

Pushbutton Interface EVR with Class D Stereo Power Amplifier

■ GENERAL DESCRIPTION

The NJU8790 is a pushbutton interface electronic volume with class D stereo power amplifier. It includes input selector, electronic volume, and limiter.

The NJU8790 can control the volume and the mode select without the micro-controller by the pushbutton interface.

The NJU8790 is suitable for low power consumption and simple control application such as mobile audio player, active speaker and cradle speaker.

■ PACKAGE OUTLINE

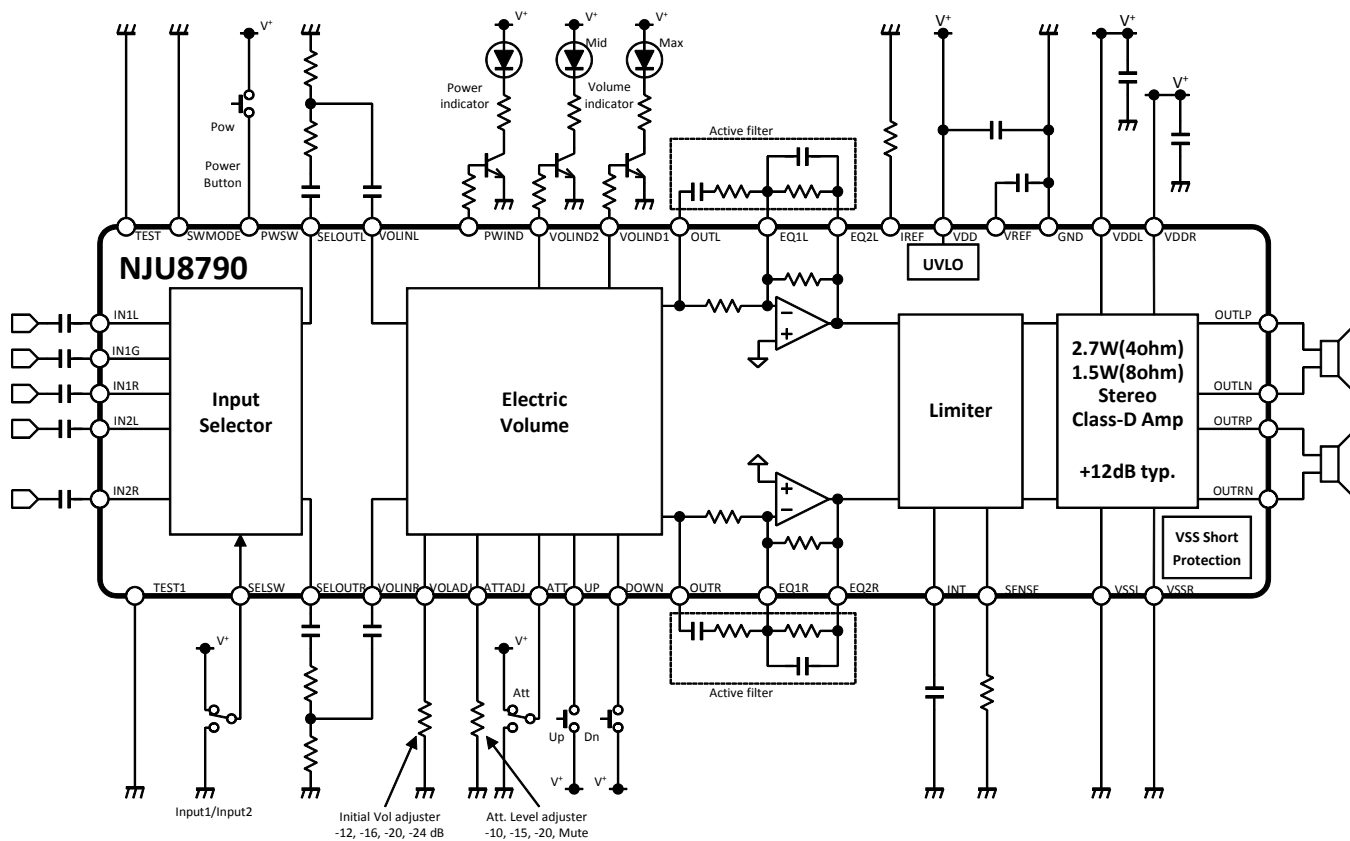


NJU8790V

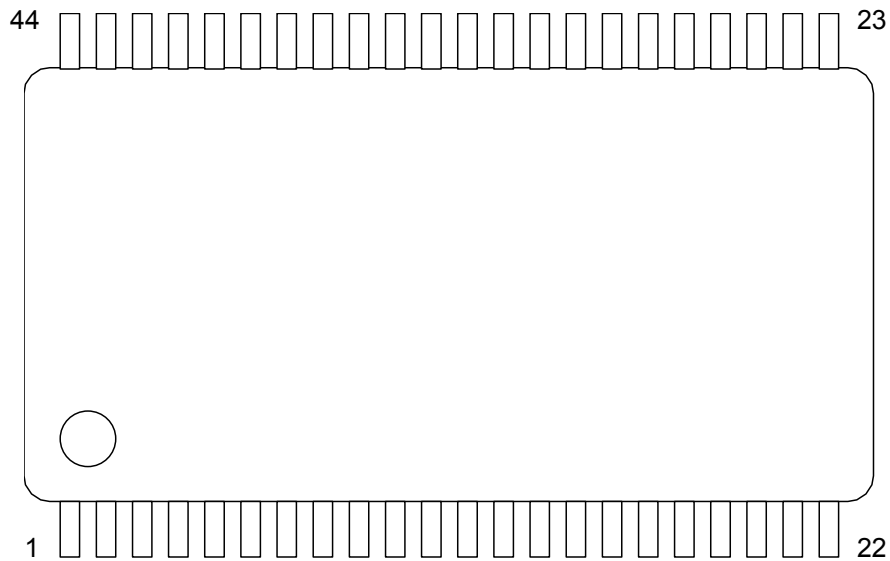
■ FEATURES

- Operating Voltage +2.7 to +5.5V
- Low operating current 10mA typ. (Active mode)
1μA max. (Stand-by mode)
- Output power 2.7W+2.7W ($V^+ = 5V$, 4ohm, BTL)
- Output filter-less
- Pop-noise reduction circuit
- Short-circuit protection circuit
- Supply voltage monitoring circuit
- 2-Input 1-Output selector (Single-end / Differential)
- Pushbutton interface EVR 0 to -68dB, MUTE
- Active filter, limiter
- CMOS Technology
- Package Outline SSOP44 (11 x 7.6 x 1.15mm, 0.5mm pitch)

■ BLOCK DIAGRAM



PIN CONFIGURATION



No.	Symbol	Function	No.	Symbol	Function
1	IN1L	Lch Input 1	23	VDD	Power Supply
2	IN1G	Common Input 1	24	VOLIND2	Volume Indicator 2
3	IN1R	Rch Input 1	25	VOLIND1	Volume Indicator 1
4	IREF	Reference Current	26	PWIND	Power Indicator
5	SWMODE	Control Mode Setting	27	TEST	Test
6	ATT	ATT Select Switch	28	VDDL	Lch Output Power Supply
7	TEST1	Test	29	OUTLN	Lch Inverted Output
8	SELOUTR	Selector Output R	30	VSSL	Lch Output GND
9	VOLINR	Volume Input R	31	OUTLP	Lch Non-inverted Output
10	OUTR	Volume Output Rch	32	VDDL	Lch Output Power Supply
11	EQ1R	Active Filter1 Rch	33	EQ2L	Active Filter2 Lch
12	EQ2R	Active Filter2 Rch	34	EQ1L	Active Filter1 Lch
13	VDDR	Rch Output Power Supply	35	OUTL	Volume Output L
14	OUTRP	Rch Non-inverted Output	36	VOLINL	Volume Input L
15	VSSR	Rch Output GND	37	SELOUTL	Selector Output L
16	OUTRN	Rch Inverted Output	38	SENSE	Limiter Sensitivity Setting
17	VDDR	Rch Output Power Supply	39	INT	Recovery Time Setting
18	SELSW	Input Selector	40	ATTADJ	Attenuator Adjustor
19	PWSW	Power ON/OFF	41	VOLADJ	Volume Initialization
20	UP	Volume Up Button	42	IN2L	Lch Input 2
21	DOWN	Volume Down Button	43	VREF	Reference voltage
22	VSS	GND	44	IN2R	Rch Input 2

*)The relations of "VSS= VSSL= VSSR=0V" and "VDD= VDDL=VDDR" must be maintained.

■ ABSOLUTE MAXIMUM RATING (Ta=25°C)

PARAMETER	SYMBOL	RATING	UNIT
Power Supply Voltage	V ⁺	+7	V
Power Dissipation* ¹⁾	P _{D2}	1200	mW
	P _{D4}	1700	mW
Maximum Input Voltage	V _{IMAX}	0 to V ⁺ * ²⁾	V
Operating Temperature Range	Topr	-40 to +85	°C
Storage Temperature Range	Tstg	-40 to +125	°C
Load Impedance	R _{LMIN}	>3.6	Ω

*¹⁾ Power Dissipation

EIA/JEDEC STANDARD Test board (2layer or 4layer) mounting.

The class-D amplifiers operate with high power efficiency and low dissipation power compared to general analog-amplifiers. In theory, the NJU8790 actualize quite high output-power such as 2.7W/channel at 5V operation into 4 ohms load, and total power is supposed to be 5.4W. For this reason, it looks as if the NJU8790 exceeds the absolute maximum rating of the power dissipation. However, in practice, the effective output-power of usual music sound is only about 1/5 to 1/10 of its maximum output power, thus it may never exceed the absolute maximum rating.

*²⁾ Don't apply the input voltage that exceeds supply voltage.

■ ELECTRICAL RECOMMENDED OPERATING CONDITION (Ta=25°C)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Voltage	V ⁺		2.7	5.0	5.5	V

■ ELECTRICAL CHARACTERISTICS

◆DC CHARACTERISTICS¹ (Ta=25°C, V⁺=5.0V, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Operating Current	I _{DD1}	No Signal, Active	-	10.0	15.0	mA
	I _{DD2}	No Signal, Standby	-	0.1	1.0	μA
Reference Voltage	V _{REF}	No signal	1.47	1.67	1.87	V
UVLO Detecting Voltage	V _{DDDET}		2.0	2.2	2.4	V

◆DC CHARACTERISTICS2 (Ta=25°C, V⁺=5.0V, unless otherwise specified)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Low Side Output Transistor Resistance	R _{DSL}	OUTLP=0.01V, OUTLN=0.01V OUTRP=0.01V, OUTRN=0.01V	-	0.4	-	Ω
High Side Output Transistor Resistance	R _{DSH}	OUTLP=VDDL-0.01V, OUTLN=VDDL-0.01V OUTRP=VDDR-0.01V, OUTRN=VDDR-0.01V	-	0.4	-	Ω
Input Resistance	R _{IN}	IN1L, IN1R, IN2L, IN2R	-	100	-	kΩ
Class-D Amplifier Switching Frequency	F _{OSC}		245	320	395	kHz
Class-D Amplifier Turn-On Time	T _{ON}	PWSW :Toggle SW mode	180	244	300	ms
Class-D Amplifier Turn-Off Time	T _{OFF}	PWSW :Toggle SW mode	180	244	300	ms
High Output Voltage	V _{OH}	I _{SOURCE} =1mA (pin 23,24,25)	V ⁺ *0.8	-	V ⁺	V
Low Output Voltage	V _{OL}	I _{SINK} =1mA (pin 23,24,25))	0	-	V ⁺ *0.8	V
High Input Voltage	V _{IH}	pin 5, pin 6, pin 7, pin 18, pin 19, pin 20, pin 21, pin 27	V ⁺ *0.8	-	V ⁺	V
Low Input Voltage	V _{IL}	pin 5, pin 6, pin 7, pin 18, pin 19, pin 20, pin 21, pin 27	0	-	V ⁺ *0.2	V
Pull-Down Resistance	R _{PULLDWN}	pin 19, pin 20, pin 21	-	100	-	kΩ
Mode Resistance range 1/4	R _{MODE1}	pin 40, pin 41	0	-	20	kΩ
Mode Resistance range 2/4	R _{MODE2}	pin 40, pin 41	40	-	60	kΩ
Mode Resistance range 3/4	R _{MODE3}	pin 40, pin 41	90	-	110	kΩ
Mode Resistance range 4/4	R _{MODE4}	pin 40, pin 41	150	-	∞	kΩ
Pulse Distinction Time	T _{JDGPLS}	pin 19, pin 20, pin 21	15	20	25	ms
Auto Increment Distinction Time	T _{JDGINC}	pin 19, pin 20, pin 21	0.7	1	1.3	s
Auto Increment cycle	T _{AINC}	pin 19, pin 20, pin 21	117	167	217	ms

◆ AC CHARACTERISTICS1

(Ta=25°C, V⁺=5.0V, V_{IN}=500mVrms, f=1kHz, BW=20Hz to 20kHz, R_L=8Ω, VOL: 0dB, unless otherwise specified)
Measurement pin: OUTR(pin10), OUTL(pin35)

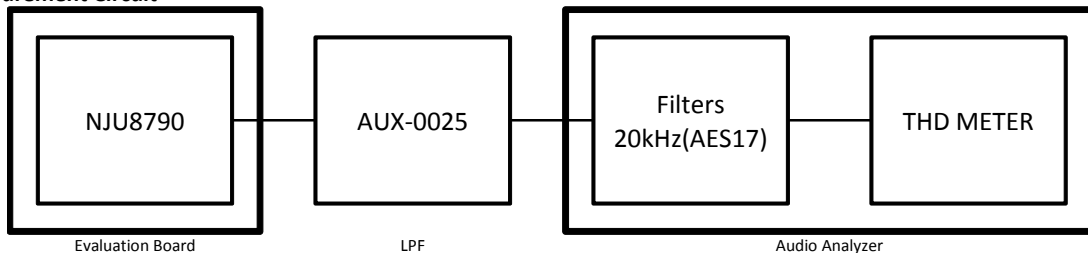
PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Maximum Input Voltage	V _{IM}	VOL=-12dB THD=1%	1.5	1.7	-	Vrms
Maximum Gain	G _{VMAX}		-1.0	0	1.0	dB
Initial Volume 1	G _{VINIT1}	R _{INIT} = 0Ω	-14	-12	-10	dB
Initial Volume 2	G _{VINIT2}	R _{INIT} = 47kΩ	-18	-16	-14	dB
Initial Volume 3	G _{VINIT3}	R _{INIT} = 100kΩ	-22	-20	-18	dB
Initial Volume 4	G _{VINIT4}	R _{INIT} = OPEN	-26	-24	-22	dB
Maximum Attenuate level	G _{VOL-68}	VOL= -68dB	-70	-68	-66	dB
Mute Level	Mute	VOL= Mute	-	-90	-84	dB
ATT Level 1	G _{VATT1}	R _{ATT} =0Ω	-12.0	-10.0	-8.0	dB
ATT Level 2	G _{VATT2}	R _{ATT} =47kΩ	-17.0	-15.0	-13.0	dB
ATT Level 3	G _{VATT3}	R _{ATT} =100kΩ	-22.0	-20.0	-18.0	dB
ATT Mute Level	G _{VATT4}	R _{ATT} =OPEN	-	-90	-84	dB
Channel Balance	G _{CB}		-1.0	0.0	1.0	dB
Cross Talk	CT	Selected Input: No Signal, R _g =0Ω	70	80	-	dB
Channel Separation	CS	R _g =0Ω	70	80	-	dB

◆ AC CHARACTERISTICS2

(Ta=25°C, V⁺=5.0V, V_{IN}=500mVrms, f=1kHz, BW=20Hz to 20kHz, R_L=8Ω, VOL: 0dB, unless otherwise specified)
Measurement pin: OUTRP-OUTRN (PIN 14-PIN16), OUTLP-OUTLN (PIN 31-PIN29)

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Power Efficiency	E _{EFF}	THD=10%	-	85	-	%
THD+N	THD+N	P _O =1W	-	0.03	-	%
Output Power1	P _O	THD+N=10%, R _L =8Ω	-	1.5	-	W/ch
Output Power2	P _O	THD+N=10%, R _L =4Ω	-	2.7	-	W/ch
Limit Level	V _{LIM}	V _{IN} =0.7Vrms, R _{SENSE} =56kΩ No-load	1.5	2.0	2.5	Vrms
Power Amplifier Gain	A _v	No-load	-	12.0	-	dB
Output Noise Voltage 1	V _{NO1}	R _g =0Ω, A-weighted	-	-80 (100)	-	dBV (μVrms)
Output Noise Voltage 2	V _{NO2}	R _g =0Ω, A-weighted VOL=-68dB	-	-80 (100)	-	dBV (μVrms)

THD+N Measurement Circuit

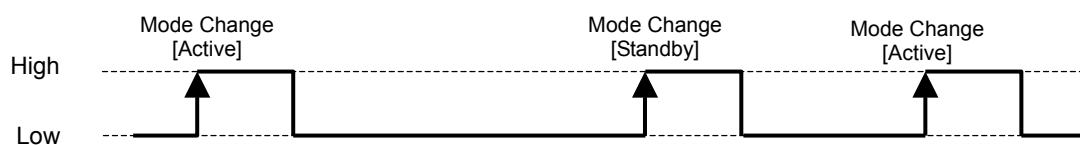


■ PIN DESCRIPTION

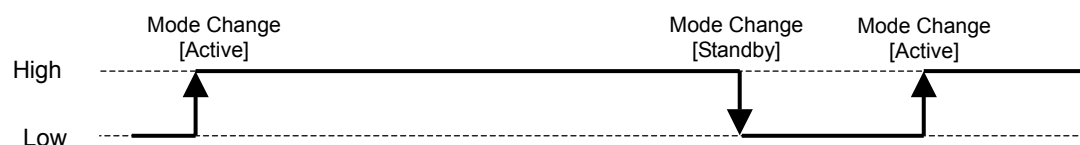
◆ SWMODE (pin 5) and PWSW (pin 19)

SWMODE (pin 5)	PWSW(pin 19)	FUNCTION
L Momentary SW mode setting	L→H	System status is changed to active mode and standby mode alternately.
	H→L	No change.
H Toggle SW mode setting	H	Active mode
	L	Standby Mode.

Momentary SW mode data format



Toggle SW mode data format



◆ ATT (pin 6)

Toggle SW Mode

PIN CONDITION	FUNCTION
L	Attenuator: OFF
H	Attenuator: ON

◆ SELSW (pin 18)

Toggle SW Mode

PIN CONDITION	FUNCTION
L	IN1R, IN1L signals are selected.
H	IN2R, IN2L signals are selected.

◆UP (pin 20)

PIN CONDITION	FUNCTION
OPEN(L)→H	Volume setting is increased 1 step. In the case that "H" signal inputs more than Auto Increment Distinction Time, volume setting is increased continuously.
H→OPEN(L)	No change.

* The "Toggle SW mode" does not support.

◆DOWN (pin 21)

PIN CONDITION	FUNCTION
OPEN(L)→H	Volume setting is decreased 1 step. In the case that "H" signal inputs more than Auto Increment Distinction Time, volume setting is decreased continuously.
H→OPEN(L)	No change.

* The "Toggle SW mode" does not support.

◆TEST (pin 27)

PIN CONDITION	FUNCTION
L	Normal operation mode
H	Test mode. Do not use for normal operation.

◆TEST1 (pin 7)

PIN CONDITION	FUNCTION
L	Normal operation mode
H	Test mode. Do not use for normal operation.

◆VOLADJ (pin 41)

CONNECTED RESISTANCE	FUNCTION
0Ω to 20kΩ	Volume initial value: -12dB
40Ω to 60kΩ	Volume initial value: -16dB
90kΩ to 110kΩ	Volume initial value: -20dB
150kΩ to OPEN	Volume initial value: -24dB

◆ATTADJ (pin 40)

CONNECTED RESISTANCE	FUNCTION
0Ω to 20kΩ	Attenuator initial value: -10dB
40Ω to 60kΩ	Attenuator initial value: -15dB
90kΩ to 110kΩ	Attenuator initial value: -20dB
150kΩ to OPEN	Mute

■CONTROL DATA

◆INITIAL CONDITION (POWER ON)

FUNCTION	TERMINAL	CONDITION
Power	Pin 19	Standby
Volume	Pin 20, Pin 21	-12dB, -16dB, -20dB, -24dB

◆Volume gain step setting

Step No.	Volume [dB]
0	MUTE
1	-68
2	-64
3	-60
4	-56
5	-52
6	-48
7	-45
8	-42
9	-39
10	-36
11	-34
12	-32
13	-30
14	-28
15	-26
16	-24 ^(*)
17	-22
18	-20 ^(*)
19	-18
20	-16 ^(*)
21	-14
22	-12 ^(*)
23	-10
24	-8
25	-6
26	-5
27	-4
28	-3
29	-2
30	-1
31	0

^(*) Initial Setting

■INDICATOR FUNCTION

◆PWIND (pin 26)

CONDITION	PIN VOLTAGE
Class-D Amplifier Standby	L
Class-D Amplifier Active	H

◆VOLIND1 (pin 25)

CONDITION	PIN VOLTAGE
Volume setting is not 0dB	L
Volume setting is 0dB (Max.)	H

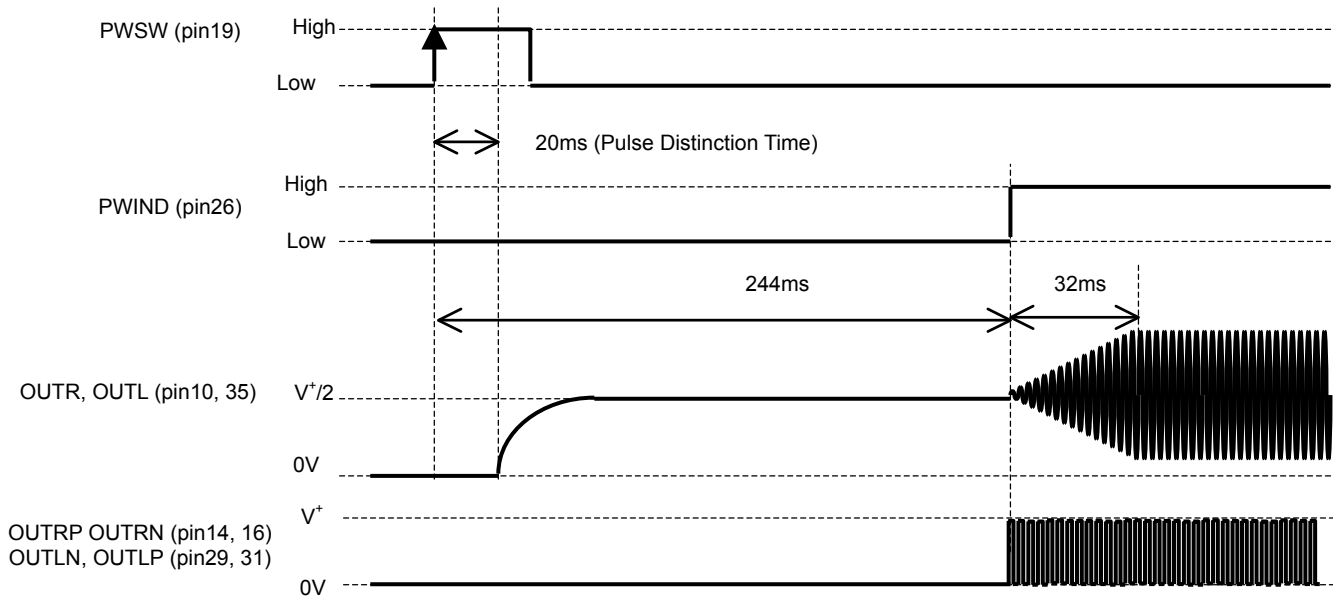
◆VOLIND2 (pin 24)

CONDITION	PIN VOLTAGE
Volume setting is -26dB or lower	L
Volume setting is -24dB or higher	H

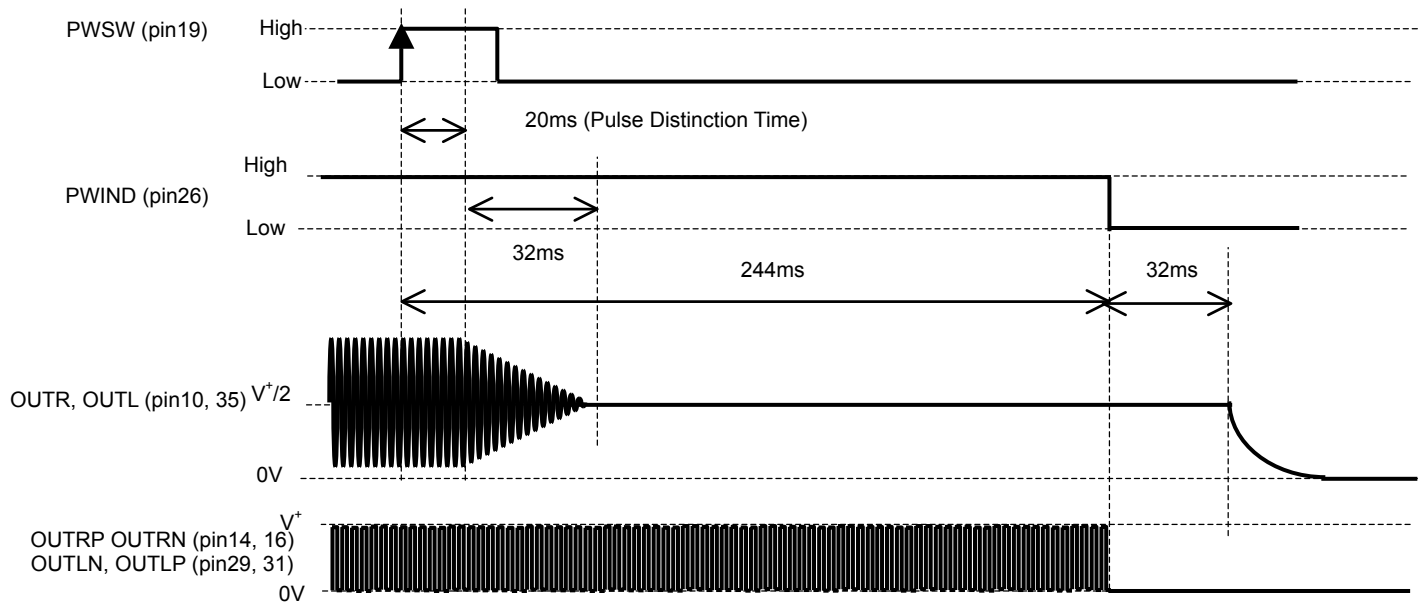
■TIMING CHART

◆PWSW Momentary SW mode

Standby release (Standby mode → Active mode)

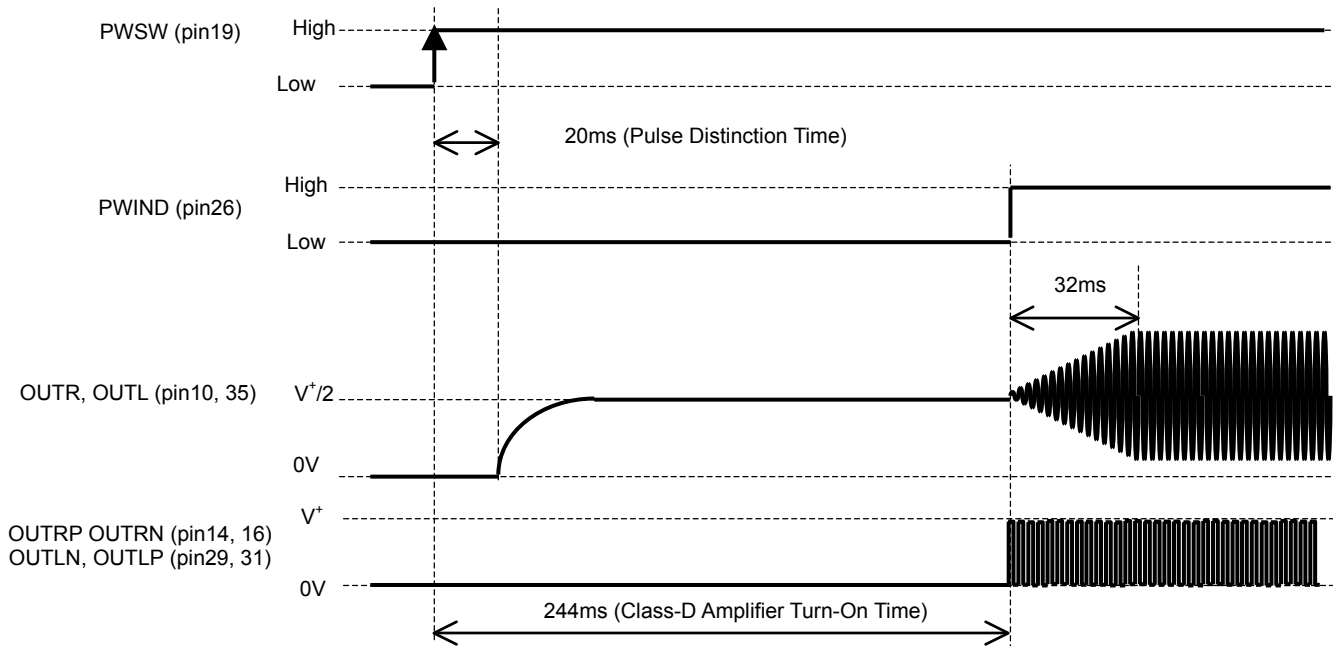


Standby (Active mode → Standby mode)

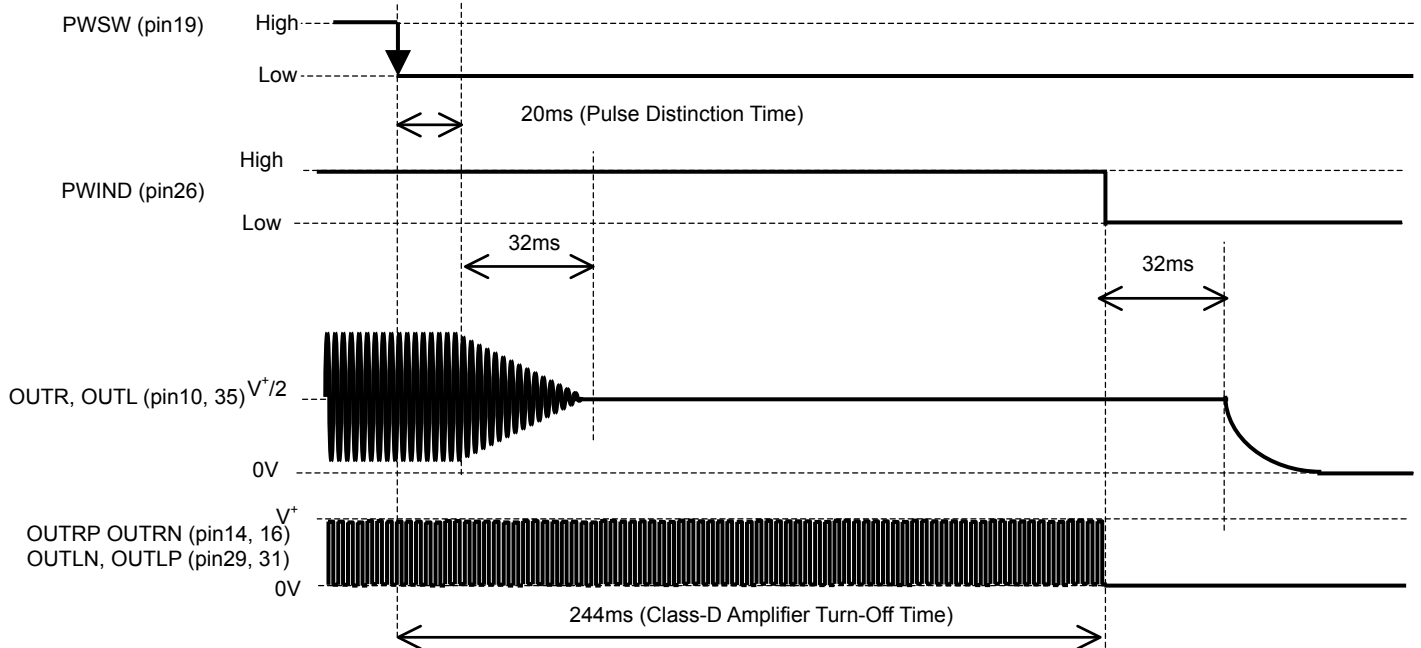


◆PWSW Toggle SW mode

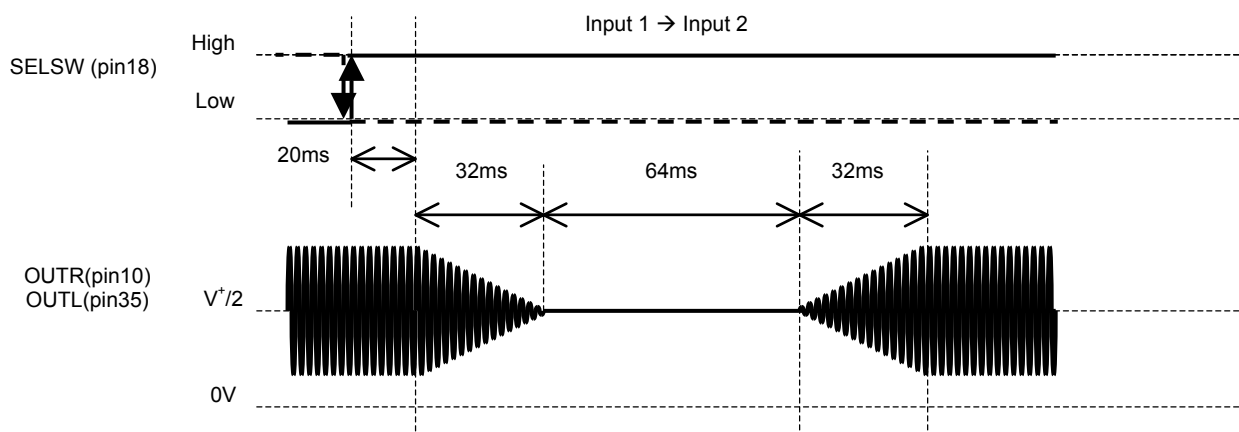
Standby release (Standby mode → Active mode)



Standby (Active mode → Standby mode)



◆Input Selector

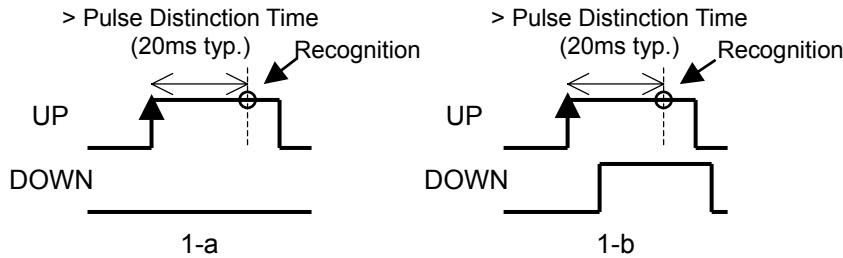


■Volume UP/DOWN control

1. Recognition condition of Volume UP/DOWN push button I/F

1-a.) The Volume UP/(DOWN) recognizes the data-command to the case that the DOWN(UP) button has not been pushed, besides that the UP(DOWN) button is pushed for the longer time than the "Pulse Distinction Time: 20ms".

1-b.) The Volume UP/(DOWN) recognizes the data-command to the case that the UP(DOWN) button has pushed earlier than the DOWN(UP) button, besides the UP(DOWN) button is pushed for the longer time than the "Pulse Distinction Time: 20ms".

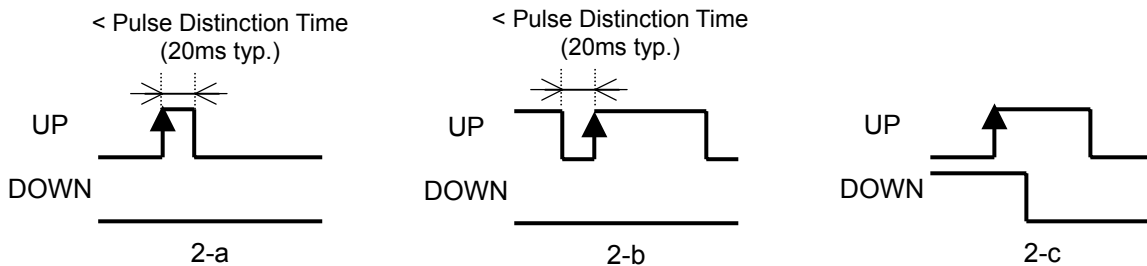


2. Invalidity condition of Volume UP/DOWN push button I/F

2-a.) The Volume UP/(DOWN) **does NOT** recognize the data-command to the case that the UP(DOWN) button has pushed for the shorter time than the "Pulse Distinction Time: 20ms". (The Chattering prevention function operates.)

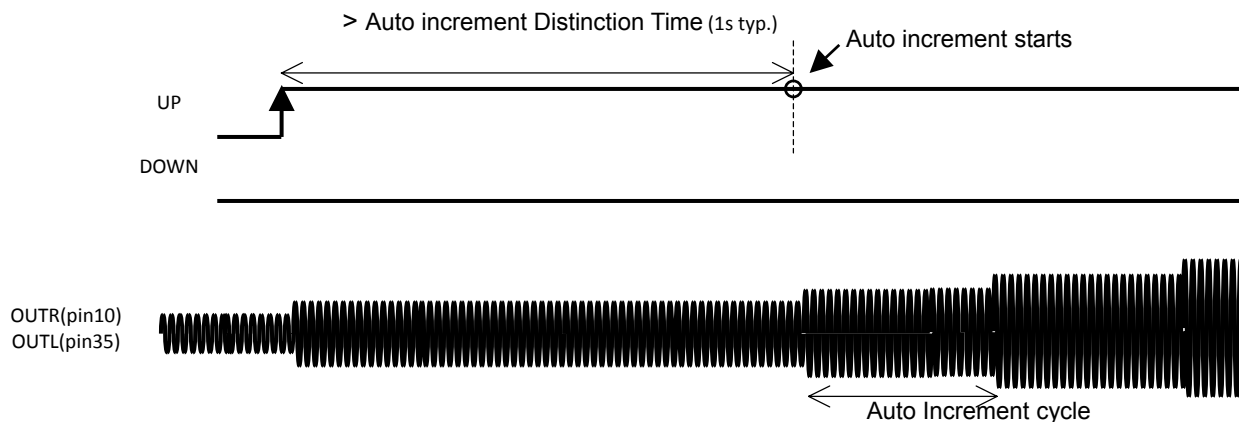
2-b.) The Volume UP/(DOWN) **does NOT** recognize the data-command to the case that the UP(DOWN) button has pushed for the shorter time than the "Pulse Distinction Time: 20ms" after released button. (The Chattering prevention function operates.)

2-c.) The Volume UP/(DOWN) **does NOT** recognize the data-command to the case that the UP(DOWN) button has pushed before releasing DOWN(UP) button.



3. Start condition of Volume UP/DOWN Auto increment function

3-a.) The Auto increment of volume UP(DOWN) is started to the case that the DOWN(UP) button has not been pushed, besides that the UP(DOWN) button is pushed for the longer time than the "Auto increment Distinction Time: 1s".

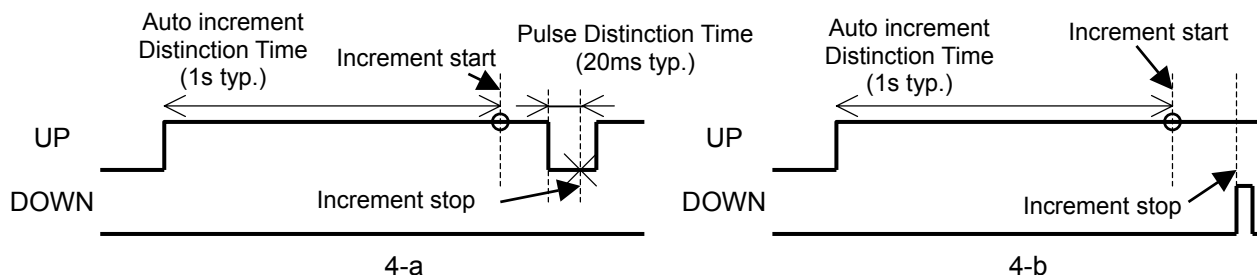


3-a

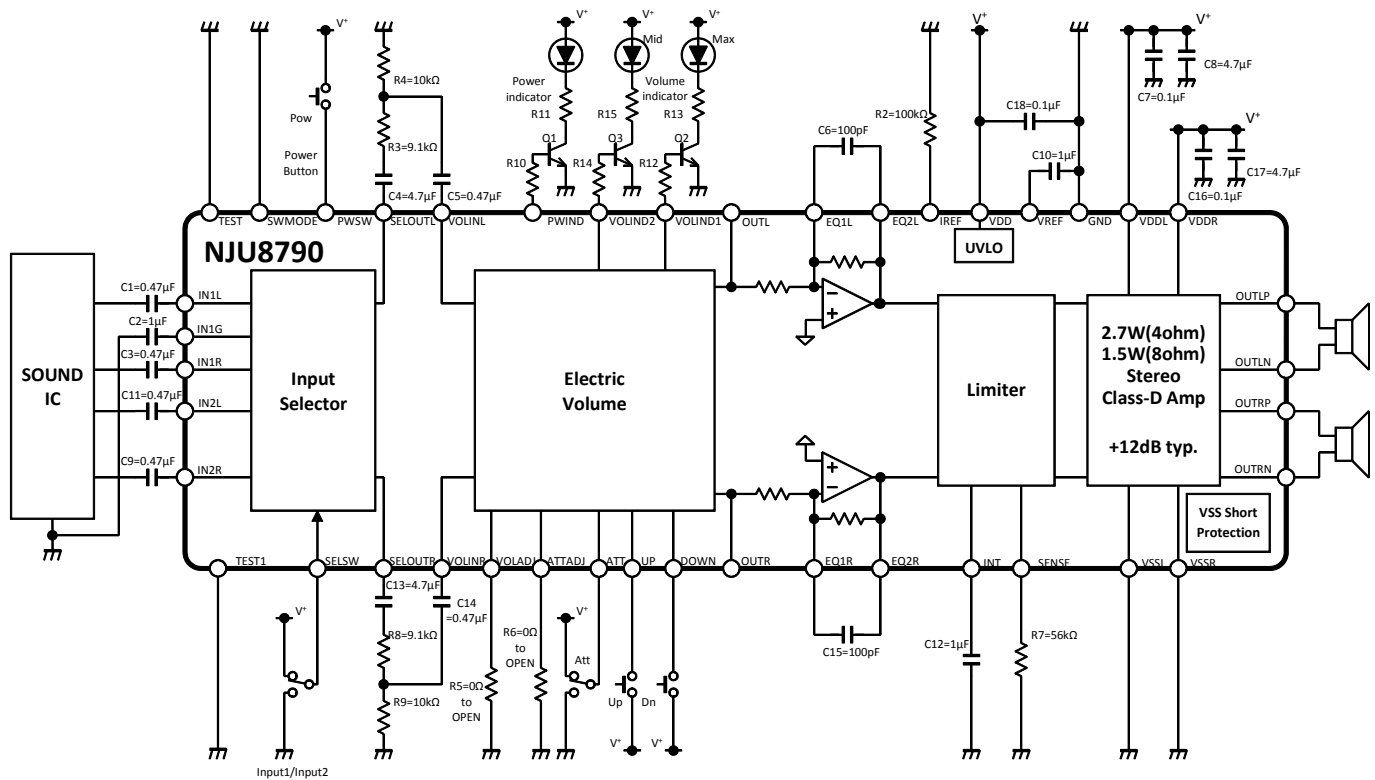
4. Stop condition of Volume UP/DOWN Auto increment function

4-a.) The Auto increment of volume UP(DOWN) is stopped to the case that the UP(DOWN) button has released for the longer time than the "Pulse Distinction Time: 20ms" for the Auto increment period.

4-b.) The Auto increment of volume UP(DOWN) is stopped to the case that the DOWN(UP) button has pushed for the Auto increment period.



APPLICATION CIRCUIT



[CAUTION]

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