12,16,20,22, 23,25,27,28	NC	–	Non connection

*V_{SS}(SSOP14:Pin No.5,10,14, QFN20:Pin No.4,12,17, QFN28:Pin No.5,17,24) should be connected at a nearest point to the IC.
*V_{DDO}(SSOP14:Pin No.7,8, QFN20:Pin No.6,7,9,10, QFN28:Pin No.8,9,13,14) should be connected at a nearest point to the IC.
*MUTEB(SSOP14: Pin No.4, QFN20, QFN28:Pin No.3) and STBYB(SSOP14:Pin No.11, QFN20:Pin No.13, QFN28:Pin No.18) must be connected to V_{DD}, when these pins are not used.

■ FUNCTIONAL DESCRIPTION

(1) Signal Output

The OUT_P and OUT_N generate PWM output signals, which will be converted to analog signal via external 2nd-order or higher LC filter. A switching regulator with a high response against a voltage fluctuation is the best selection for the V_{DDO}, which are the power supply for output drivers. To obtain better THD performance, the stabilization of the power is required.

(2) Standby

By setting the STBYB pin to "L", the standby mode is enabled. In the standby mode, the entire functions of the **NJU8752/52B** enter a low-power state, and the output pins (OUT_P and OUT_N) are high impedance.

(3) Mute

By setting the MUTEB pin to "L", the Mute function is enabled. In the Mute mode, the output pins (OUT_P and OUT_N) output square wave (Duty: 50%).

(4) Low Voltage Detector

When the power supply voltage drops down to below V_{DD} (MIN), the internal oscillation is halted for prevention to generate unwanted frequency, and the output pins (OUT_P and OUT_N) become in high impedance.

(5) Short Circuit Protection

The short protector, which protects the **NJU8752/52B** against high short-circuit current, turns off the output driver. After about 5 seconds from the protection, the **NJU8752/52B** returns to normal operation. The short protector functions at the following accidents.

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

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 the **NJU8752/52B**.

■ ABSOLUTE MAXIMUM RATINGS

(Ta=25°C)

PARAMETER		SYMBOL	RATING	UNIT
Supply Voltage		V_{DD} V_{DDO}	-0.3 ~ +4.0 -0.3 ~ +18.0	V V
Input Voltage		Vin	-0.3 ~ V_{DD}+0.3	V
Operating Temperature		Topr	-40 ~ +85	°C
Storage Temperature		Tstg	-40 ~ +125	°C
Power Dissipation	SSOP14	P_D	450	mW
	QFN20		620	
	QFN28		640	

* : Mounted on two-layer board of based on the JEDEC.

Note 1) All voltage are relative to "V_{SS} =0V" reference.
Note 2) The LSI must be used inside of the "Absolute maximum ratings". Otherwise, a stress may cause permanent damage to the LSI.
Note 3) De-coupling capacitors for V_{DD}-V_{SS} and V_{DDO}-V_{SS} should be connected for stable operation.

■ ELECTRICAL CHARACTERISTICS

-NJU8752-

(Ta=25°C, V_{DD}=3.3V, V_{DDO}=12.0V, V_{SS}=0V,Input Signal=1kHz, Input Signal Level=200mVrms, Frequency Band=20Hz~20kHz, Load Impedance=0.8μF, 2nd-order 34kHz LC Filter(Q=0.75))

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT	Note
V_{DD} Supply Voltage	V_{DD}		2.7	3.3	3.6	V	
V_{DDO} Supply Voltage	V_{DDO}		6.0	12.0	16.0	V	
Input Impedance	Z_{IN}	IN pin	-	20	-	kΩ	
Voltage Gain	A_V		-	31	-	dB	
Output THD	THD	Input Signal Level =200mVrms	-	0.05	0.08	%	4
Maximum Output	Vo	Output THD=10%	7	10	-	Vrms	
S/N	SN	A weight	-	80	-	dB	4
Dynamic Range	Drange	A weight	-	83	-	dB	4
Maximum Mute Attenuation	MAT		90	-	-	dB	
Operating Current(Stanby)	I_{ST}		-	-	1	μA	
Operating Current (No signal input)	I_{DD}	No-load operating No Signal Input	-	3.5	10	mA	
Input Voltage	V_{IH}	MUTEB, STBYB pins	0.7V_{DD}	-	V_{DD}	V	
	V_{IL}	MUTEB, STBYB pins	0	-	0.3V_{DD}	V	
Input Leakage Current	I_{LK}	MUTEB, STBYB pins	-	-	±1.0	μA	

-NJU8752B-

(Ta=25°C, V_{DD}=3.3V, V_{DDO}=12.0V, V_{SS}=0V,Input Signal=1kHz, Input Signal Level=700mVrms, Frequency Band=20Hz~20kHz, Load Impedance=0.8μF, 2nd-order 34kHz LC Filter(Q=0.75))

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT	Note
V_{DD} Supply Voltage	V_{DD}		3.1	3.3	3.6	V	
V_{DDO} Supply Voltage	V_{DDO}		6.0	12.0	16.0	V	
Input Impedance	Z_{IN}	IN pin	-	20	-	kΩ	
Voltage Gain	A_V		-	20	-	dB	
Output THD	THD	Input Signal Level =700mVrms	-	0.05	0.08	%	4
Maximum Output	Vo	Output THD=10%	7	10	-	Vrms	
S/N	SN	A weight	-	80	-	dB	4
Dynamic Range	Drange	A weight	-	83	-	dB	4
Maximum Mute Attenuation	MAT		-	90	-	dB	
Operating Current(Stanby)	I_{ST}		-	-	1	μA	
Operating Current (No signal input)	I_{DD}	No-load operating No Signal Input	-	3.5	10	mA	
Input Voltage	V_{IH}	MUTEB, STBYB pins	$0.7V_{DD}$	-	V_{DD}	V	
	V_{IL}	MUTEB, STBYB pins	0	-	$0.3V_{DD}$	V	
Input Leakage Current	I_{LK}	MUTEB, STBYB pins	-	-	±1.0	μA	

Note 4) Test system of the output THD, S/N and Dynamic Range

The output THD, S/N and dynamic range are tested in the system shown in Figure 1, where a 2nd-order LC LPF and another filter incorporated in an audio analyzer are used.

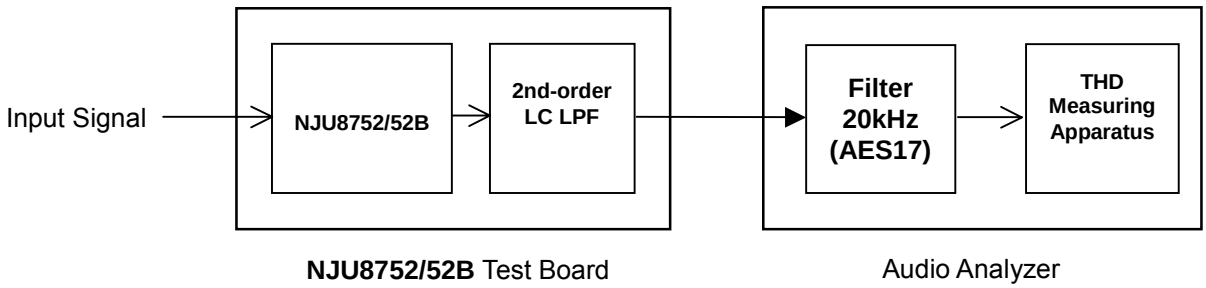


Figure 1. Output THD, S/N and Dynamic Range Test System

2nd-order LPF : Refer to “Typical Application Circuit”.
Filters : 22Hz HPF + 20kHz LPF(AES17)
(with the A-Weight filter for S/N and Dynamic-range tests)

■ TYPICAL APPLICATION CIRCUIT

•LLB2520 is manufactured by TOKO, INC.
For detail information, please refer its technical papers.

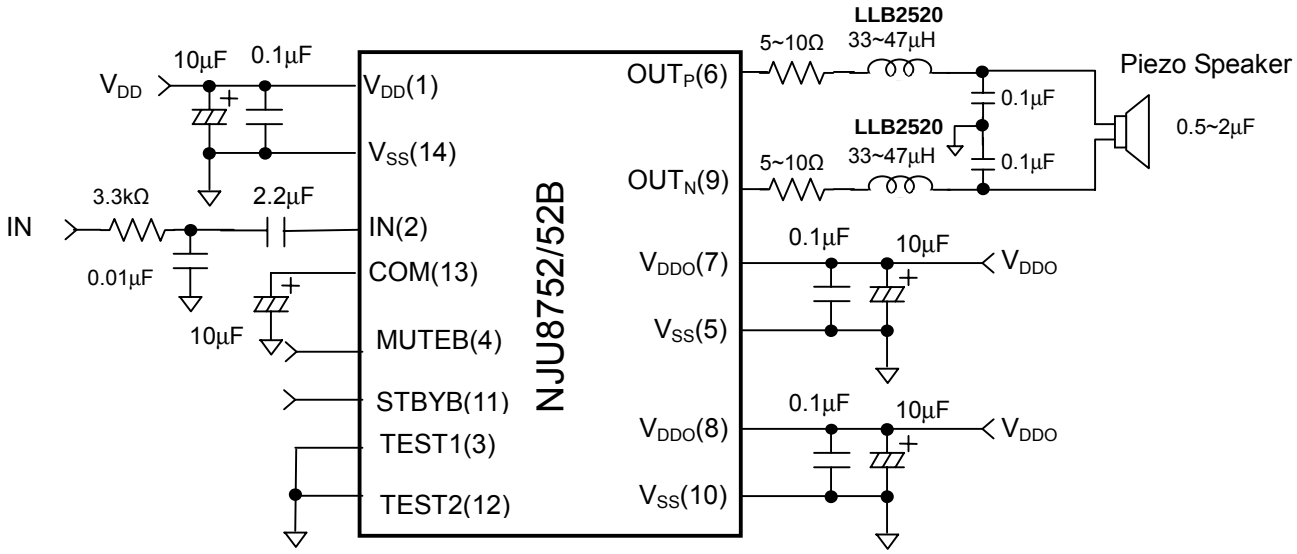


Figure 2.1 Application Circuit example (SSOP14)

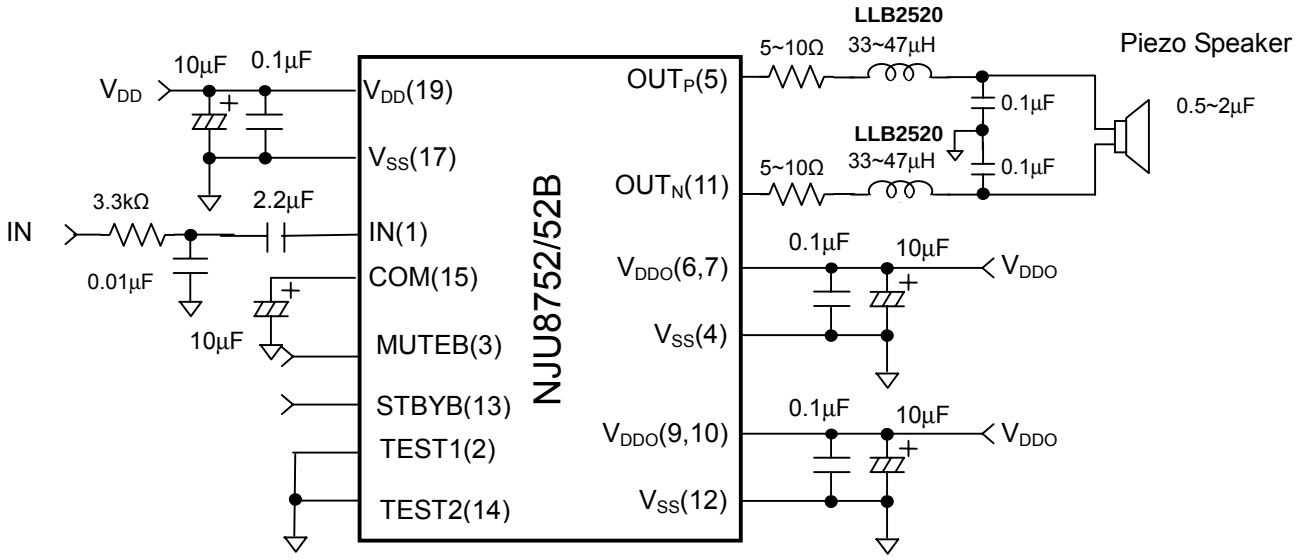


Figure 2.2 Application Circuit example (QFN20)

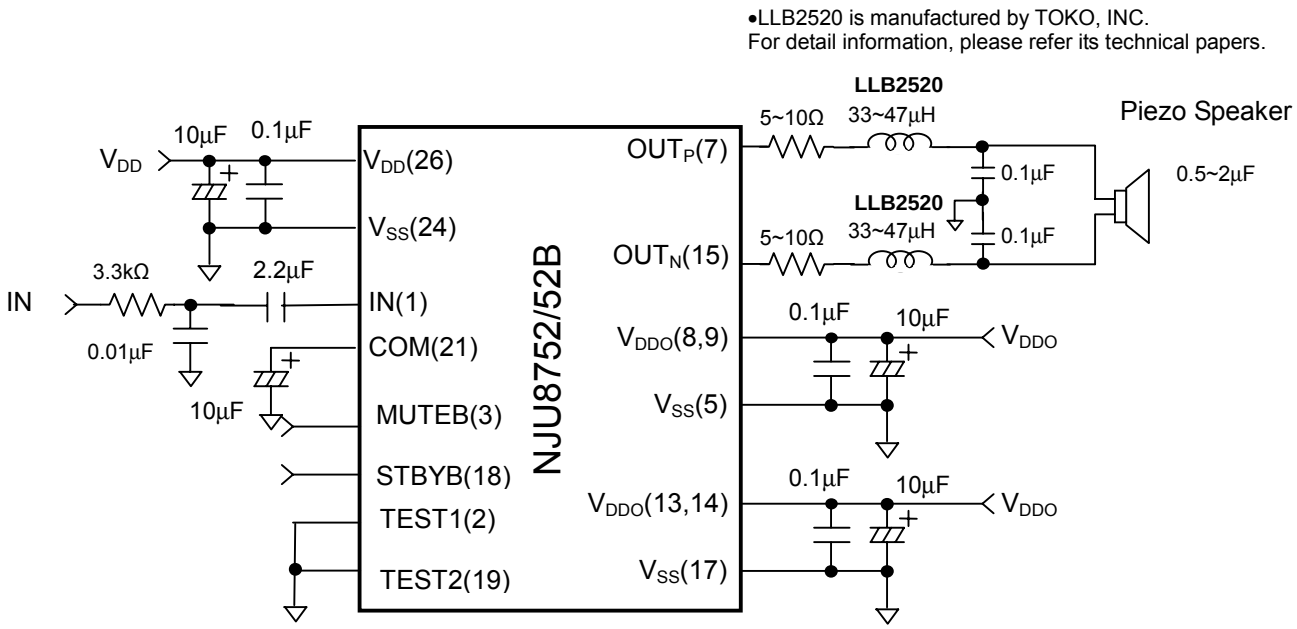


Figure 2.3 Application Circuit example (QFN28)

Note 5) De-coupling capacitors must be connected between each power supply pin and GND.
The capacity value should be adjusted on the application circuit and the operation temperature. It may malfunction if capacity value is small.

Note 6) The power supply for V_{DDO} require fast driving response performance such as a switching regulator for better THD.
THD performance becomes worse by ripple if the capacity of De-coupling capacitors is small.

Note 7) 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.
The cutoff frequency of the LC filter influences the quality of sound.
The Q factor of the LC filter must be less than "1". Otherwise, the operating current increase when the frequency of input signal is closed to the cutoff frequency.

Note 8) The transition time for MUTEB and STBYB signals must be less than 100μs. Otherwise, a malfunction may be occurred.

Note 9) (1)-(26) indicates pin number.