AN4301
Application note

STEVAL-CCA036V1 demonstration board guidelines for single operational amplifiers

Introduction

The STEVAL-CCA036V1 demonstration board is designed to help characterize single operational amplifiers housed in SO8 packages.

This application note provides:

- a brief description of the STEVAL-CCA036V1 demonstration board
- a view of the top and bottom layers of the STEVAL-CCA036V1 demonstration board
- some examples of classic configurations that can be tested with the board

Contents

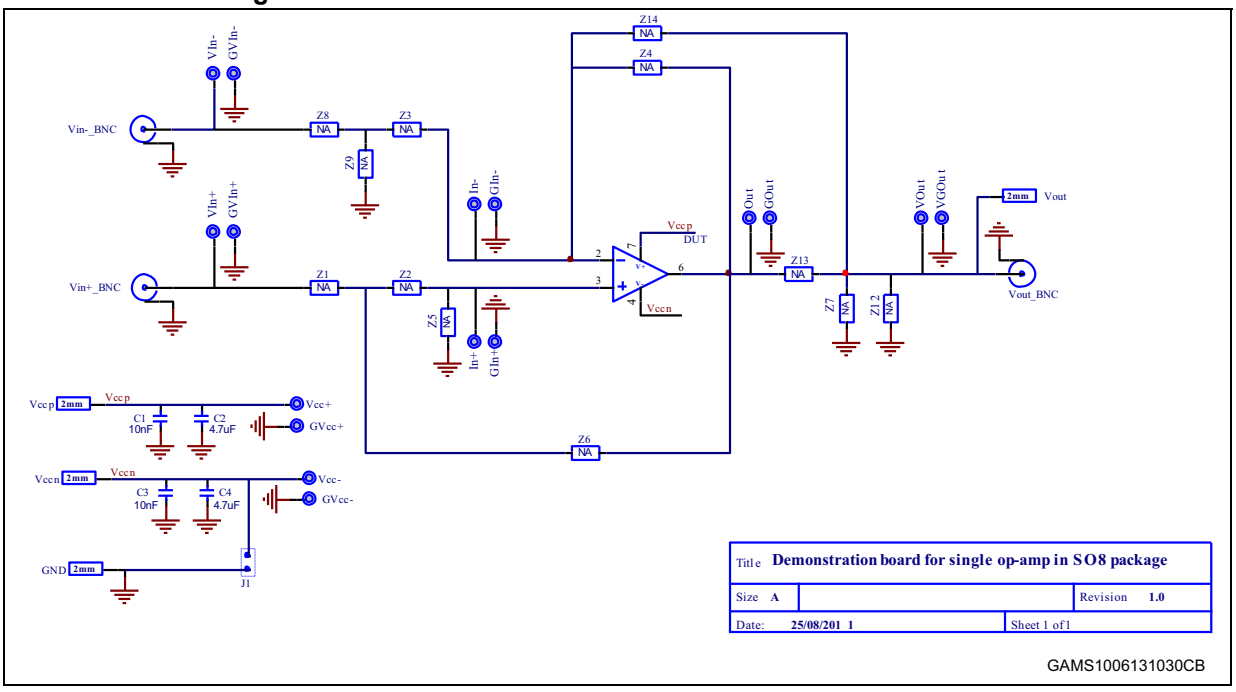
1 STEVAL-CCA036V1 description

The STEVAL-CCA036V1 demonstration board is designed with versatility in mind. In particular, its components allow it to be configured as:

- a low-pass Sallen-Key circuit
- a high-pass Sallen-Key circuit
- a differential amplifier
- an AC-coupled circuit
- an in-the-loop compensation circuit
- an out-of-loop compensation circuit
- numerous other possible configurations not described here

The STEVAL-CCA036V1 demonstration board is designed for surface-mounted components and can be used to perform on-board characterization prior to the integration of STMicroelectronics' products in designs. Resistor and capacitor footprints are implemented for the 0805 series. A set of two decoupling capacitors have been implemented on both power supply pins of the op-amp so as to benefit from the maximum performance of ST products. In order to reject a wide range of frequencies, 10 nF and 4.7 µF are good values for these capacitors.

Figure 1. STEVAL-CCA036V1 demonstration board schematic



2 STEVAL-CCA036V1 layout

The STEVAL-CCA036V1 demonstration board has a triangular shape which looks like the op-amp symbol.

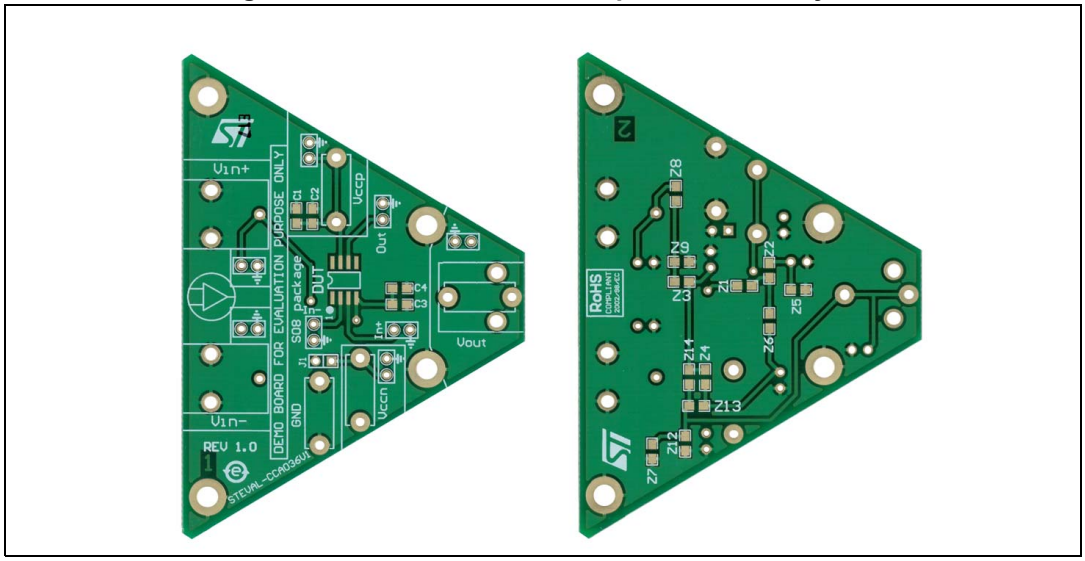
The board is a two-layer printed circuit board (PCB) with the following dimensions:

3040 mils x 2140 mils (77.2 mm x 54.4 mm)

For the V_{out} connection, either a BNC connector or a 2 mm female connector can be implanted. V_{in+} and V_{in-} can be directly connected by BNC connectors to ease the design. You can also implant test points on these three voltages which will facilitate the visualization of the signals.

The STEVAL-CCA036V1 top and bottom layers are shown in *Figure 2*.

Figure 2. STEVAL-CCA036V1 top and bottom layers



3 STEVAL-CCA036V1 possible configurations

Section 3.1 through to *Section 3.6* give some instruction on how to set up the STEVAL-CCA036V1 demonstration board to perform several classical configurations. The configurations are shown in the following figures:

- *Figure 3: Low-pass Sallen-Key configuration*
- *Figure 4: High-pass Sallen-Key configuration*
- *Figure 5: Differential amplifier*
- *Figure 6: In-the-loop compensation configuration*
- *Figure 7: Out-of-loop compensation configuration*
- *Figure 8: AC coupled configuration*

To obtain a more complex configuration, put several boards in cascade.

3.1 Low-pass Sallen-Key configuration

The low-pass Sallen-Key configuration (*Figure 3*) is a second order filter configuration. This circuit has 40 dB roll-off per decade.

Z4 and Z9 set the gain.

Equation 1 describes the filter cut-off frequency.

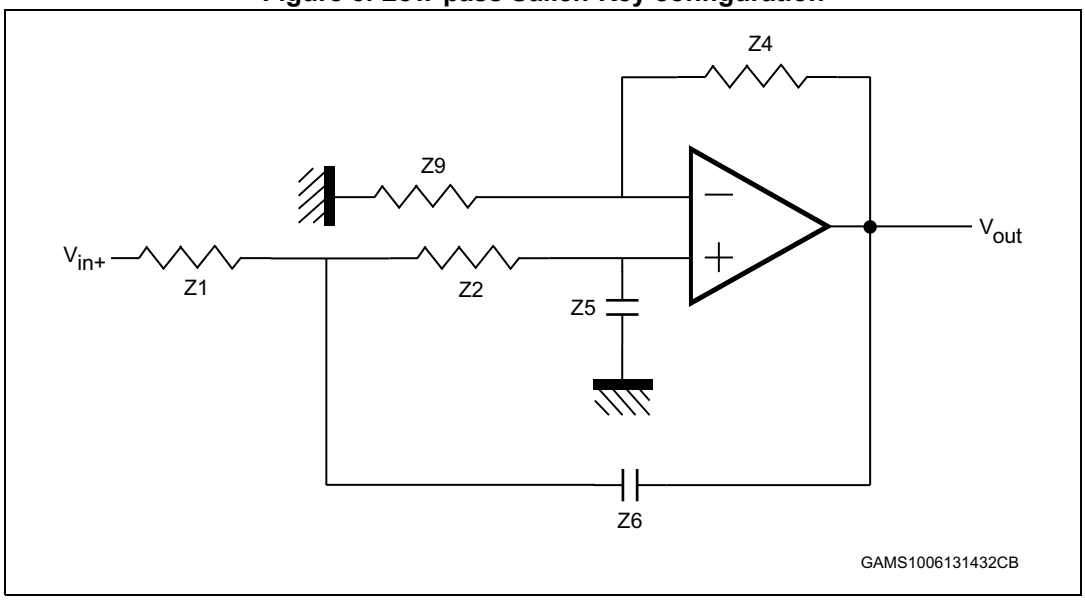
Equation 1

$$f_C = \frac{1}{2\pi\sqrt{Z1.Z2.Z5.Z6}}$$

Z7, Z8, Z12, and Z14 must not be connected.

Z3 and Z13 must be shorted.

Figure 3. Low-pass Sallen-Key configuration



3.2 High-pass Sallen-Key configuration

The high-pass Sallen-Key configuration (*Figure 4*) is also a second order filter configuration. It has a slope of 40 dB per decade.

Z4 and Z9 set the gain.

Equation 2 describes the filter cut-off frequency.

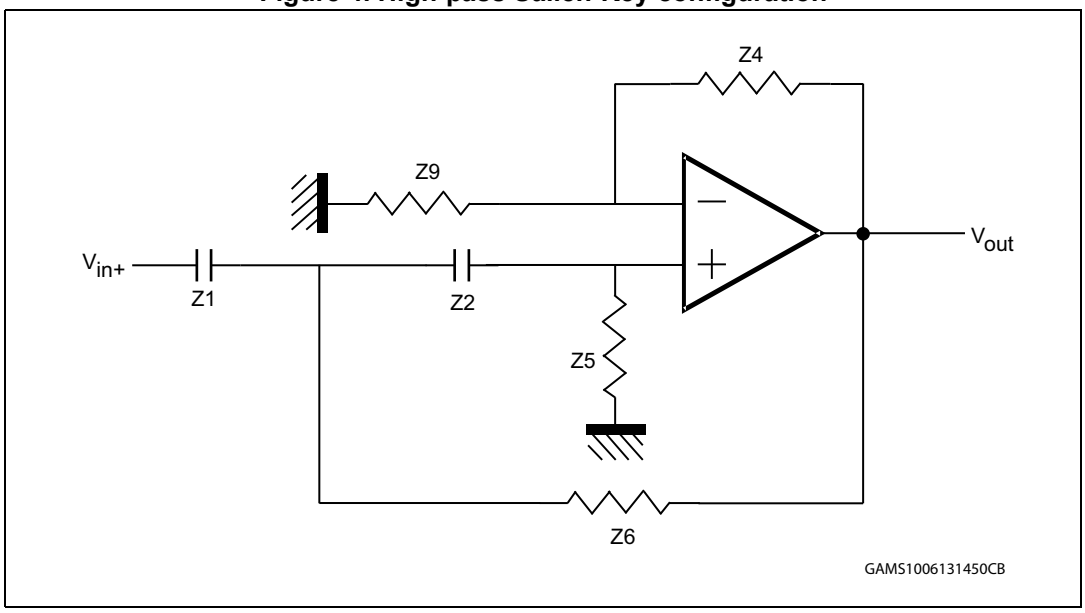
Equation 2

$$f_C = \frac{1}{2\pi\sqrt{Z1.Z2.Z5.Z6}}$$

Z7, Z8, Z12, and Z14 must not be connected.

Z3 and Z13 must be shorted.

Figure 4. High-pass Sallen-Key configuration



3.3 Differential amplifier

The differential amplifier (*Figure 5*) allows two voltages to be subtracted.

Equation 3 describes the output voltage of the op-amp.

Equation 3

$$V_{out} = V_{in+} \cdot \left(\frac{Z8 + Z4}{Z8} \frac{Z5}{Z1 + Z5} \right) - V_{in-} \cdot \frac{Z4}{Z8}$$

Choosing Z8 = Z1 and Z4 = Z5 gives *Equation 4*.

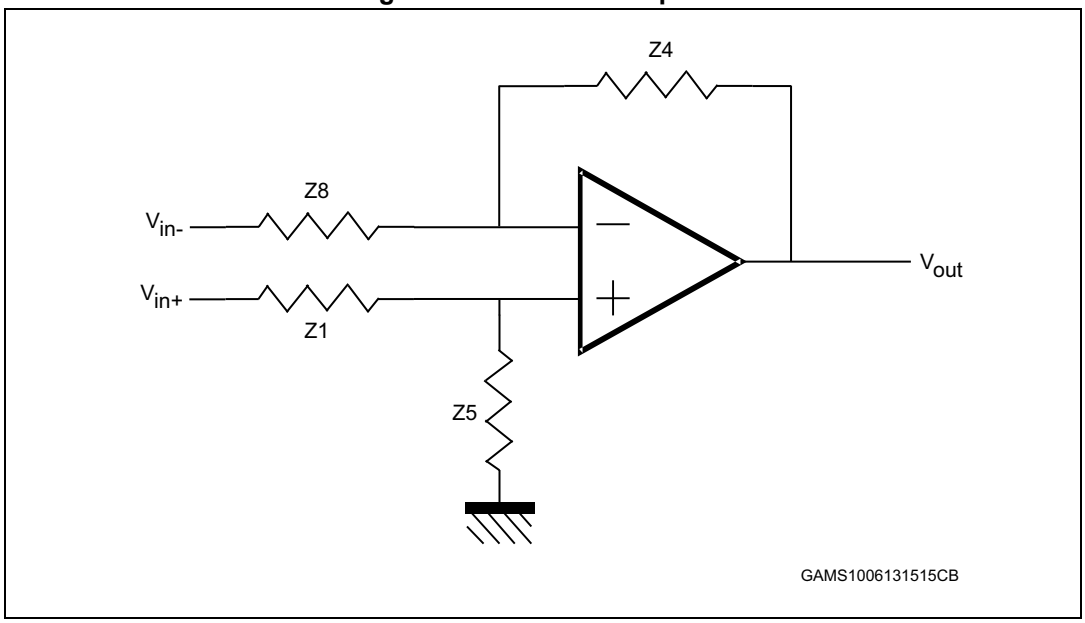
Equation 4

$$V_{out} = (V_{in+} - v_{in-}) \cdot \frac{Z4}{Z8}$$

Z6, Z7, Z9, Z12, and Z14 must not be connected.

Z2, Z3, and Z13 must be shorted.

Figure 5. Differential amplifier



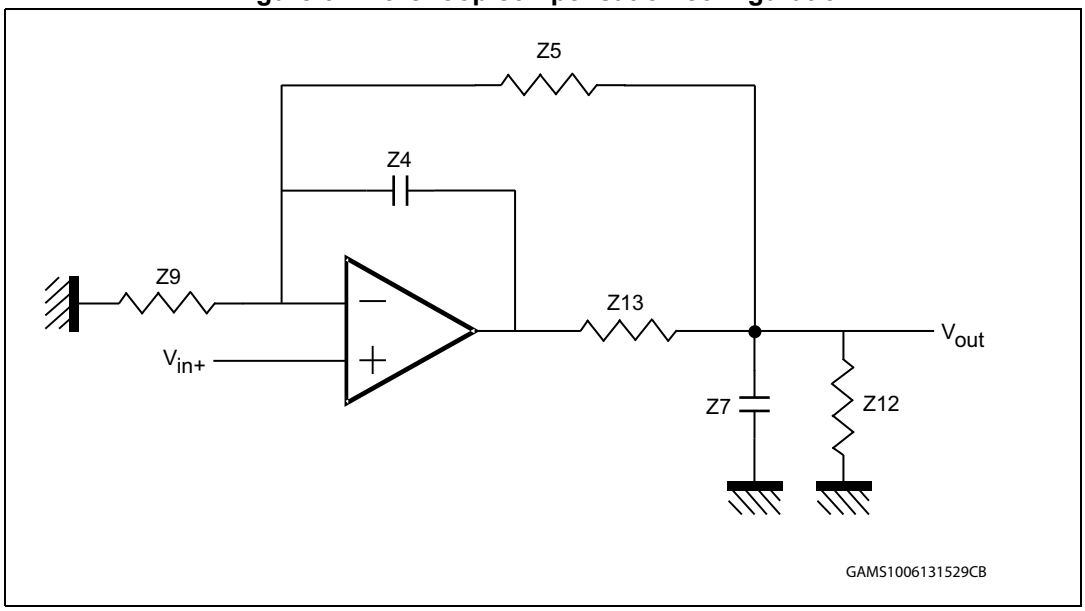
3.4 In-the-loop compensation configuration

The goal of in-the-loop compensation configuration (*Figure 6*) is to stabilize the amplifier configuration with a capacitive load. This compensation is called "*in-the-loop"* because the additional components (Z14 and Z4) used to improve the stability are inserted in the feedback loop.

Z5, Z6, and Z8 must not be connected.

Z1, Z2, and Z3 must be shorted.

Figure 6. In-the-loop compensation configuration



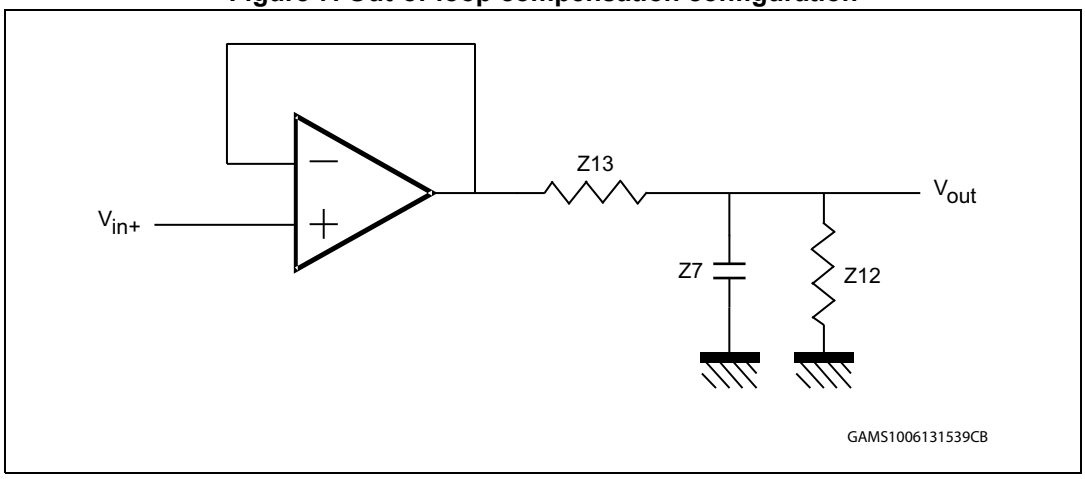
3.5 Out-of-loop compensation configuration

Out-of-loop compensation configuration (*Figure 7*) is a simple compensation method, using only one extra component. The component is a resistor (Z13) which is added in series between the output of the amplifier and its load. It is often referred to as the out-of-loop compensation method because the additional component is added outside of the feedback loop.

Z3, Z5, Z6, Z8, Z9, and Z14 must not be connected.

Z1, Z2, and Z4 must be shorted.

Figure 7. Out-of-loop compensation configuration



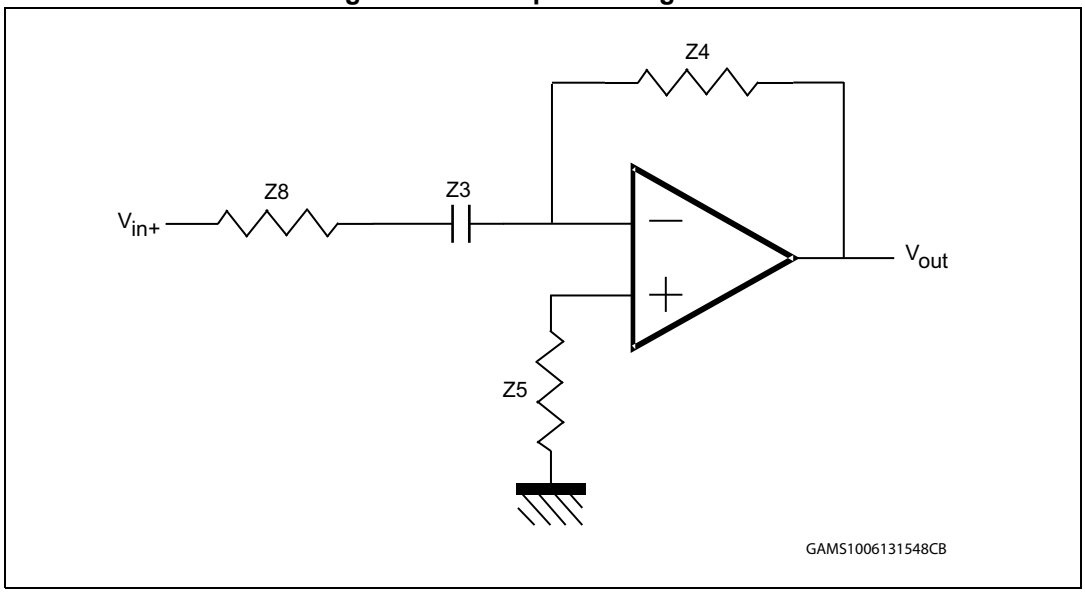
3.6 AC coupled circuit configuration

The AC coupled circuit configuration (*Figure 8*) allows the AC part of the input signal to be amplified.

Z2, Z6, Z7, Z9, Z12, and Z14 must not be connected.

No component is shorted.

Figure 8. AC coupled configuration



4 Associated products in the SO8 package

Table 1. Associated products in the SO8 package

Generic part number	General description	V_{CC} range (V)
LF351	JFET inputs, low input bias, and offset current, (15 nV/√Hz and 0.01 %)	6 – 32
LM201A	Input and output overload protection, low input offset current	5 – 40
LM301A		
MC33171	Low consumption versus speed	4 – 44
TL061	JFET inputs, low input bias current	6 – 36
TL071		5 – 36
TL081		
TS1851	1.8 V minimum voltage supply, micropower	1.8 – 6
TS1871	1.8 V input/output, rail-to-rail, low-power op-amps	1.8 – 6
TS271	Micropower, programmable op-amp	3 – 16
TS461	Output, rail-to-rail op-amps	2.7 – 10
TS507	High-precision, single-supply, rail-to-rail op-amp	2.7 – 5.5
TS921	Rail-to-rail, high-output current op-amps	2.7 – 12
TS931	Micropower amplifier with CMOS inputs	2.7 – 10
TS941	Ultra-micropower amplifier with CMOS inputs	2.5 – 10
TS951	Real input and output, rail-to-rail/low distortion (0.01 %)	2.7 – 12
TS971	Output rail-to-rail, very low-noise op-amps	2.7 – 10
TSV321	General-purpose, low-voltage, rail-to-rail input/output op-amp	2.5 – 6
TSV911	Rail-to-rail, input/output, widebandwidth op-amps	2.5 – 5.5
TSV991	Rail-to-rail, input/output, high merit factor op-amps	
UA741	Wide application range	5 – 44
UA748		5 – 40

5 Related demonstration boards

The STEVAL-CCA022V1 demonstration board is designed especially for characterizing ST operational amplifiers in SOT23 and SC70 packages.

More information can be found on:

http://www.st.com/web/catalog/tools/FM116/SC1079/PF245721

6 Revision history

Table 2. Document revision history

Date	Revision	Changes
13-Jun-2013	1	Initial release.