# AN2995

## Demonstration board user guidelines for single operational amplifiers

## Introduction

This demonstration board is designed to help in the characterization of single operational amplifiers in SOT23-5 (two different pinouts) and SC70-5 packages. Operational amplifiers in SOT23-6 and SC70-6 packages can also be characterized, but their respective standby pin cannot be used since it is connected to $V_{CC}+$ on the board.

This document provides:

- a brief description of the demonstration board.
- a layout of the top and bottom layers.
- some examples of typical configurations that can be tested with the board.

# 1 Board description

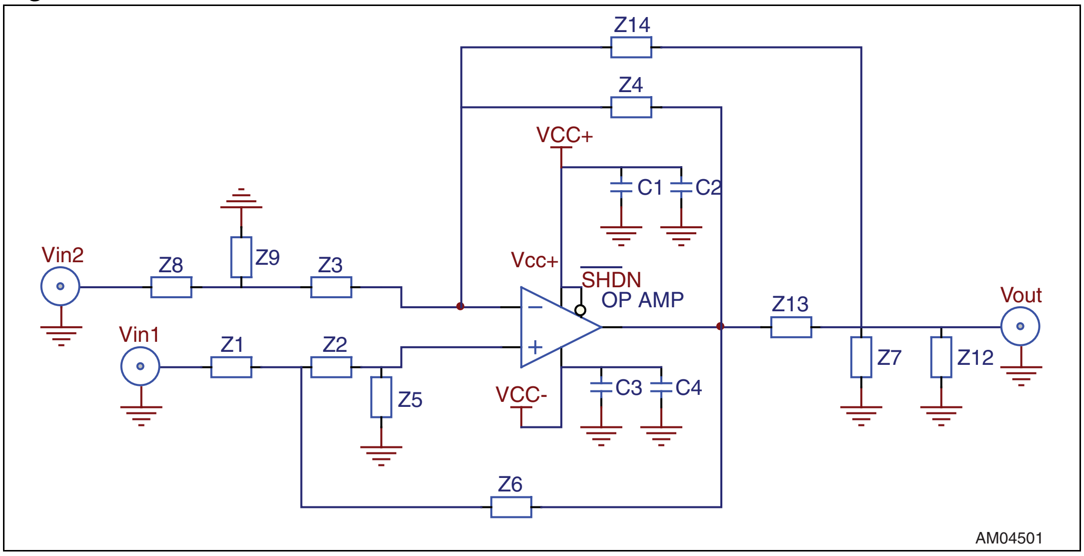
This board is designed with versatility in mind. In particular, its components allow it to be configured as:

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

The board is designed for surface-mounted components in SOT23-5 (and SOT23-6) or SC70-5 (SC70-6) packages. It can be used to perform on-board characterization prior to the integration of STMicroelectronics' products in your designs. Resistor and capacitor footprints are implemented in the 0805 series.

A set of two decoupling capacitors have been implemented on both power supply pins so as to benefit from the maximum performances of ST products. In order to reject a wide range of frequencies, 100 nF and 4.7 µF are good values for these capacitors.

**Figure 1. Demonstration board schematics**



# 2 Board layout

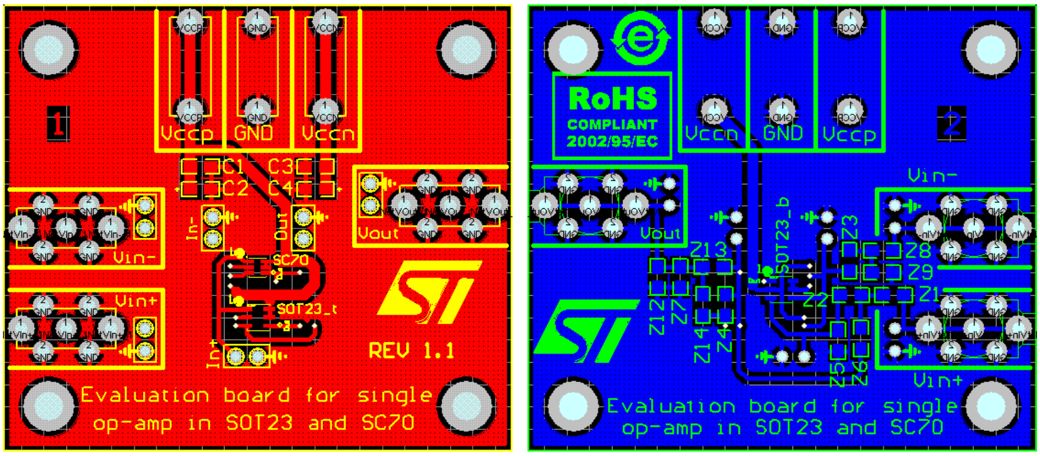
The board has the following physical characteristics.

- Board dimensions: 2080 x 1900 mils (52.8 x 48.3 mm).
- 2-layer PCB.

For Vout, Vin1 and Vin2, male SMB or 2-mm female connectors can be implemented. You can also implement test points on these three voltages to facilitate visualization of your signals.

*Figure 2* shows the top and bottom layers of the board.

**Figure 2. Top and bottom layers**



# 3 Possible configurations

This chapter provides instructions on how to set-up the board with several typical configurations.

- *Figure 3*: low-pass Sallen-Key configuration
- *Figure 4*: high-pass Sallen-Key configuration
- *Figure 5*: differential amplifier configuration
- *Figure 6*: in-loop compensation configuration
- *Figure 7*: out-of-loop compensation configuration
- *Figure 8*: AC-coupled configuration

You can also connect several boards together if you need to evaluate more complicated schematics using several operational amplifiers.

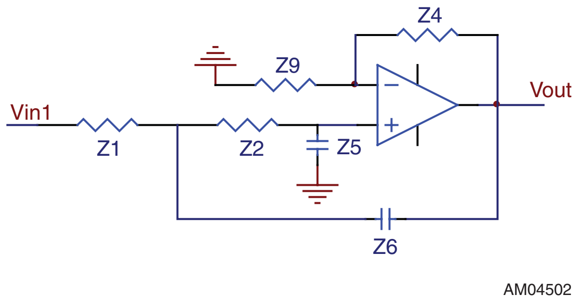
## 3.1 Low-pass Sallen-Key configuration

The low-pass Sallen-Key configuration is a second-order filter configuration. Z4 and Z9 are used to set the gain.

Fc = 1/(2*PI*sqrt(Z1*Z2*C5*C6))

Z7, Z8, Z12 and Z14 must be "not connected". Z3 and Z13 must be shorted.

**Figure 3. Low-pass Sallen-Key configuration**



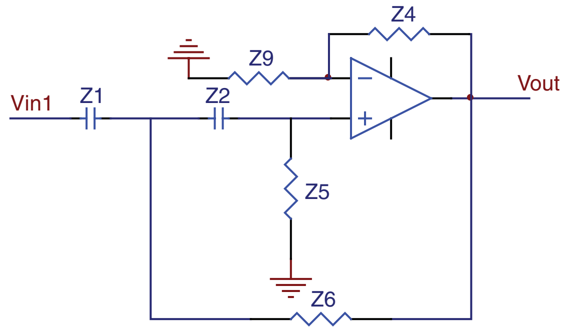

## 3.2 High-pass Sallen-Key configuration

Like the low-pass Sallen Key configuration, this is also a second-order filter configuration. Z4 and Z9 are used to set the gain.

Fc = 1/(2*PI*sqrt(C1*C2*Z5*Z6))

Z7, Z8, Z12 and Z14 must be "not connected". Z3 and Z13 must be shorted.

**Figure 4. High-pass Sallen-Key configuration**




## 3.3 Differential amplifier configuration

The differential amplifier configuration allows the subtraction of two voltages.

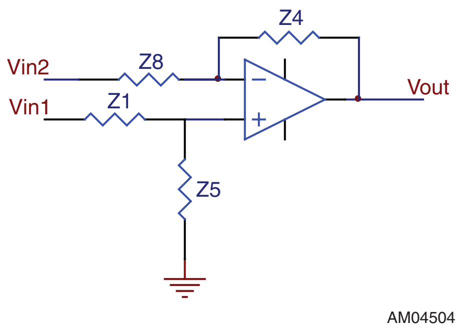
The transfer function is: Vout = Vin1 ((Z8+Z4)/Z8 * Z5/(Z1+Z5)) - Z4/Z8*Vin2.

Choosing Z8 = Z1 and Z4 = Z5 gives:

Vout = (Vin1-Vin2)*Z4/Z8

Z6, Z7, Z9, Z12 and Z14 must be "not connected". Z2, Z3 and Z13 must be shorted.

**Figure 5. Differential amplifier configuration**



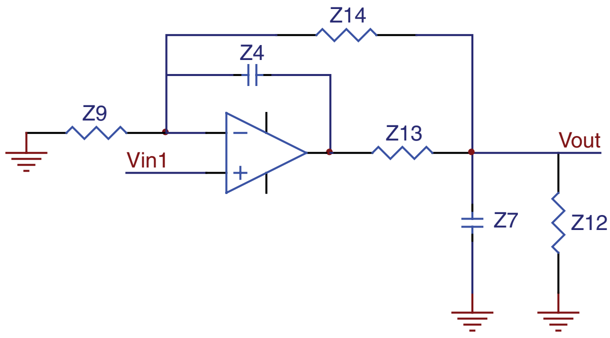

## 3.4 In-loop compensation configuration[a]

The goal of this compensation technique is to stabilize an amplifier configuration with a capacitive load. This compensation is called *in-loop* because the additional components (Z13 and Z4) used to improve the stability are inserted in the feedback loop.

Z5, Z6 and Z8 must be "not connected". Z1, Z2 and Z3 must be shorted.

a. More information on compensation methods can be found in application note *AN2653: Operational amplifier stability compensation methods for capacitive loading applied to TS507* (see *Table 2: Document references*).

**Figure 6. Compensation: in-loop configuration**

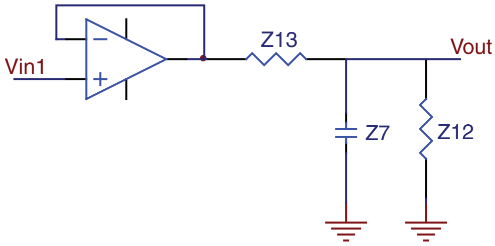



## 3.5 Out-of-loop compensation configuration[b]

A simple compensation method, using only one extra component, consists in adding a resistor (Z13) 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 be "not connected". Z1, Z2 and Z4 must be shorted.

**Figure 7. Compensation: out-of-loop configuration**

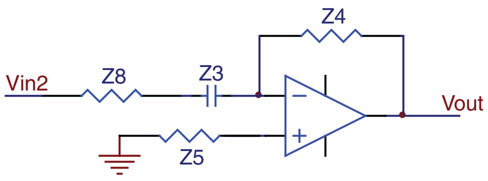



## 3.6 AC-coupled circuit configuration

This typical configuration allows you to amplify the AC part only of the input signal. Z2, Z6, Z7, Z9, Z12 and Z14 must be "not connected". No component is shorted.

b. More information on compensation methods can be found in application note *AN2653: Operational amplifier stability compensation methods for capacitive loading applied to TS507* (see *Table 2: Document references*).

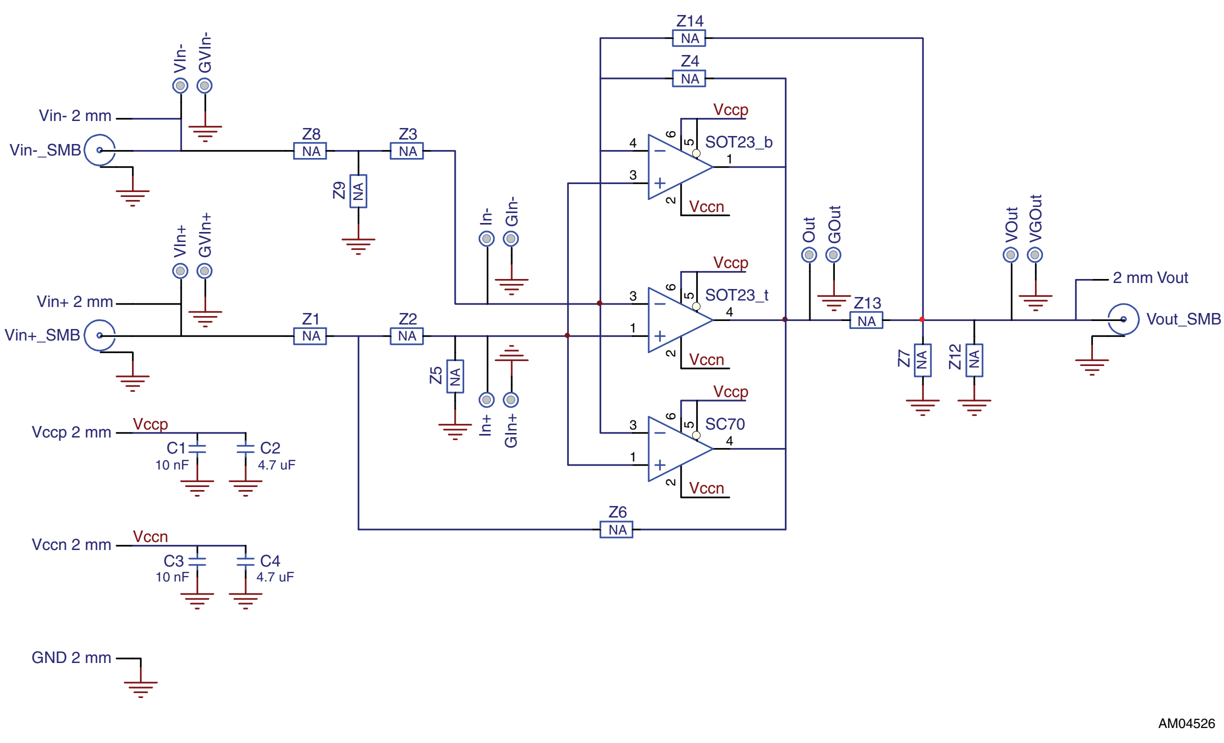
Figure 8. AC-coupled circuit configuration



# Appendix A Board schematics and associated products

## A.1 Board schematic

Figure 9. Demonstration board for single operational amplifier in SOT23 and SC70 packages



## A.2 Associated products in SOT23 or SC70 packages(c)

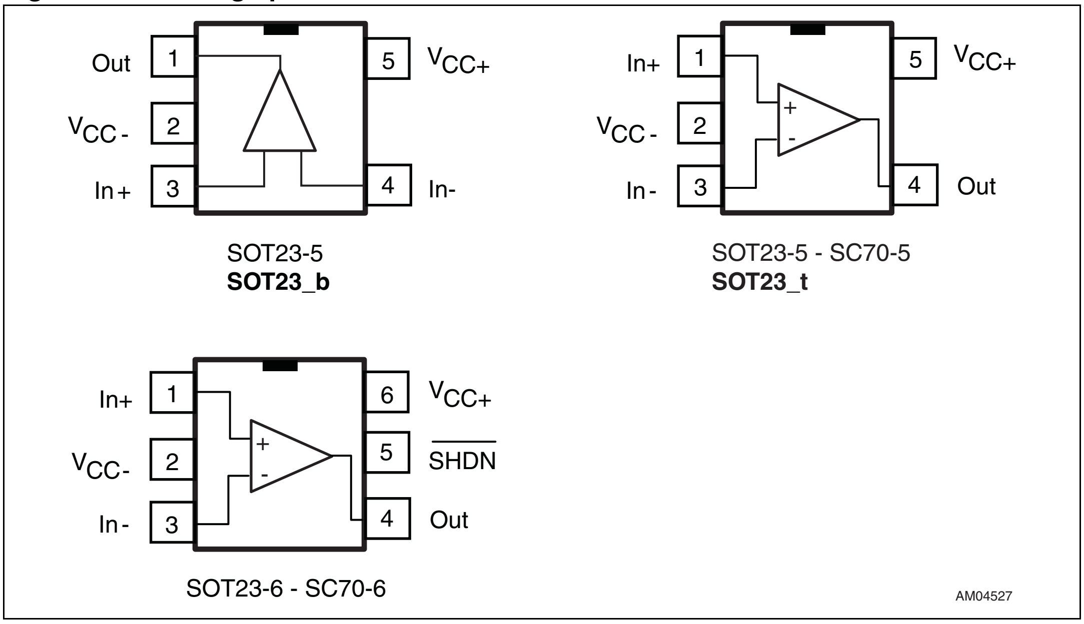
**Table 1. List of operational amplifiers in SOT23 or SC70 packages**

| Product | SOT23-5(1)/6 | | SC70-5/6 | Description |
|---|---|---|---|---|
| TSV611 | | SOT23_t | SC70-5 | 11 µA, 120 kHz, RR I/O CMOS op-amp |
| TSV6191 | | SOT23_t | SC70-5 | 11 µA, 450 kHz, RR I/O CMOS op-amp |
| TSV620 | | SOT23_6 | SC70-6 | 29 µA, 420 kHz, RR I/O op-amp with SHDN |
| TSV621 | | SOT23_t | SC70-5 | 29 µA, 420 kHz, RR I/O CMOS op-amp |
| TSV6290 | | SOT23_6 | SC70-6 | 29 µA, 1.3 MHz, RR I/O op-amp with SHDN |
| TSV6291 | | SOT23_t | SC70-5 | 29 µA, 1.3 MHz, RR I/O CMOS op-amp |
| TSV630 | | SOT23_6 | SC70-6 | 60 µA, 880 kHz, RR I/O op-amp with SHDN |
| TSV631 | | SOT23_b | SC70-5 | 60 µA, 880 kHz, RR I/O CMOS op-amp |
| TSV6390 | | SOT23_6 | SC70-6 | 60 µA, 2.5 MHz, RR I/O op-amp with SHDN |
| TSV6391 | | SOT23_b | SC70-5 | 60 µA, 2.5 MHz, RR I/O CMOS op-amp |
| TSV911 | SOT23_b | | | RR I/O 8 MHz op-amp |
| TSV991 | SOT23_b | | | RR I/O 20 MHz op-amp |
| TS507 | SOT23_b | | | High precision, RR I/O op-amp |
| LMV321 | SOT23_b | | | Low-cost, low-power RR I/O op-amp |
| TSV321 | SOT23_b | | | General-purpose RR I/O op-amp |
| TS1851 | SOT23_b | | | 1.8 V, RR I/O low-power op-amp |
| TS1871 | SOT23_b | | | 1.8 V, RR I/O low-power op-amp |
| TS321 | SOT23_b | | | Low-power, high-voltage op-amp |
| TS461 | SOT23_b | | | Output RR low-noise op-amp |
| TS931 | SOT23_b | | | Output RR micropower op-amp |
| TS941 | SOT23_b | | | Output RR micropower op-amp |
| TS951 | SOT23_b | | | RR I/O low-power op-amp |
| TS971 | SOT23_b | | | Output RR very low-noise op-amp |

1. The SOT23-5 comes with two possible pin configurations as shown in *Figure 10 on page 10*.

c. Note that operational amplifiers in SOT23-6 or SC70-6 packages (single with standby) can be evaluated but the standby pin is by default connected to $V_{CC+}$ and cannot be changed.

Figure 10. Package pinouts



# Ordering information

To order the board online, go to *http://www.st.com/stonline/products/families/evaluation_boards/steval-cca022v1.htm*

# References

**Table 2. Document references**

| Document |
| --- |
| AN2653: Operational amplifier stability compensation methods for capacitive loading applied to TS507 (*http://www.st.com/stonline/products/literature/anp/14130.pdf*) |

# Revision history

Table 3. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 23-Jun-2009 | 1 | Initial release. |