2Vrms Ground Referenced Stereo Line Amplifier with LPF

■ GENERAL DESCRIPTION

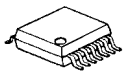
The **NJU72010** is an audio line Amplifier .

It can swing 2Vrms (5.6V peak-to-peak) signal at 3.3V operating voltage.

Ground-referenced outputs eliminate output coupling capacitor. The pop noise suppression circuit removes a pop noise at the power-on and power-off.

It is suitable for audio line interface of audio equipment which does not have over 9V regulator.

■ PACKAGE OUTLINE



NJU72010RB2 NJU72010V

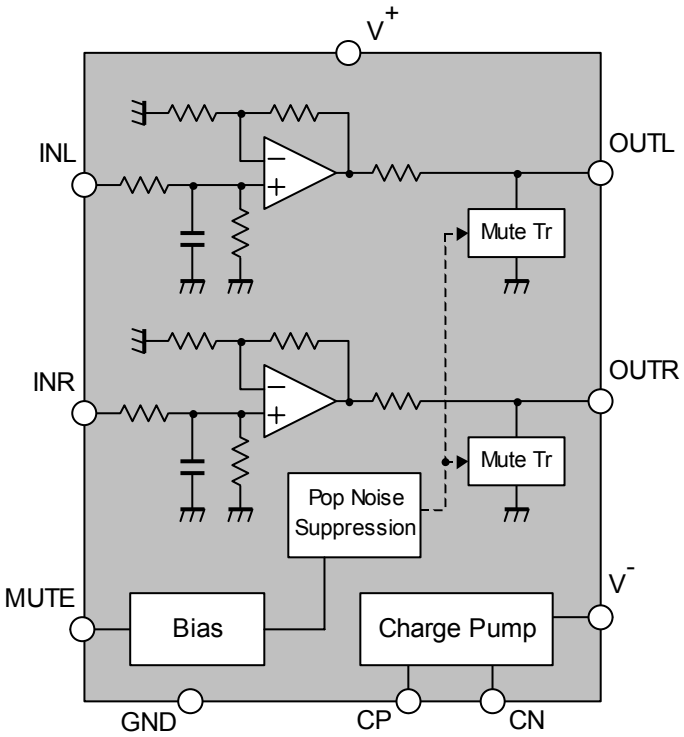
■ APPLICATIONS

● Audio applications requiring 2Vrms outputs

■ FEATURES

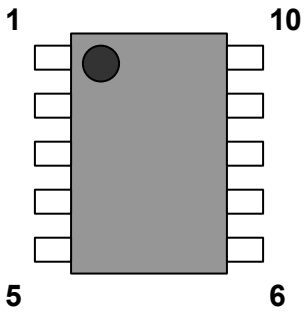
● Operating Voltage	+2.7 to +3.6V
● Operating Current	I_{DD}=5mA typ. at V^+=3.3V, R_L=47kΩ, No Signal
● Output Coupling Capacitor-less	
● Pop Noise Suppression Circuit	
● LPF	
● C-MOS Technology	
● Package Outline	TVSP10, SSOP14

■ BLOCK DIAGRAM



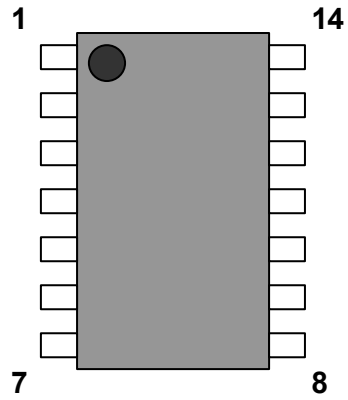
■ PIN CONFIGURATION

TVSP10



No.	Symbol	Function
1	INL	Lch Input
2	OUTL	Lch Output
3	V+	V+ Power Supply
4	CP	Flying Capacitor Positive Terminal
5	CN	Flying Capacitor Negative Terminal
6	V-	V- Power Supply
7	MUTE	Mute / Pop Noise Suppression
8	GND	Ground
9	OUTR	Rch Output
10	INR	Rch Input

SSOP14



No.	Symbol	Function
1	NC	NC
2	INL	Lch Input
3	OUTL	Lch Output
4	V+	V+ Power Supply
5	CP	Flying Capacitor Positive Terminal
6	CN	Flying Capacitor Negative Terminal
7	NC	NC
8	NC	NC
9	V-	V- Power Supply
10	MUTE	Mute / Pop Noise Suppression
11	GND	Ground
12	OUTR	Rch Output
13	INR	Rch Input
14	NC	NC

■ **ABSOLUTE MAXIMUM RATING** (Ta=25°C)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	V^+	+4	V
Power Dissipation	P_D	TVSP10 : 530(Note1) SSOP14 : 550(Note1)	mW
Maximum Input Voltage	V_{IMAX}	$-V^+$ -0.3 ~ V^+ +0.3	V
Operating Temperature Range	Topr	-40 ~ +85	°C
Storage Temperature Range	Tstg	-40 ~ +125	°C

(Note1) EIA/JEDEC STANDARD Test board (76.2x114.3x1.6mm, 2layer, FR-4) mounting

■ **RECOMMENDED OPERATING CONDITIONS**

(Ta=25°C unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	V^+		2.7	3.3	3.6	V

■ **ELECTRICAL CHARACTERISTICS**

(Ta=25°C, V^+=3.3V, f=1kHz, Vin=1Vrms, Mute=OFF, R_L=47kΩ unless otherwise specified)

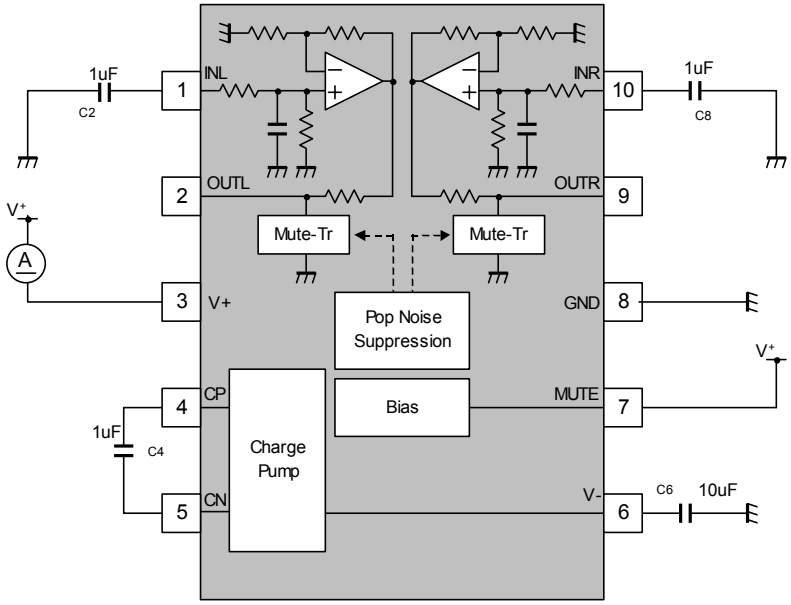
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I_{DD}	No signal	-	5	10	mA
Output Gain	G_V		5.2	6.2	7.2	dB
Output Gain Error	ΔG_V		-0.5	0	0.5	dB
Maximum Output Voltage Level	V_{OMAX}	THD=1%	-	2.3	-	Vrms
Mute Level	V_{MUTE}	Rg=0Ω, Mute=ON	-	-110	-	dB
Equivalent Input Noise Voltage	V_{NO}	Rg=0Ω, BW:400Hz-22kHz	-	-106	-	dB
Total Harmonic Distortion	THD	BW:400Hz-22kHz	-	0.003	-	%
Channel Separation	CS	Rg=600Ω	80	-	-	dB
Cut-off Frequency	f_C	2^{nd} order LPF	100	150	200	kHz
Output Offset Voltage	V_{OS}	Rg=0Ω	-	1	5	mV
Power Supply Rejection Ratio	PSRR	Vripple=1kHz / 100mVrms	-	45	-	dB
Output Impedance	R_{OUT}		-	300	-	Ω

■ **CONTROL CHARACTERISTICS**

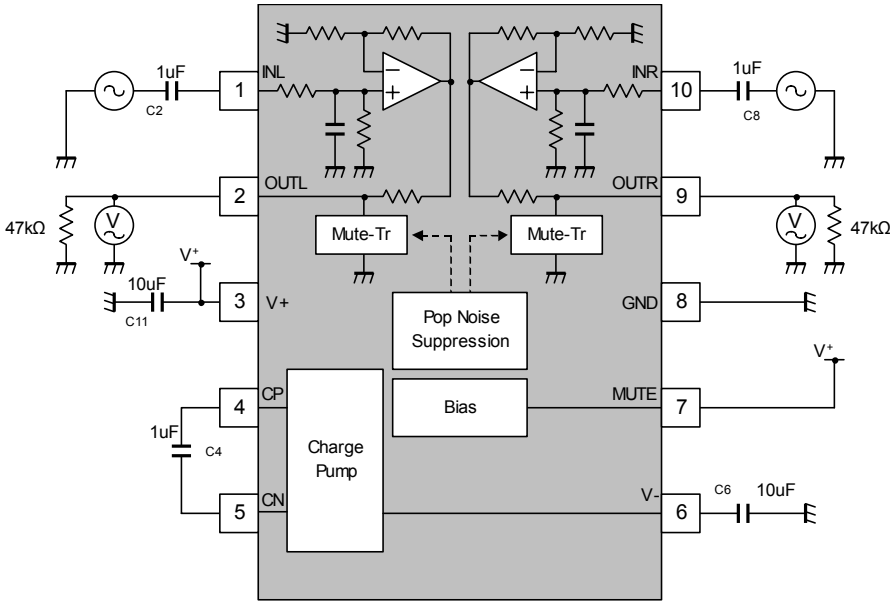
(Ta=25°C, V^+=3.3V, R_L=47kΩ unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Mute terminal High	MuteH	Mute=OFF	$0.8V^+$	-	V^+	V
Mute terminal Low	MuteL	Mute=ON	0	-	$0.2V^+$	V

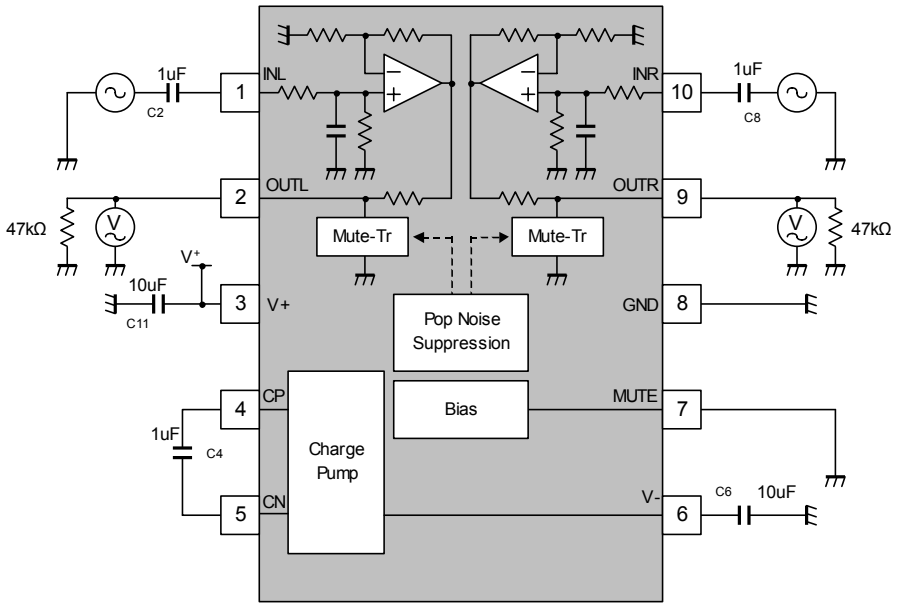
■**TEST CIRCUIT (I_{DD})**



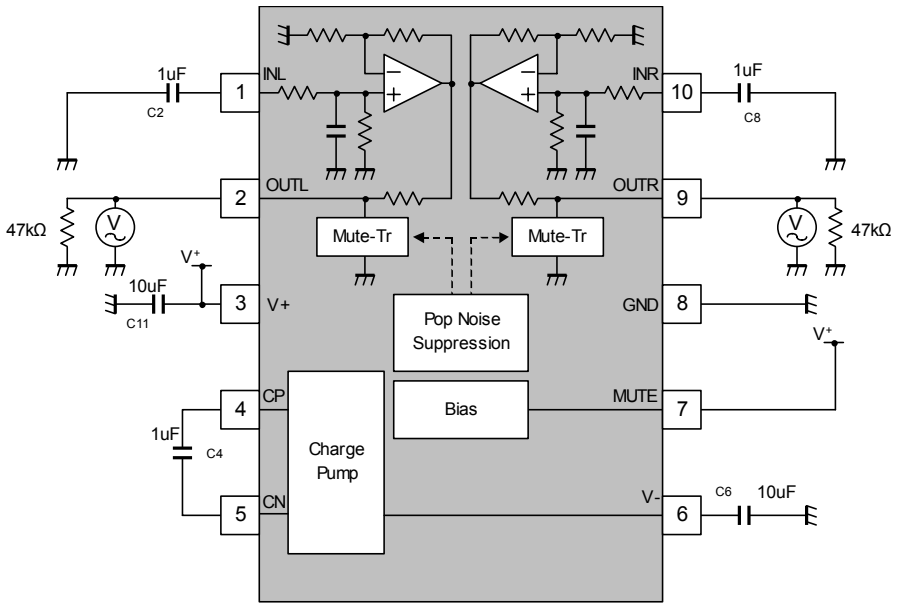
■**TEST CIRCUIT** (G_V, V_{OMAX}, THD)



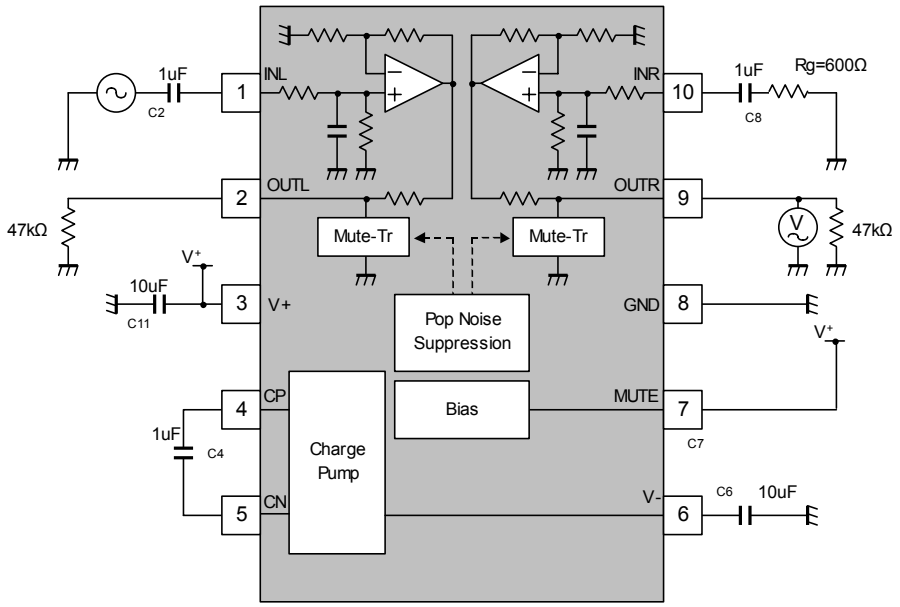
■**TEST CIRCUIT** (V_{MUTE})



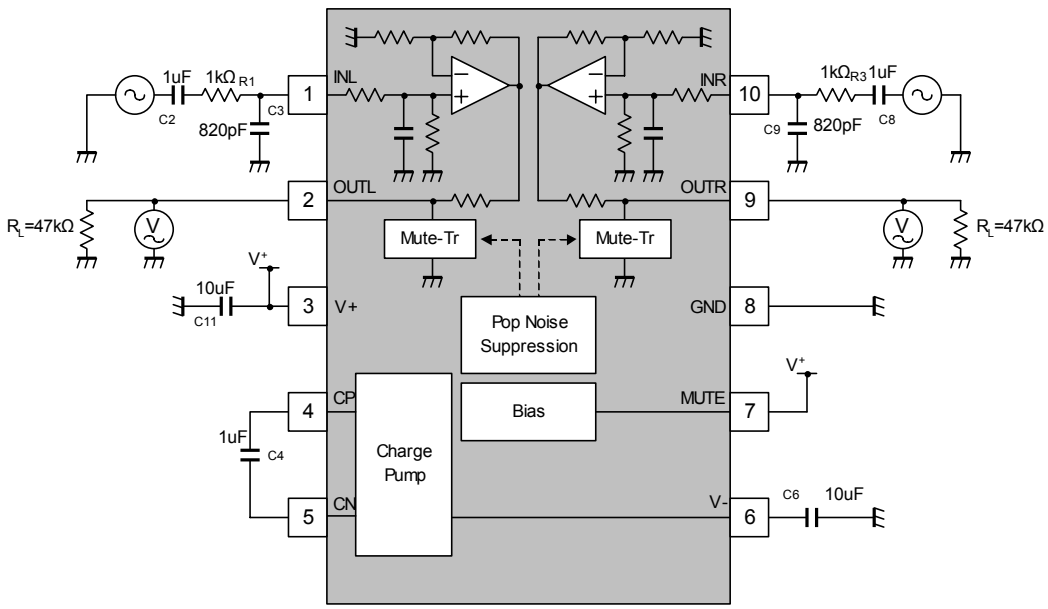
■**TEST CIRCUIT** (V_{NO})
V_{NO}=(measurement)-Gv1



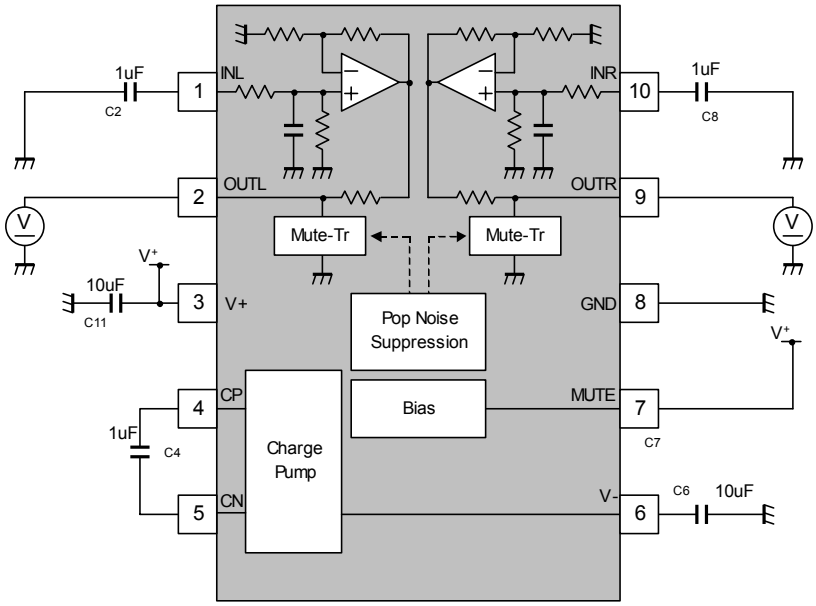
■**TEST CIRCUIT** (CS)



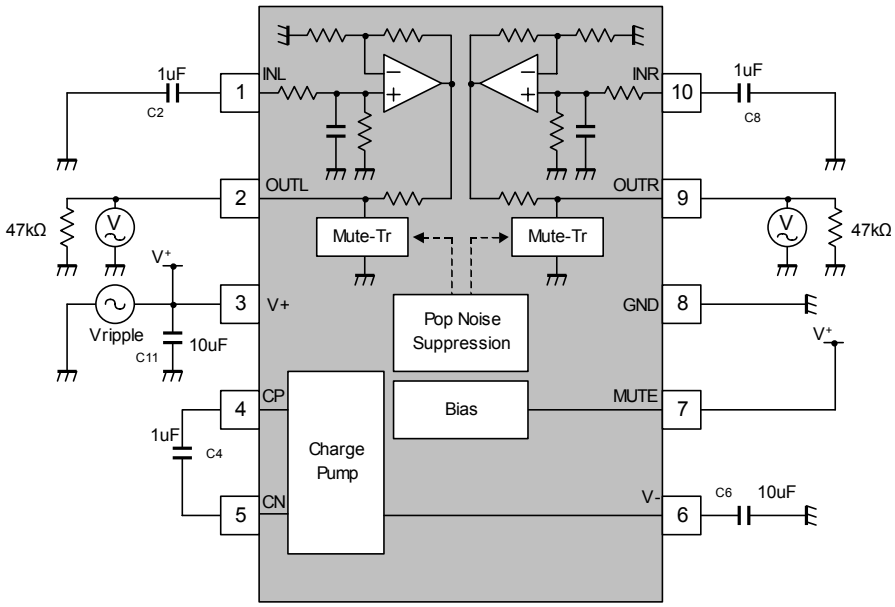
■**TEST CIRCUIT** (f_C)



■**TEST CIRCUIT** (V_{OS})

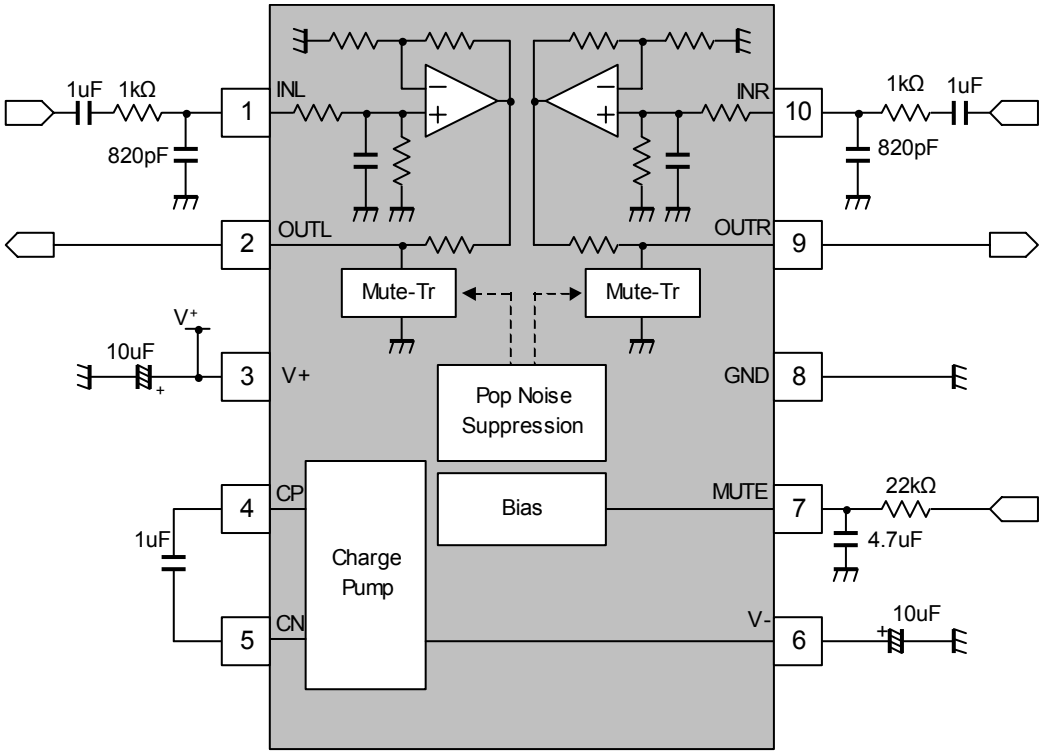


■**TEST CIRCUIT** (PSRR)
Vripple=1kHz / 100mVrms



■APPLICATION CIRCUIT

2nd order LPF



■ APPLICATION NOTE

The NJU72010 is an audio line amplifier that eliminates the need for external dc-blocking output capacitors. The NJU72010 has built-in pop suppression circuitry to eliminate disturbing pop noise during power-on, power-off and mute-control.

1. Operating Principle

The NJU72010 has the built-in non-inverted input operational amplifiers, voltage inverter, and pop noise suppression circuitry (Fig.1).

The voltage inverter for NJU72010 eliminates the need for external dc-blocking output capacitors. The pop suppression circuitry for NJU72010 eliminates the pop noise during power-on, power-off and mute-control.

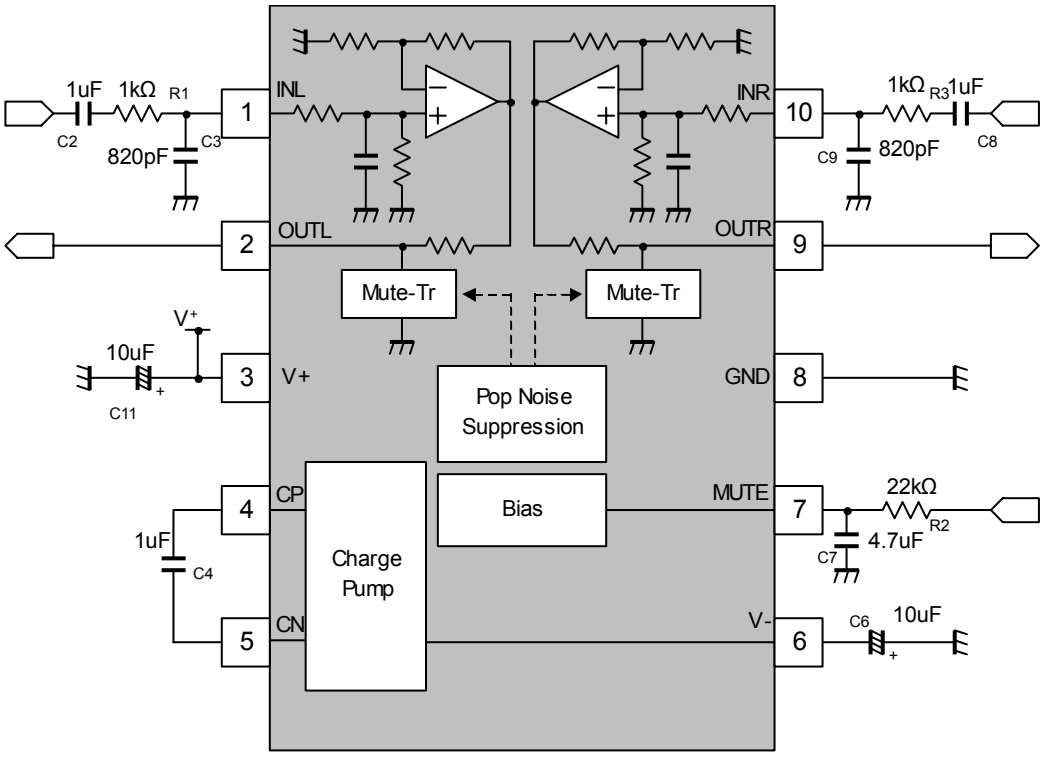


Fig.1 The NJU72010 functional block diagram

1.1 External parts

1.1.1 Input coupling capacitors C_i (C2, C8)

The input coupling capacitor (C_i) and the total of the external resistance (R1, R3) and the input resistance (R_{in}=218kΩ typ.) for the non-inverted terminal form a high-pass filter with the corner frequency determined in [$fc=1/(2\pi \times (R1+218k\Omega) \times C_i)$). It is necessary to adjust 1uF or more.

1.1.2 Flying capacitor (C4)

Use capacitors with a low-ESR (ex. ceramic capacitors) for optimum performance. Design to provide low impedance for the wiring between CP terminal (4pin), CN terminal (5pin), and the flying capacitor (C4).

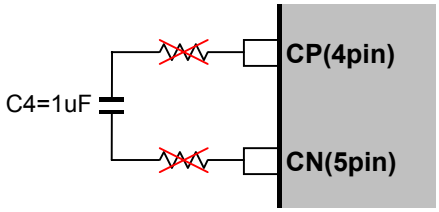


Fig.2 The NJU72040 block diagram (4pin, 5pin)

1.1.3 Hold capacitor (C6)

Use capacitors with a low-ESR (ex. ceramic capacitors) for optimum performance. Design to provide low impedance for the wiring between the hold capacitor (C6), V- terminal (6pin) and the GND on the PCB.

Separate the GND pattern connecting to the hold capacitor (C6) from that connecting to the GND terminal (8pin), thus suppressing the influence of switching noise by removing the common impedance of the GND wiring.

Design no short-circuits of V- terminal (6pin) and V+ terminal (3pin) on the PCB pattern.

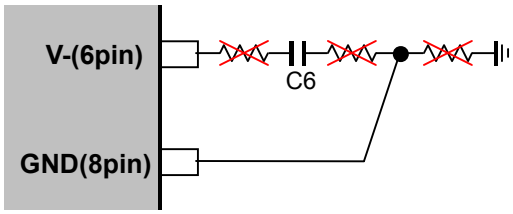


Fig.3 The NJU72010 block diagram (6pin, 8pin)

1.1.4 Mute terminal pop noise countermeasures (R2, C7)

Mute terminal needs time constant more than R2 x C7=0.1. It is necessary to adjust 22kΩ or less.

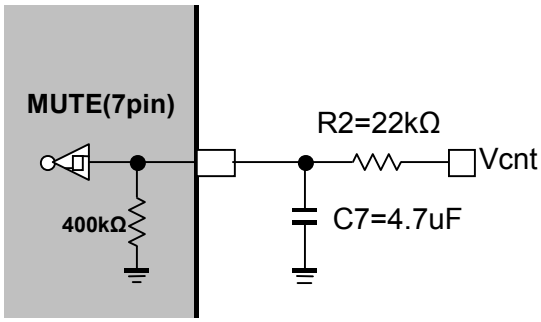


Fig.4 The NJU72010 block diagram (7pin)

1.2 Control of V+ terminal and Mute terminal

1.2.2 Power-on procedure

1. Turn on the V+.
2. After 100msec from power on, change the control voltage of MUTE terminal (Vcnt) from "Low" to "High".

* It is necessary to stabilize an IC for 100msec.
By releasing the MUTE function, the output terminal output the signal.

1.2.3 Power-off procedure

1. Change the control voltage of MUTE terminal (Vcnt) from "High" to "Low".

By the MUTE function, the output signals are stopped from output terminal.

2. Turn off the V+ after “2RC” sec from MUTE.

* It is necessary to stabilize a MUTE condition for “2RC” sec.
Ex.) R2=22kΩ, C7=4.7uF -> 2R2 x C7=200msec

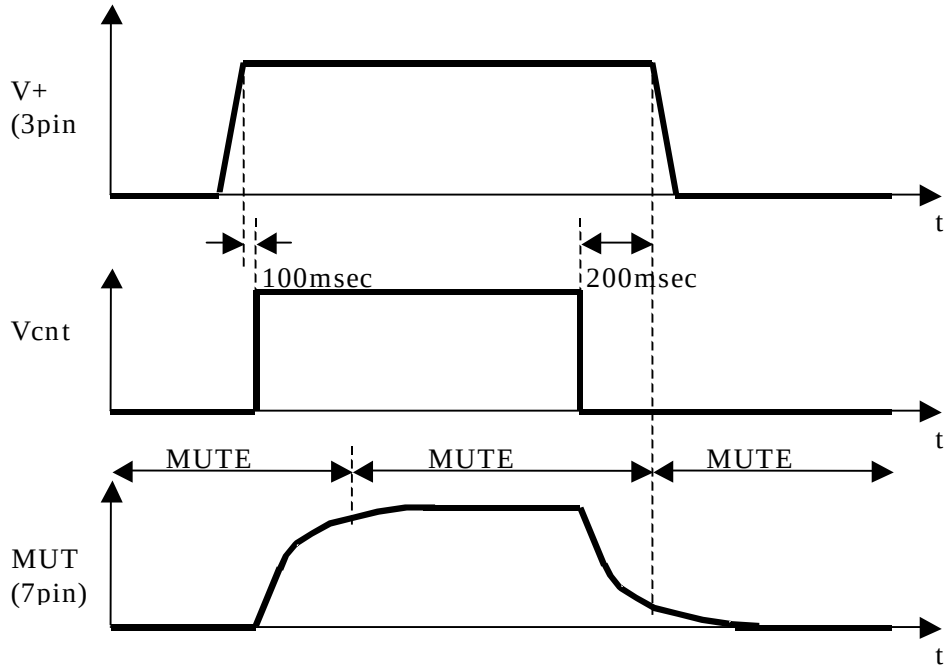
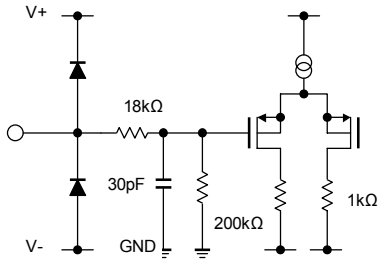
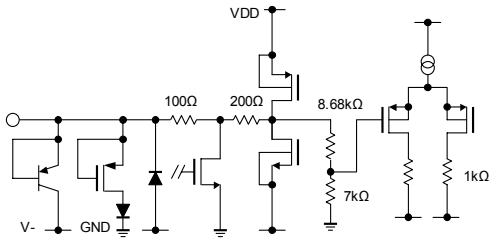
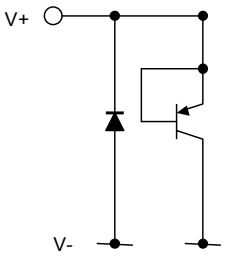
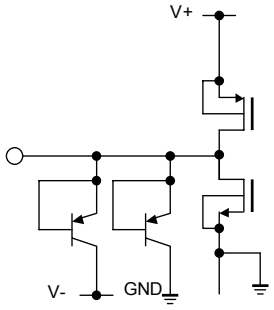
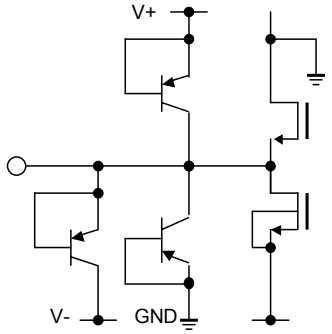
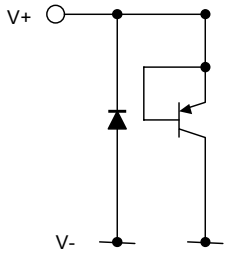
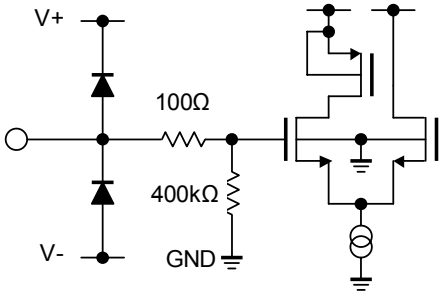


Fig.5 Power-on / Power-off timing chart

■TERMINAL DESCRIPTION

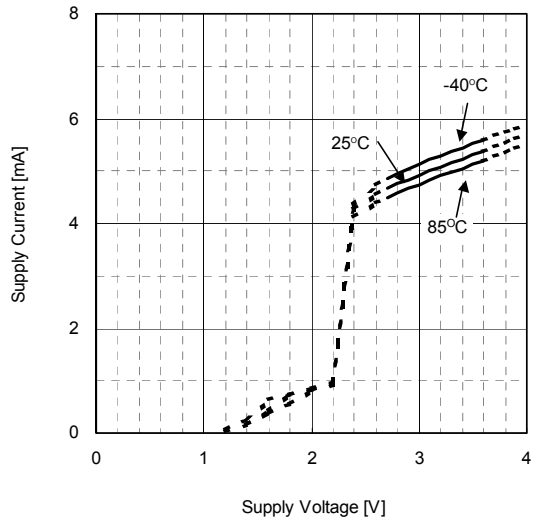
Terminal	SYMBOL	FUNCTION	EQUIVALENT CIRCUIT	VOLTAGE
1 10	INL INR	AC Input		0V
2 9	OUTL OUTR	AC Output		0V
3	V+	Supply Voltage		V+
4	CP	Flying Capacitor Positive Terminal		-

■TERMINAL DESCRIPTION

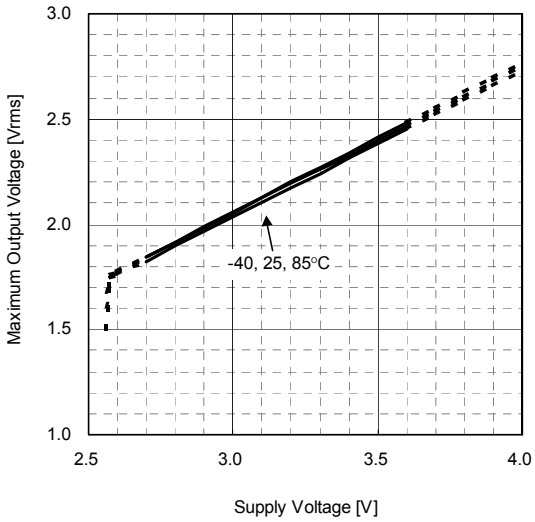
Terminal	SYMBOL	FUNCTION	EQUIVALENT CIRCUIT	VOLTAGE
5	CN	Flying Capacitor Negative Terminal		-
6	V-	V- Voltage		-[V+]
7	MUTE	MUTE/Pop Noise Suppression		0V

■TYPICAL CHARACTERISTICS

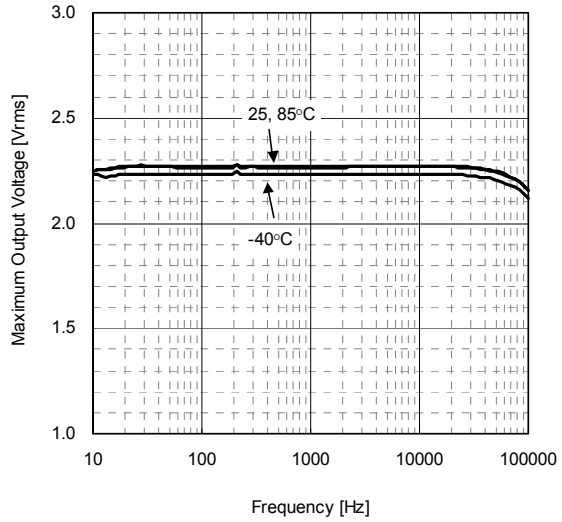
Supply Current vs Supply Voltage
No signal



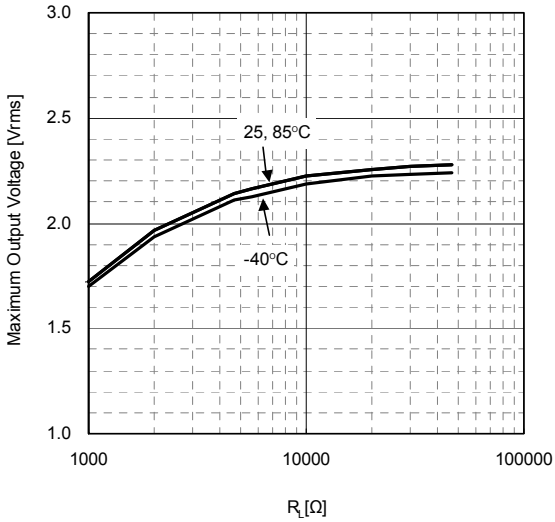
Maximum Output Voltage vs Supply Voltage
THD=1%, R_L=47kohm, I/O: INL-OUTL



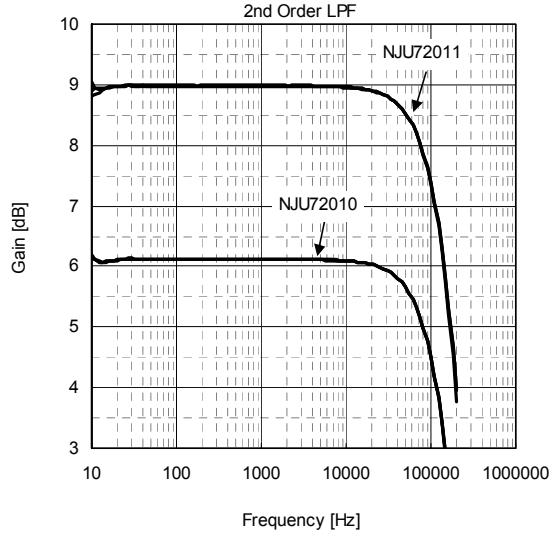
Maximum Output Voltage vs Frequency
V^+=3.3V, THD=1%, R_L=47kohm, I/O: INL-OUTL



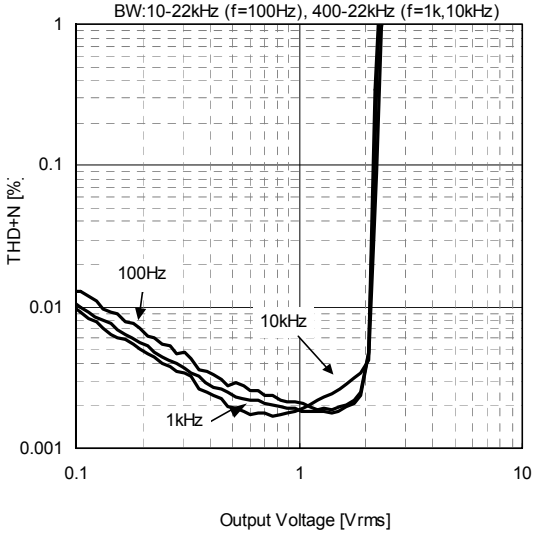
Maxium Output Voltage vs Load Resistance
V^+=3.3V, f=1kHz ,I/O: INL-OUTL



Gain vs Frequency
V^+=3.3V, Vout=2Vrms, R_L=47kohm, I/O: INL-OUTL
2nd Order LPF



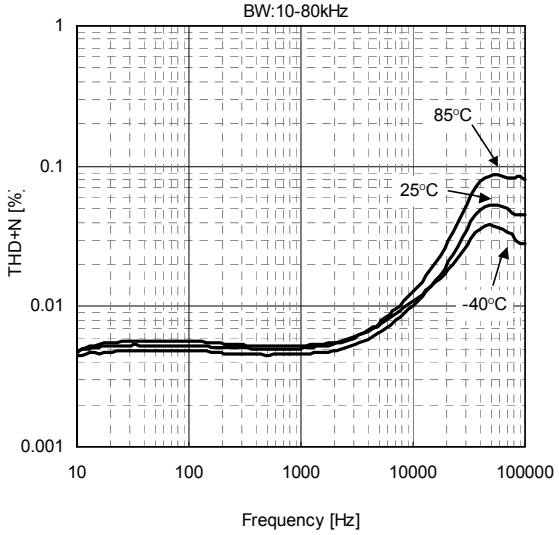
THD+N vs Output Voltage
V^+=3.3V, Ta=25°C, R_L=47kohm, I/O: INL-OUTL
BW:10-22kHz (f=100Hz), 400-22kHz (f=1k,10kHz)



■TYPICAL CHARACTERISTICS

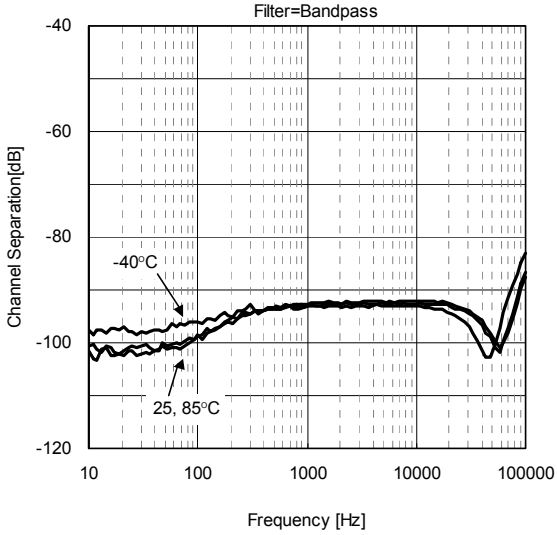
THD+N vs Frequency

V+=3.3V, R_L=47kohm, Vout=2Vrms, I/O: INL-OUTL
BW:10-80kHz



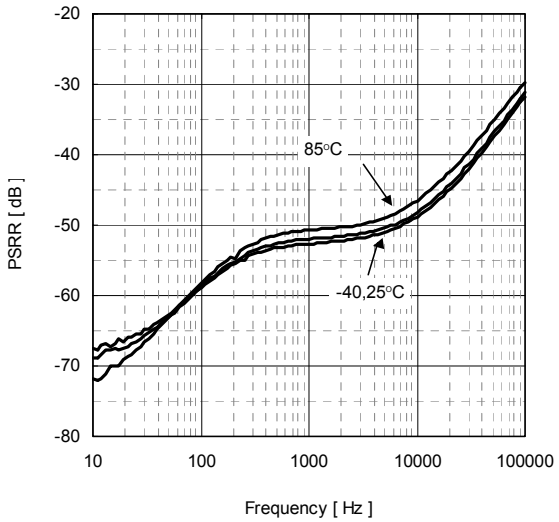
Channel Separation vs Frequency

V+=3.3V, RL=47kohm, Vout=2Vrms, I/O:INL-OUTR
Filter=Bandpass



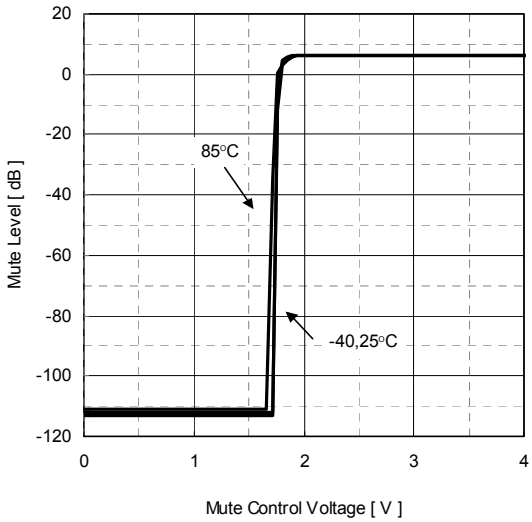
PSRR vs. Frequency

V+=3.3V, Vripple=100mVrms, f=1kHz, Filter=Bandpass



Mute Control Voltage vs. Mute Level

V+=3.3V, Vout=2Vrms, f=1kHz, Filter=Bandpass



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