

OPA861

Output Stage for AYA II DAC

Extract of AYA II Assembly Manual

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IMPORTANT PRECAUTION

This document is a guide only. Building should be attempted only by skilled and competent persons. No liability is assumed by Audial d.o.o.

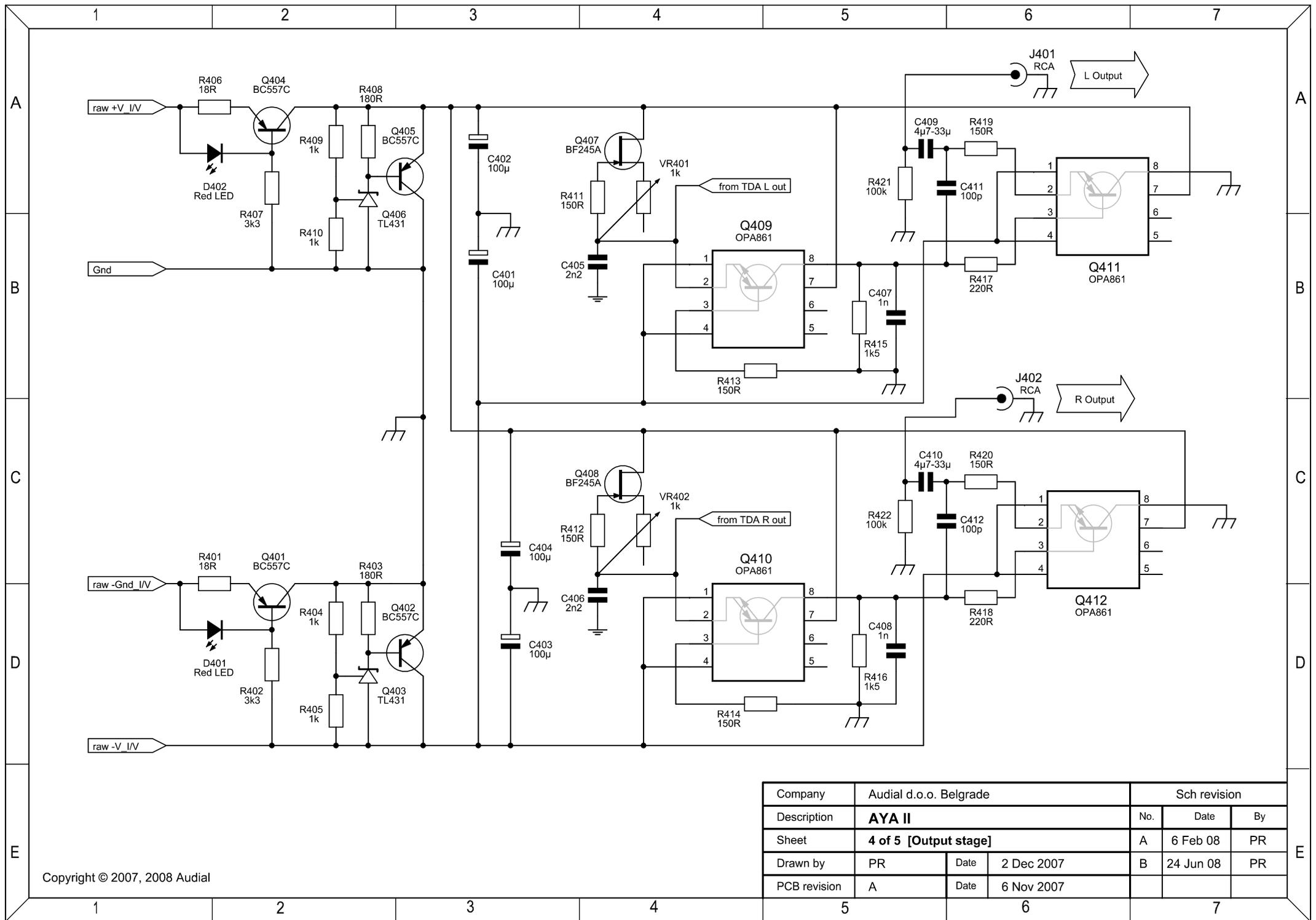
The AYA II is the first DAC that employs zero feedback I/V converter based on the OPA861 chip, colloquially named a transconductance *opamp*. (But we won't talk "opamp" unless feedback is employed, and here it is not.) Its use however is probably not that unexpected, since previous AYA, and two previous Pedja Rogic's TDA1541A DIY DAC projects as well, have been employing AD844 the same way, and the same topology built around now obsolete MAX436 has been published.

As seen from the outside, OPA861 operates like a "super-transistor", and consequently has the base input, emitter input/output and collector output. In this case OPA861 is used like a transimpedance (common base) stage, which means that its emitter is the input and its collector is the output. Emitter is low impedance point (impedance is equal to $1/G_m$ i.e. it is 10 Ohm @ $I_q=7$ mA), so the output current of TDA1541A flows into and modulates the quiescent current of this "emitter", which is the first array of OPA861 current mirror. Additionally, the offset of TDA1541A output current, which is a 0/-4 mA current sink, is nullified by 2 mA JFET current source, where the exact offset is set by VR401/VR402. BF245A is recommended for its availability; also, its zero tempco point is relatively close to 2 mA so it won't contribute much to the overall thermal drift. As a result, OPA861 emitter current is modulated by +/-2 mA so it is not exposed to the excessive offset, and hence it works in the most linear range. This is important because there is no feedback to manage overall linearity. The same current is then mirrored to the OPA861 "collector", which is a high impedance node. At this point I/V resistor is low impedance path to the ground, so this current flows through this resistor, developing voltage which is the product of this current and the value of this resistor. So, with 4 mA peak-to-peak output current, typical CD/DAC output voltage of 2 V is achieved by 1k5 resistors ($4 \text{ mA} \times 1k5 \text{ R} = 6 \text{ V}$ peak-to-peak i.e. about 2.1 V RMS).

Another OPA861 is used like a voltage buffer, so its base is the input and its emitter is the output. Output series resistors 150 Ohm are used mostly to protect OPA861 from short, because OPA861 don't have internal protection. The output impedance of the AYA II is hence the sum of OPA861 emitter impedance and this resistor. If there is a requirement for lower output impedance, the value of this resistor can be lower, but please note that the coupling capacitors also raise the impedance at low frequencies. To alleviate this issue, a higher value caps should be used. Also, due to use of offset nullifying circuit there is not any significant output offset (all the actual offset is about the thermal drift), so these caps can be omitted too, of course taking into account possible risks. If these caps are omitted, it is wise to null the offset not across the I/V resistors but according to the outputs of the Q411/Q412 (the grounds of the I/V resistors remain 0 V reference). Capacitors C411/C412, along the output resistors and R417/R418 should keep the output buffer stable on any reasonable load.

Please note that in this application there is no replacement part for OPA861.

This circuit includes two identical 5 VDC shunt regulators, used at both positive and negative rail. Hence it must be supplied by two floating 10 VDC voltages.



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Company	Audial d.o.o. Belgrade			Sch revision		
Description	AYA II			No.	Date	By
Sheet	4 of 5 [Output stage]			A	6 Feb 08	PR
Drawn by	PR	Date	2 Dec 2007	B	24 Jun 08	PR
PCB revision	A	Date	6 Nov 2007			

HARMONIC DISTORTION @ 1kHz

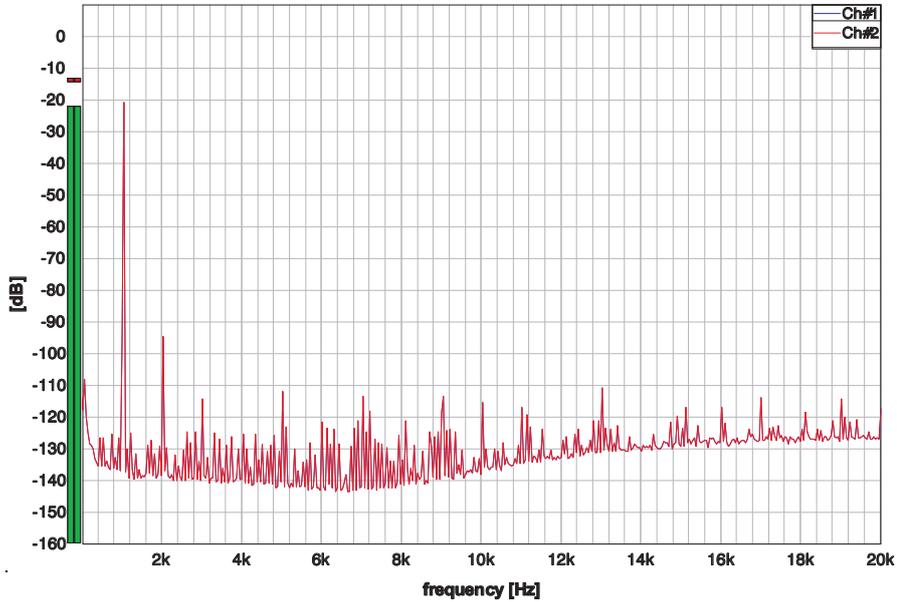


Figure 1:
FFT analysis of dithered sine wave 1kHz @ -20dBFS
THD = 0.02%

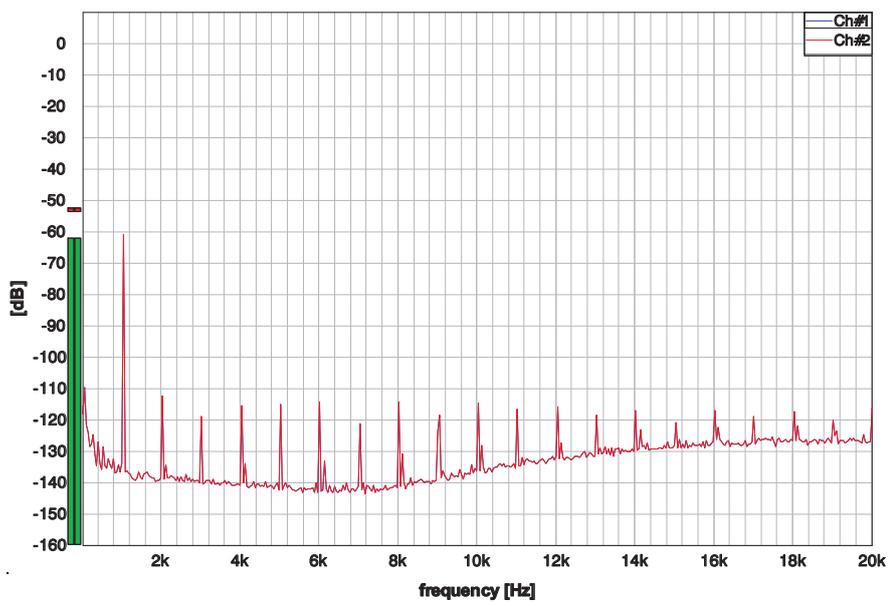


Figure 2:
FFT analysis of dithered sine wave 1kHz @ -60dBFS
THD = 0.72% (dominated by TDA1541A)

