

I2S Amplifier

An NS4168 that takes I2S samples from an ESP32 and drives a 4 or 8 Ω speaker directly.



Speaker only, and neither wire is ground

Both speaker wires switch. **Never join either to GND, to headphones or to another amplifier's input.** Power it from 3V3 as printed: at 5 V the chip wants 3.5 V for a logic HIGH, more than an ESP32 pin gives.

Pins, and which to wire

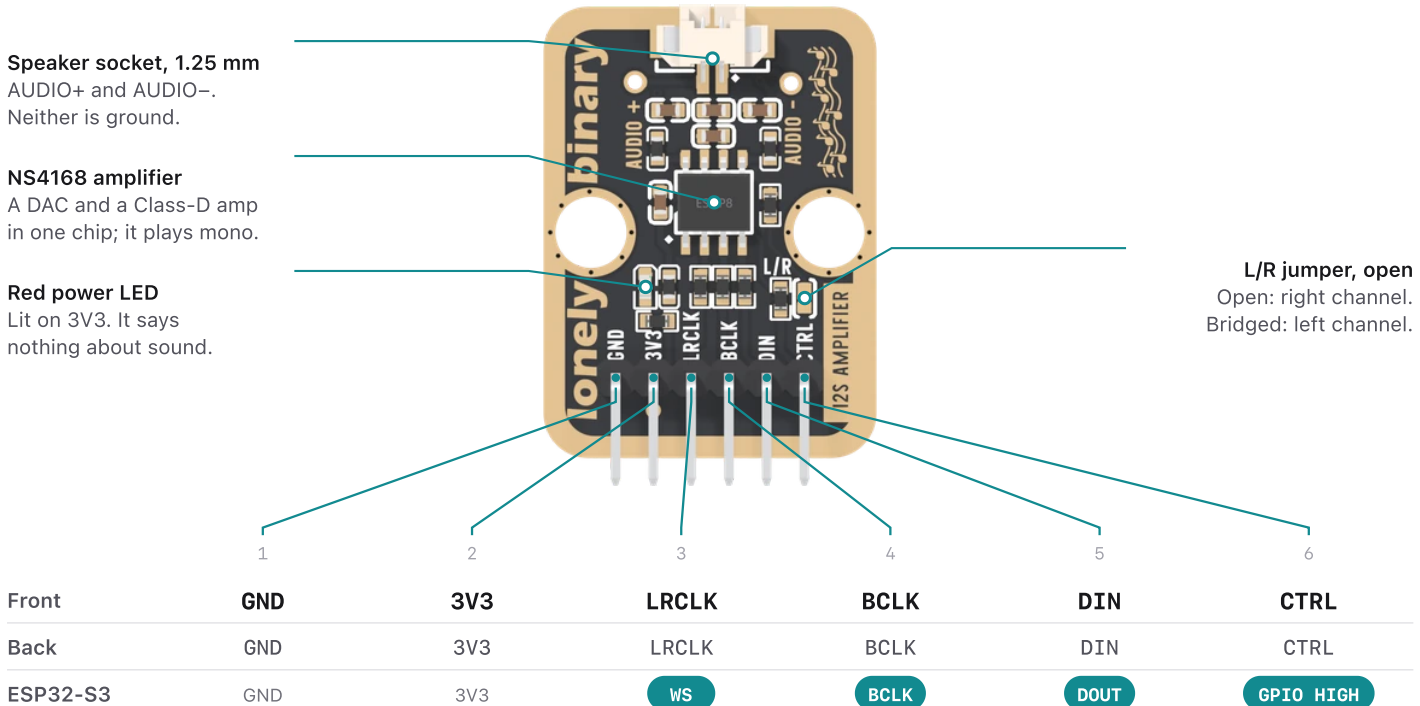
Drawn from above, speaker socket at the top. BCLK, LRCLK and DIN come from the ESP32, which makes every clock. CTRL switches the chip on and chooses which channel of the stereo stream it plays.

Speaker socket, 1.25 mm
AUDIO+ and AUDIO−.
Neither is ground.

NS4168 amplifier
A DAC and a Class-D amp
in one chip; it plays mono.

Red power LED
Lit on 3V3. It says
nothing about sound.

L/R jumper, open
Open: right channel.
Bridged: left channel.



CTRL must be driven HIGH

The chip is off below 0.4 V on CTRL. Left unconnected, CTRL floats or is pulled down, so the board lights up and stays silent. Wire CTRL to a GPIO and set it HIGH before you play; LOW turns the amplifier off again.

CTRL, and what the chip does

CTRL HIGH, jumper open

3.30 V on the
chip's CTRL

1.5 V to VDD: plays the **right** channel. As shipped.

CTRL HIGH, jumper bridged

1.03 V on the
chip's CTRL

0.9 to 1.15 V: plays the **left** channel.

CTRL LOW or unconnected

0 V on the
chip's CTRL

0 to 0.4 V: off, about 1 μ A.

The sketches put the same sample in both channels, so either setting plays them. A stereo file on one TK100 plays one side only; two TK100s on the same three wires, one bridged, make a stereo pair.

The chip's CTRL bands are Nsiway's (NS4168 V1.2, section 10.2.4). 1.03 V is 3.3 V across the board's 22 k Ω and 10 k Ω , worked out, not measured. Output about 1.2 W into 4 Ω at 3.6 V by the same datasheet. Sketch compiled for the ESP32-S3 with esp32 core 3.3.10.

First sound: seven notes

Arduino IDE · Board: ESP32S3 Dev Module · USB CDC On Boot: Enabled · No libraries

```
#include <ESP_I2S.h>

const int PIN_BCLK = 15, PIN_LRCLK = 16;
const int PIN_DIN = 17, PIN_AMP_ON = 18;
const int RATE = 16000;
I2SClass i2s;

void playNote(float hz, int ms) {
    int16_t frame[2];
    float phase = 0, step = 2 * PI * hz / RATE;
    for (int i = 0; i < RATE * ms / 1000; i++) {
        frame[0] = frame[1] = (int16_t)(6000 * sinf(phase));
        i2s.write((uint8_t *)frame, sizeof(frame));
        phase += step;
        if (phase > 2 * PI) phase -= 2 * PI;
    }
}

void setup() {
    Serial.begin(115200);
    pinMode(PIN_AMP_ON, OUTPUT);
    digitalWrite(PIN_AMP_ON, HIGH); // wake the amplifier
    i2s.setPins(PIN_BCLK, PIN_LRCLK, PIN_DIN);
    i2s.begin(I2S_MODE_STD, RATE, I2S_DATA_BIT_WIDTH_16BIT,
             I2S_SLOT_MODE_STEREO);
}

void loop() {
    const float notes[] = {261.63, 293.66, 329.63, 349.23,
                           392.00, 440.00, 493.88};

    for (float hz : notes) {
        Serial.println(hz);
        playNote(hz, 400);
        playNote(0, 100);
    }
    delay(1000);
}
```

261.63
293.66
329.63

The Serial Monitor at 115200, one line per note, while the speaker plays the scale.

Loud, and what limits it

About 1.2 W into 4 Ω at 3.6 V, by the datasheet, and somewhat less at 3.3 V. When the output would clip, the chip turns its own gain down and lets it back up over about a second, so loud passages sound compressed rather than distorted. The datasheet suggests about 100 μF on the supply; the board carries small ceramics, so a bulk capacitor between 3V3 and GND helps if loud passages crackle.

When it does not work

The LED is on and there is no sound

CTRL is not HIGH. Wire it to a GPIO and set it HIGH before playing.

A stereo file plays only one part

The chip plays one channel: right as shipped. Mix to mono, or bridge L/R for left.

Hum or hiss from the speaker

Check GND to the ESP32, keep the I2S wires short, and keep them away from the speaker wires.

Specifications

Chip	NS4168 (Nsiway), I2S Class-D, mono	Supply	3.3 V, as printed
Output	About 1.2 W into 4 Ω at 3.6 V	Speaker	4 or 8 Ω, 1.25 mm socket
CTRL	HIGH plays; LOW or open is off	Channel	Right; left with L/R bridged
Sample rate	8 to 96 kHz	Board	22.4 × 30.4 mm, header fitted

Wiring

	FRONT	ESP32-S3
1	GND	GND
2	3V3	3V3
3	LRCLK	GPIO 16
4	BCLK	GPIO 15
5	DIN	GPIO 17
6	CTRL	GPIO 18

The I2S pins go through the ESP32-S3's GPIO matrix, so any free GPIO works; avoid 0, 3, 45 and 46, and 19 and 20 (USB). Do not name a constant PIN_CTRL: the ESP32-S3 core already defines it, and the sketch will not compile.