AN4576
Application note

STEVAL-CCA057V4 evaluation board user guidelines for dual operational amplifiers in an DFN8 with exposed pad package

Introduction

The STEVAL-CCA057V4 evaluation board from STMicroelectronics is designed to help customers quickly prototype new dual op amp circuits in an DFN8 with exposed pad package and reduce design time.

The evaluation board can be used with almost any STMicroelectronics dual op amp in various configurations and applications. The evaluation board is a bare board (that is, there are no components or amplifier soldered to the board; these must be ordered separately).

This document provides:

- A description of the evaluation board
- A layout of the top and bottom layers

Some examples of classic configurations that can be tested with the board.

Figure 1. DFN8 (2 x 2) pinout

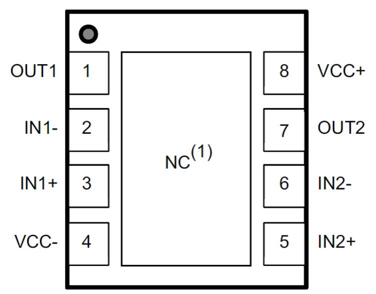
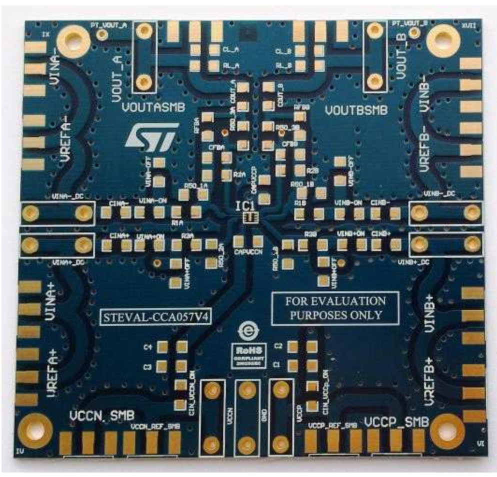


Figure 2. STEVAL-CCA057V4 evaluation board



Contents

1 Description

This board is designed with versatility in mind, and allows many circuits to be constructed easily and quickly.

A few possible circuits are as follows:

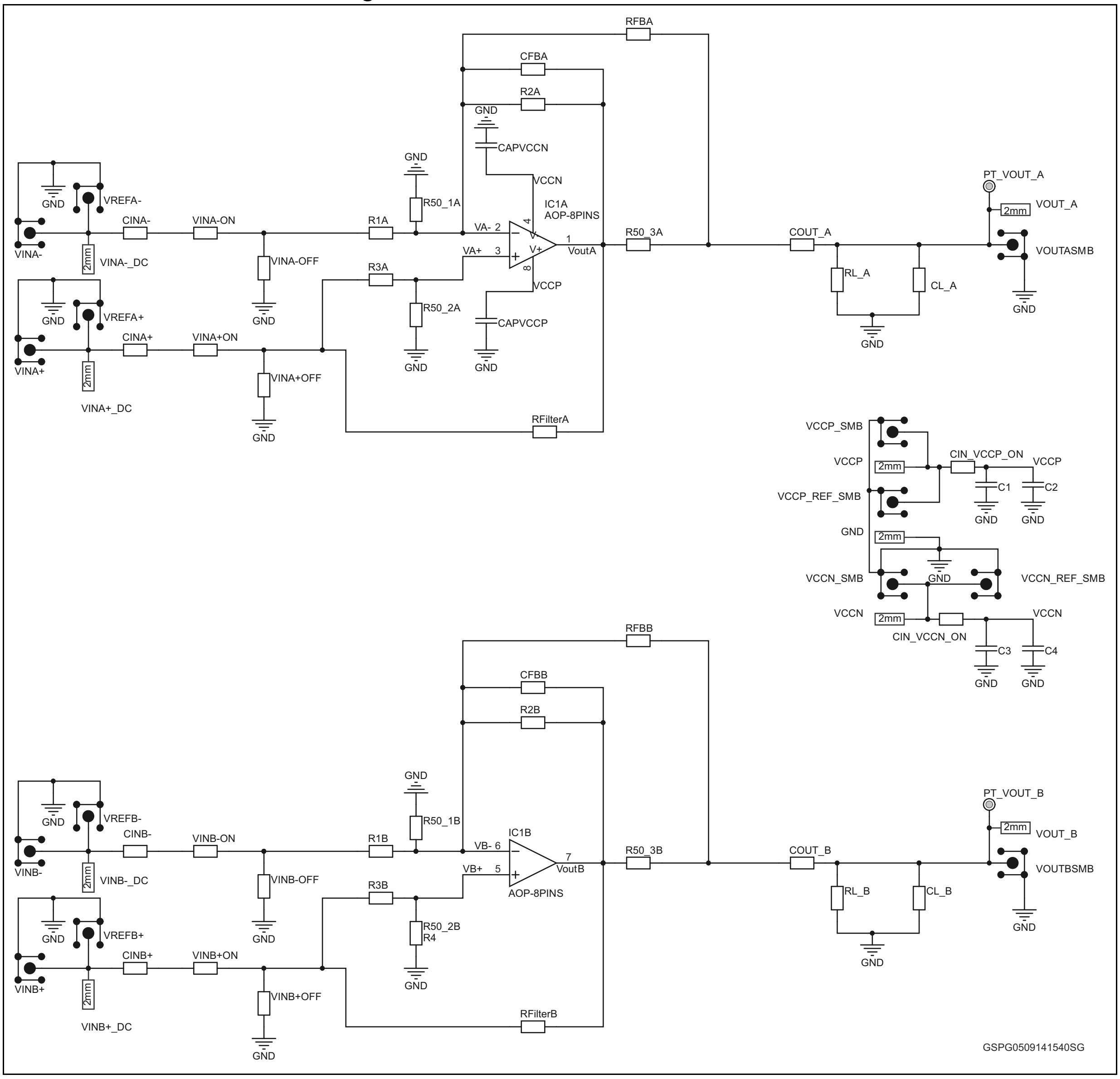
- Voltage follower
- Non-inverting amplifier
- Inverting amplifier
- Sallen-key filter
- Instrument amplifier
- AC-coupled circuit
- Out-of-loop compensation circuit

Circuit

The circuit schematic in *Figure 3* shows the connections for all possible components. Each configuration uses only some of the components.

The board is designed for surface-mounted components and can be used to perform on-board characterization prior to the integration of STMicroelectronics products in your designs. Resistor and capacitor footprints are implemented for the 1206 series.

Figure 3. Evaluation board schematics



Power requirements

A 0 Ω resistance must be connecting on CIN_VCCN_ON and CIN_VCCP_ON in order to supply power to the dual amplifier.

A set of two decoupling capacitors (C1, C2 and C3, C4) have been implemented on both power supply pins, so as to benefit from the maximum performance of ST products. In order to reject low frequencies, 1 µF and 10 µF are good values for these.

Others decoupling capacitors (CAPVCCN, CAPVCCP) as close as possible to the DFN8 with exposed pad package, might also be used to obtain excellent power supply decoupling. 100 pF values can be used in order to reject high frequencies.

When using single-supply circuits, the negative supply is shorted to ground by bridging C3 or C4 capacitances. Power is therefore between VCCP and GND.

Output options

The outputs have additional resistor (RL_A, RL_B) and capacitor (CL_A, CL_B) placements for loading. Or it might be used as an anti-alias filter, or to limit amplifier output noise by reducing its output bandwidth.

Note: Operational amplifiers are sensitive to output capacitance and may oscillate. In the event of oscillation, reduce output capacitance by using shorter cables, or add a resistor in series on COUT_A, COUT_B placement with a suitable value in order to improve amplifier phase margin.

Measurement tips

In the datasheet, some measurements, such as settling time and peaking, have been performed with 50 Ω output equipment. In order to keep the integrity of the square input signal, the input tracks from VINA+, VINB+, VINA-, VINB+, have an impedance of 50 Ω.

And in order to adapt input impedance, 50 Ω resistances can be added on the R50_1A, R50_2A and R50_1B, R50_2B.

2 Layout

The board has the following physical characteristics:

– Board dimensions: 3526 x 3300 mils (89.6 x 83.8 mm)
– 2-layer PCB
– Both sides have a ground plane.

For Vout_A, Vout_B, VinA+, VinA-, VinB+ and VinB- female SMB or female 2 mm connectors can be implanted. You can also implant test points on these voltages. They will facilitate the visualization of your signals.

Top and bottom layers are shown on *Figure 4* and *Figure 5*:

Figure 4. Top layer

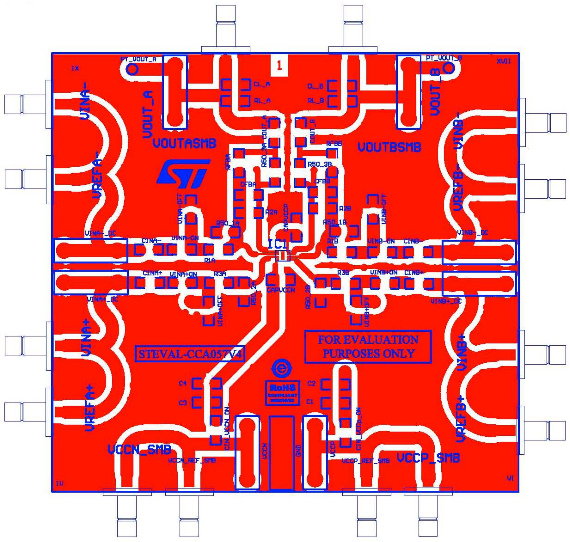
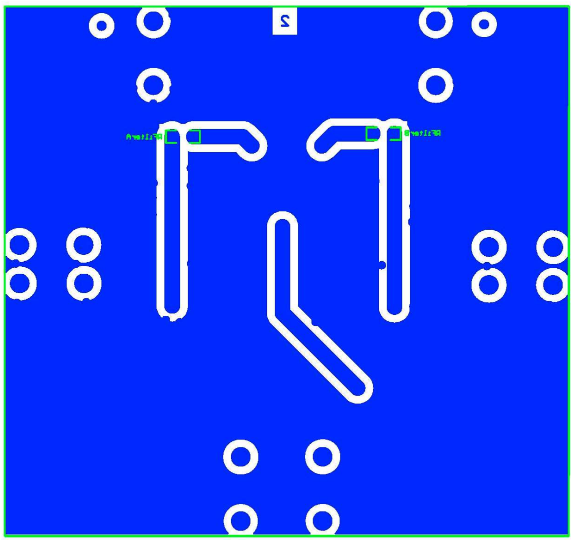


Figure 5. Bottom layer



3 Different possible configurations

The following provides some instructions on how to set up the board in order to perform several classical configurations.

- *Figure 6*: Low-pass Sallen-key filter order 4
- *Figure 7*: High-pass Sallen-key filter order 4
- *Figure 8*: Instrumentation amplifier
- *Figure 9*: Transimpedance configuration
- *Figure 10*: AC coupled configuration

You can also put several boards in cascade which allows you to obtain a more complex configurations.

3.1 Low-pass Sallen-key configuration

The following low-pass Sallen-key configuration is a fourth order filter configuration. This circuit has 80 dB roll-off per decade.

The transfer function is:

Equation 1

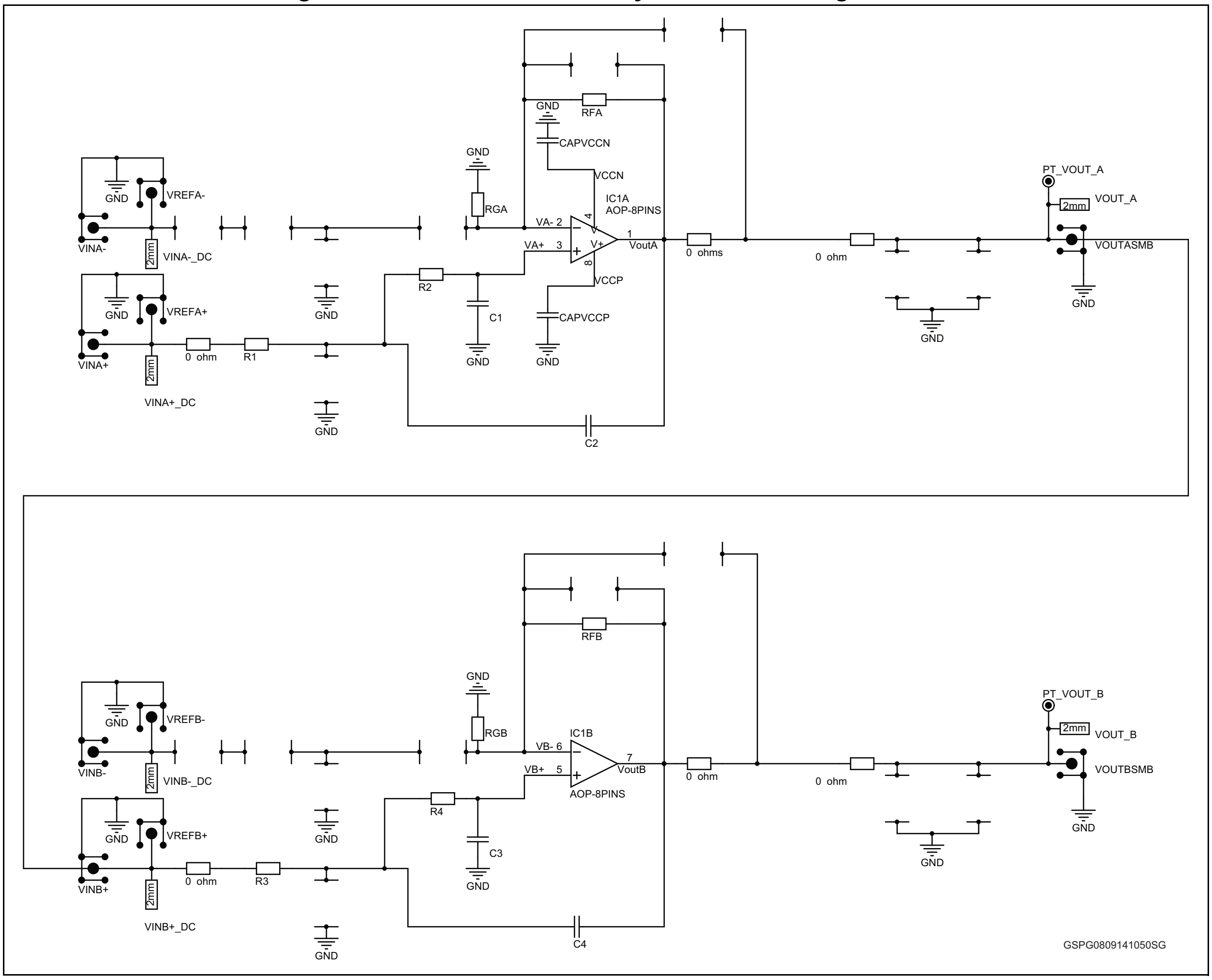
$$\frac{Vout}{Vin} = \frac{1+\frac{RFA}{RGA}}{1+\left(R1.C2\left(1-\frac{RFA}{RGA}\right)+C1(R1+R2)\right)j\omega+R1.R2.C1.C2(j\omega)^2} * \frac{1+\frac{RFB}{RGB}}{1+\left(R3.C4\left(1-\frac{RFB}{RGB}\right)+C3(R3+R4)\right)j\omega+R3.R4.C3.C4(j\omega)^2}$$

The low frequency gain is:

Equation 2

$$G = \left(1+\frac{RFA}{RGA}\right) * \left(1+\frac{RFB}{RGB}\right)$$

Figure 6. Low-Pass Sallen-key 4th order configuration



3.2 High-pass Sallen-key configuration

Like the low-pass Sallen-key configuration above, this one is also a fourth order. It has a slope of +80 dB per decade.

The transfer function is:

Equation 3

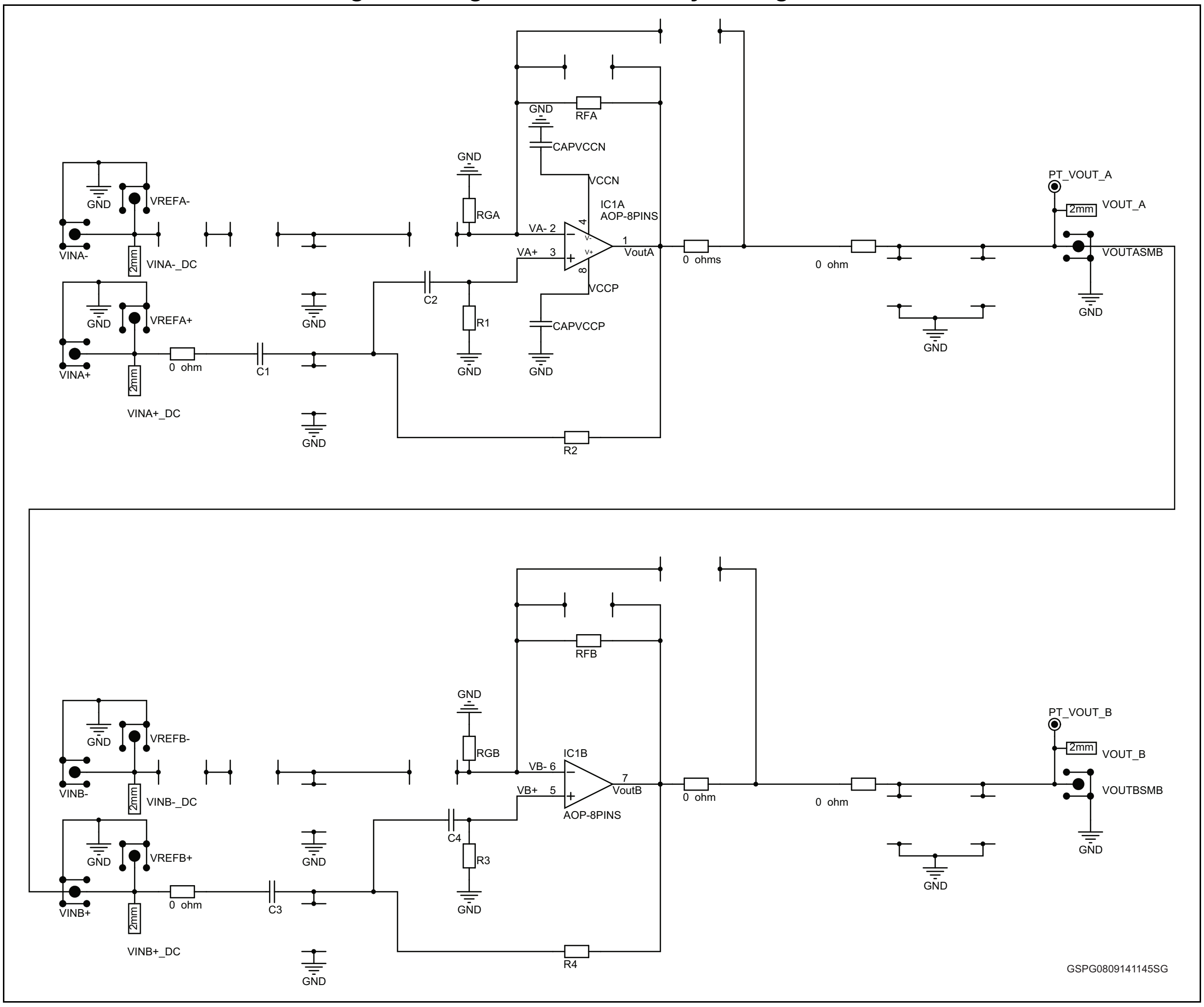
$$\frac{Vout}{Vin} = \frac{\left(1+\frac{RFA}{RGA}\right).R1.R2.C1.C2.(j\omega)^2}{1+\left(R2(C1+C2)-R1.C2.\frac{RFA}{RGA}\right)j\omega+R1.R2.C1.C2(j\omega)^2} * \frac{\left(1+\frac{RFB}{RGB}\right).R3.R4.C3.C4.(j\omega)^2}{1+\left(R4(C3+C4)-R3.C4.\frac{RFB}{RGB}\right)j\omega+R3.R4.C3.C4(j\omega)^2}$$

The high frequency gain is:

Equation 4

$$G = \left(1+\frac{RFA}{RGA}\right) * \left(1+\frac{RFB}{RGB}\right)$$

Figure 7. High-Pass Sallen-key configuration



The upper limit of the frequency range is determined by the GBP of the op amp $(F \ll \frac{GBP}{1+\frac{RF}{RG}})$

3.3 Instrumentation amplifier

The instrumentation amplifiers are generally used for precise measurement in a differential way.

The architecture of the instrumentation amplifier with dual op amps is the simplest one. The input impedance is high as the non-inverting of the both op amps are used as input.

By considering R1.R2 = RFA.RFB

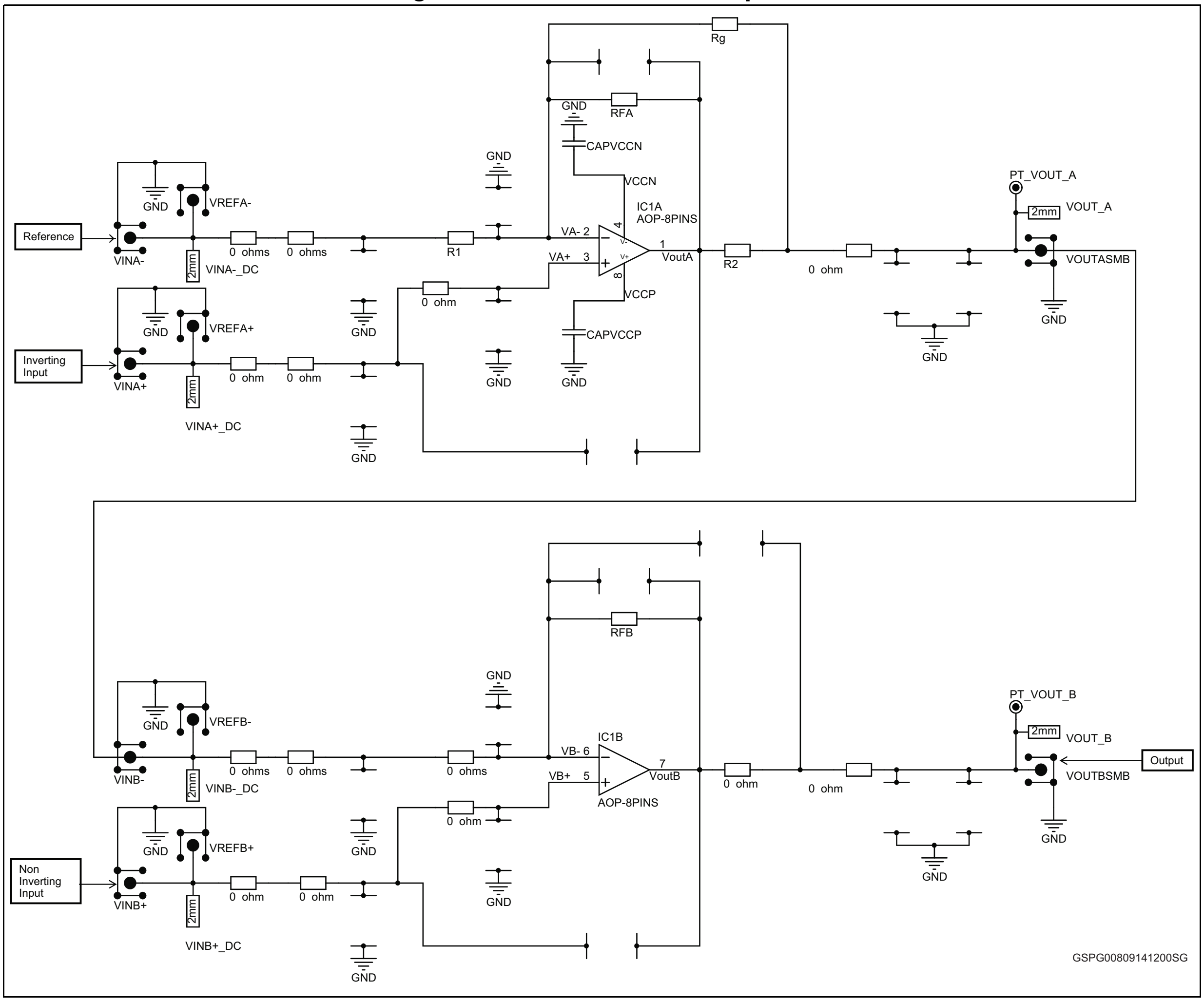
And Vout = Vreference for Vdiff = 0 V

The gain can be expressed as follows:

Equation 5

$$G = 1 + \frac{RFB}{Rg} + \frac{R1}{Rg} + \frac{R1}{RFA}$$

Figure 8. Instrumentation amplifier



3.4 Transimpedance configuration

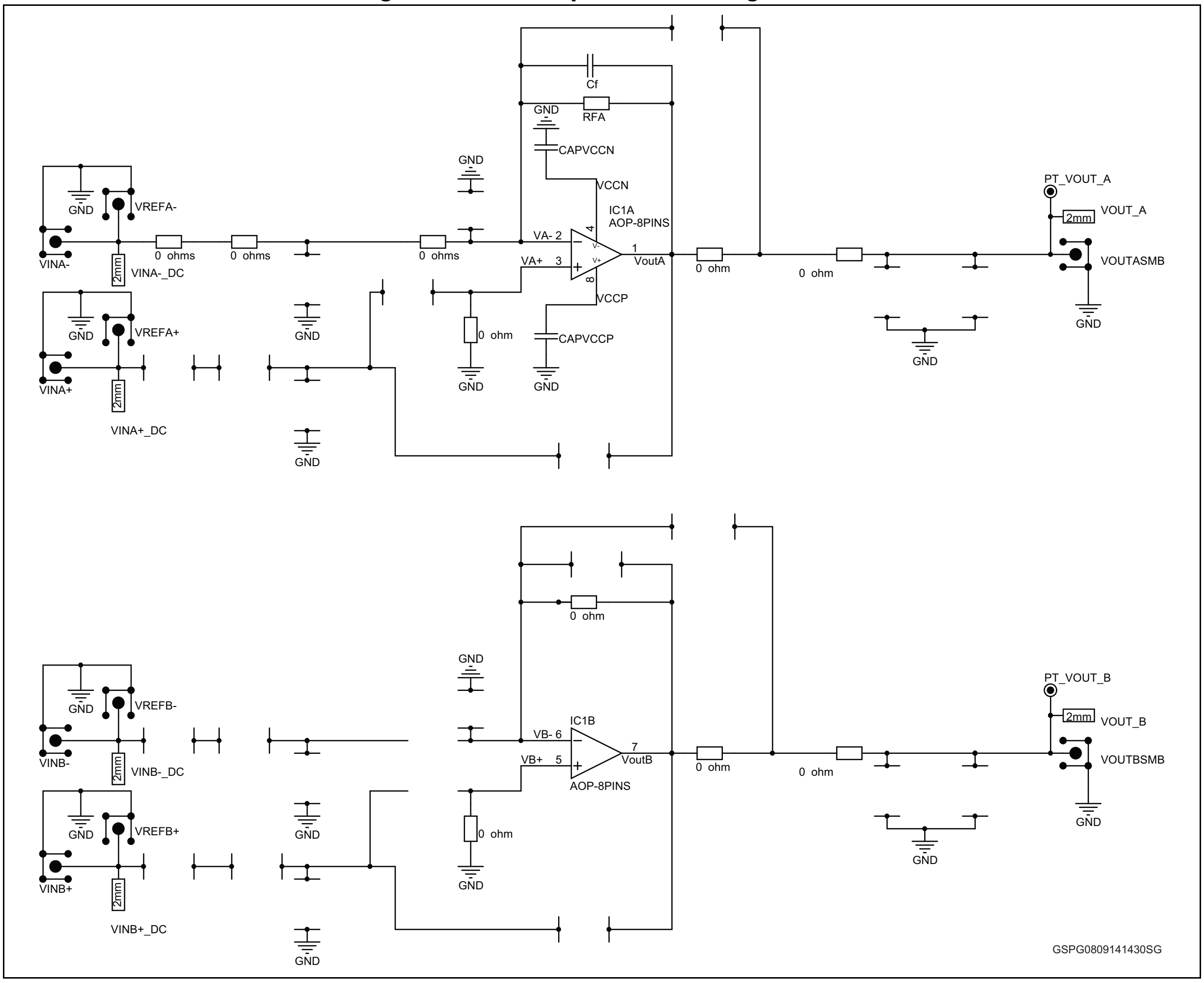
The *Figure 9* shows how to configure op amp IC1A as a transimpedance amplifier (TIA). The output voltage of the TIA is the input current multiplied by the feedback resistor RFA:

Equation 6

$$VOUT_A = (Iin + Ibias) * RFA - Vos$$

where Iin is defined as the input current source applied at the VINA- pad, IBIAS is the input bias current, and VOS is the input offset voltage of the op amp. For the type of usage, the feedback resistor RFA is generally high and the impedance seen on the VA- node is pretty capacitive (ex: photodiode). In order to stabilize the op amp it is recommended to connect a feedback capacitance CF.

Figure 9. Transimpedance configuration

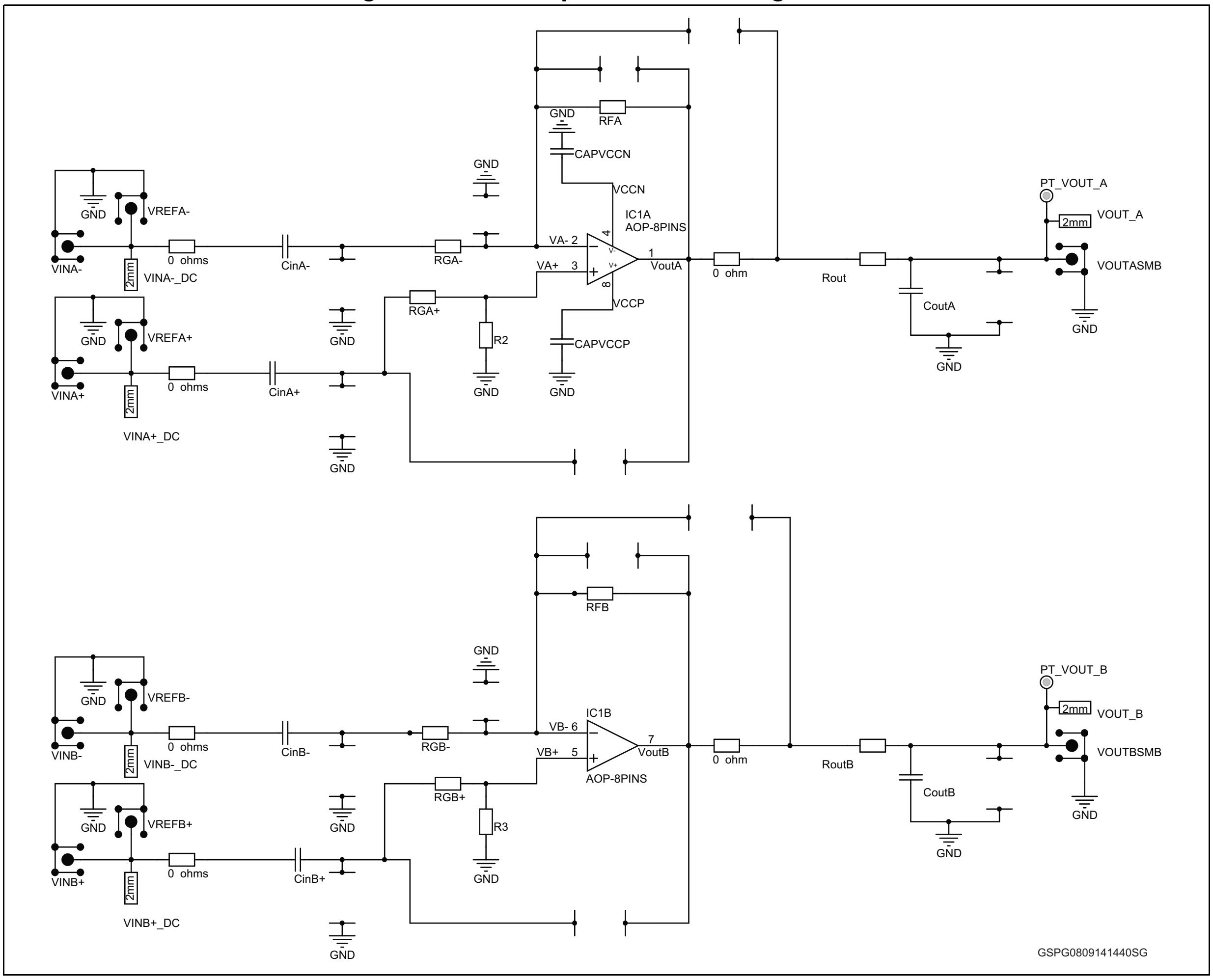


Note: If only IC1A op amp is used as transimpedance amplifier, the second one, IC1B, should be configured in follower mode in order to avoid any undesired oscillation on its output.

3.5 AC coupled circuit configuration

This typical configuration allows you to amplify the AC part of the input signal only; for example, a typical stereo audio amplifier.

Figure 10. AC coupled circuit configuration



4 Associated products

Table 1. Associated products

Part number	General description
LM258IQ2T	Low power dual op amps with low input bias current
LM2904IQ2T	Low power, bipolar op amp
LM358IQ2T	Low power dual op amps with low input bias current
LMV822IQ2T	Low power, high accuracy, general purpose operational amplifier
LMX358IQ2T	Low power, general-purpose operational amplifier
TSV522IQ2T	High merit factor (1.15 MHz for 45 µA) CMOS op amps
TSV522AIQ2T	High merit factor (1.15 MHz for 45 µA) CMOS op amps
TSV630IQ2T	Micro-power CMOS op amp with standby
TSV632IQ2T	Micro-power CMOS op amp
TSV632AIQ2T	Micro-power CMOS op amp
TSV852IQ2T	Low power, high accuracy, general-purpose operational amplifier
TSV912IQ2T	Rail to rail input/output widebandwidth op amps
TSV991IQ2T	Rail to rail input/output high merit factor op amps
TSZ122IQ2T	Very high accuracy (5 µV) zero drift micropower 5 V

5 Revision history

Table 2. Document revision history

Date	Revision	Changes
11-Sep-2014	1	Initial release.