# OPA861 Fully Balanced Zero Feedback I/V Stage

By IanCanada Nov.10, 2022 Ver. 1.0

## A. Introduction

OPA861 is a very special operational transconductance amplifier. It has super-high slew rate up to 900V/us over a wide bandwidth extended to 80MHz. The OPA861's performance is pretty much like a super transistor. In current input voltage output mode with zero feedback, the input impedance can be less than 10 ohms. This very low input impedance (closed to short circuit) and the ultra-high speed make it almost the perfect solution of an I/V converter. Actually, OPA861 was confirmed very successful as the SE I/V stage for TDA1541 DAC.

This is the first OPA861 I/V stage running in fully balanced mode. Different from all other active OP amplifier I/V stages, OPA861 I/V is more closed to passive I/V stages such as a resistor I/V or Transformer I/V but with much better dynamic performance.
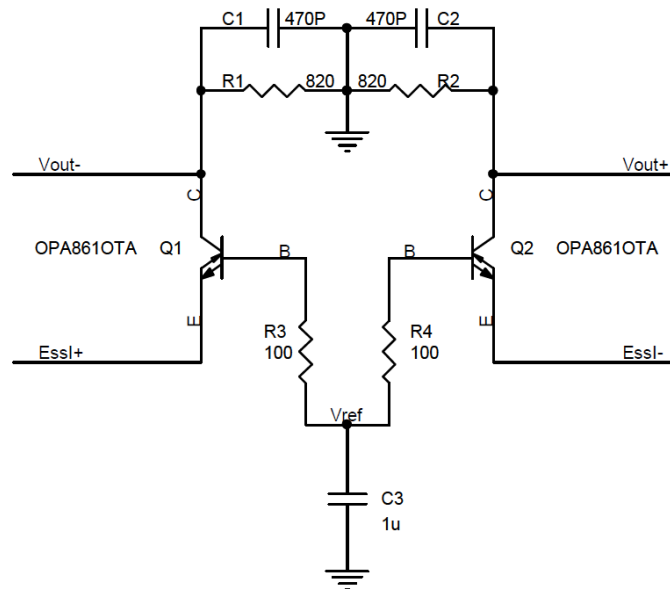
FULLY BALANCED OPA861 I/V STAGE

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The sound style is also totally different from a traditional I/V stage. According to my own listing test, it brings the best clarity so far I have experienced. The sound is very detail and at the same time is also very rich. The soundstage is widely open and focused. The music is vivid and dynamic. It doesn't color the music but just makes it more close to the original. I cannot say it is the perfect I/V stage, but I have to say it's the most impressive one.

This OPA861 would be a great option for the high-performance current mode DACs in balanced configuration such as the ESS9038 Q2M Dual mono, the ES9028Q2M, and ES9038Pro, AK4499, PCM1704, TDA1541 and so on.

## B. Features and specifications

- Zero feedback

- OPA861 transconductance amplifiers work in two channels fully balanced configuration

- True current input mode with impedance less than10 ohms

- 80Mhz high bandwidth and 900V/us slew rate. This ultra-high speed performance would be great for an ESS DAC running by high frequency MCLK from 20MHz to 100MHz.

- Power supply: External +-5V power supplies

- Balanced output levels: 4VRMS @ 0dB

- Current input DC offset voltage: 1.65V

- High precision low noise thin film metal resistors

- Connection-compatible with Ian's ES9038Q3MPi dual mono and ES9028Q2MPi DAC HATS

## C. Layout and Dimensions (in mm)
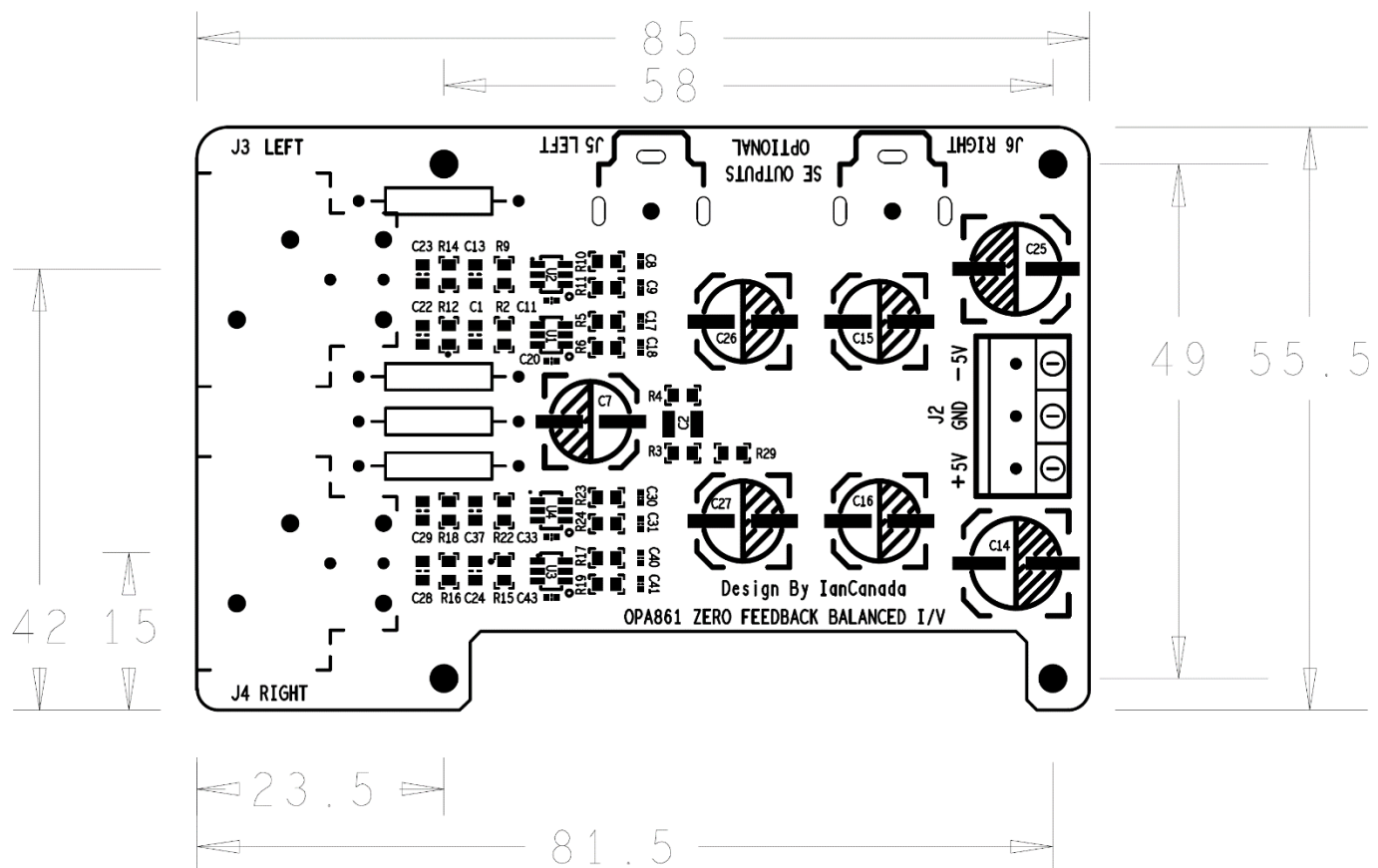
## D. Quick-Start Guide

1. Connect the OPA861 I/Von top of a ES9028Q2M or a ES9038Q2M Dual Mono DAC HAT. Be sure connector J1 is properly seated. Please install 13mm standoffs in between.

2. Connect a dual rail +-5V power supply to power terminal block J2. Linear power supply is preferred. MAINTAIN CORRECT POLARITY!!!

3. Connect the XLR cable to your amplifier or preamplifier to J3 / J4 Balanced outputs. Please don't reverse the left and right channels. You can also use J5 / J6 single-ended RCA outputs for function test. The SE output is just for a functional test. To get the best sound quality, please use the balanced outputs.

4. Apply power to your Raspberry Pi audio system as usual, as well as the OPA861 I/V. If it is possible, we recommend you apply power to your amplifier after all upstream gear has powered up and stabilized.

5. Enjoy the music.

## E. Connectors

**J2: DC power input**
Connect a dual rail +-5V DC supply with 50mA or higher rated current to this 3-pin 5.0mm terminal, MAINTAINING CORRECT POLARITY!!!. Use a good, low noise linear power supply for the best results. LinearPi Dual in 5V configuration is recommended for this OPA861 I/V stage. Ultracapacitor power supplies would be even great as an upgrade.

**J3 (Life), J4(Right): Balanced output XLR connectors**
Your OPA861 I/V is supplied with these connectors installed. Connect your left channel XLR cable to J3, right channel to J4. 0dB output level will be approximately 4V RMS. DC offsets will be 0V during normal operating.

**J5, J6: Single-ended output RCA sockets**
Connect your left channel cable to J5, right channel to J6. 0dB output level will be approximately 2V RMS. J5 / J6 single-ended RCA outputs are designed for functional test. J5/J6 is not recommended for serious listening

**J1 I/V input connector**

When you connect your OPA861 I/Von top of a ES9038Q3MPi or ES9028Q2MPi RaspberryPi DAC HAT (or compatible DAC HAT), ensure this 10PIN 2.54 connector is properly seated to the matching raw balanced output on the DAC HAT.

| PIN number | Descriptions |
|---|---|
| 1 | NC |
| 2 | NC |
| 3 | L+, Left positive current-mode signal input |
| 4 | L-, Left negative current-mode input signal input |
| 5 | GND |
| 6 | GND |
| 7 | R+, Right positive current-mode signal input |
| 8 | R-, Right negative current-mode signal input |
| 9 | 3.3V ACVV for ESS DAC HAT |
| 10 | NC |

## F. How to produce the best sound quality when using the OPA861 I/V

Two things are very significant to the sound quality of this OPA861 I/V stage: Power supply and the I/V resistors.

### 1. Use better power supply

The +-5V power supply has a big impact on the sound quality of this OPA861 I/V stage. Low-noise high-performance linear power supplies are always preferred. I recommend the LinearPi Dual at 5V configuration as power supply of this OPA861 I/V board. You can also upgrade them with two UcConditioner 5V for even more improvements. This configuration has confirmed producing very good sound quality.

Two UcPure 5V ultracapacitor power supplies would be the greatest option so far but could be at a much higher overall cost.

### 2. I/V resistors

The I/V resistors are very important to the sound style especially to the clarity and sound styles. Have to use high accuracy, low noise, metal film resistors. By default, four of 680 ohms Vishay/Dale CMF55 series resistors are used for OPA861 board as the I/V resistors. The CMF55 series is carefully selected as so far the best I/V resistors available for production.

Upgrading to better I/V resistors is possible to improve sound quality more or change the sound style. However, I wouldn't suggest to make the change unless you have very high-quality resistors really better than the default CMF55 series

## G. Pictures

1. OPA861 balanced I/V stage board as shipped



2. I/V board installation with RaspberryPi, ESS DAC HAT and ESS controller