

## FEATURES

- 0.8V to 5.5V Single-supply operation
- AC-coupled Inverting configuration supplied
- Fully Assembled and Tested
- 2mm x 2mm 2-layer demo board

## COMPONENT LIST

DESIGNATION	QTY	DESCRIPTION
C1, C2, C3, C5	4	0.1 $\mu$ F $\pm$ 10% capacitors (0805)
C4, C6	2	1 $\mu$ F $\pm$ 10% capacitors (0805)
R2	1	665k $\Omega$ $\pm$ 1% resistor (0805)
R7	1	500k $\Omega$ $\pm$ 1% resistor (0805)
R5, R6, R10	3	1M $\Omega$ $\pm$ 1% resistors (0805)
R8, R9	2	1.25M $\Omega$ $\pm$ 1% resistors (0805)
R1, R3, R4	3	2M $\Omega$ $\pm$ 1% resistors (0805)
U1, U2	2	TS1005 operational amplifiers
V <sub>DD</sub> , V <sub>in</sub> , V <sub>out</sub> , GND	11	Test points

## DESCRIPTION

The demo board for the TS1005 is a completely assembled and tested circuit board that can be used for evaluating the TS1005. The TS1005 is a precision CMOS operational amplifier fully specified to operate over a supply voltage range from 0.8V to 5.5V with a GBWP of 20kHz. Fully specified at 1.8V, the TS1005 is optimized for ultra-long-life battery powered applications. The TS1005 exhibits a typical input bias current of 2pA, and rail-to-rail input and output stages.

The TS1005 is fully specified over the industrial temperature range (-40°C to +85°C). The TS1005 evaluation board is offered with either a PCB-space saving 5-lead SC70 or 5-lead SOT23 packaging.

Product data sheets and additional documentation can be found on factory web site at [www.touchstonesemi.com](http://www.touchstonesemi.com).

## Ordering Information

Order Number	Description
TS1005DB	SC70 Packaging Demo Board
TS1005DB-SOT	SOT23 Packaging Demo Board

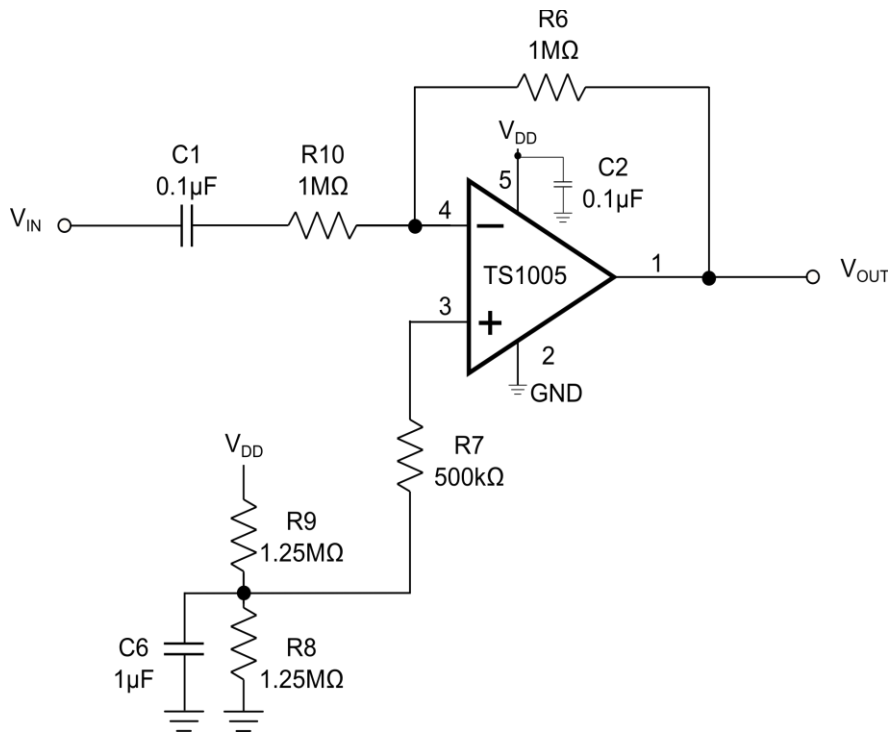


Figure 1. Inverting Configuration

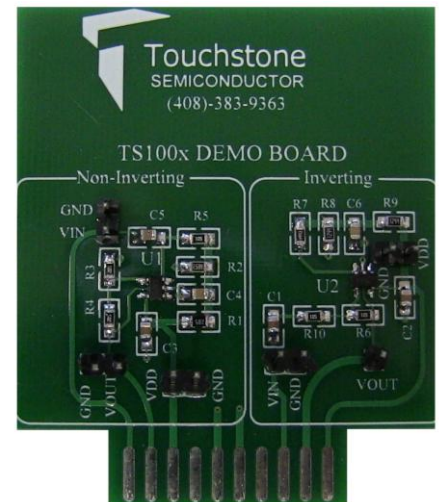


Figure 2. TS1005-SOT Evaluation Board

## Description

The TS1005DB evaluation board with SC70 packaging provides one configuration, namely an inverting configuration. The TS1005DB-SOT evaluation board with SOT23 packaging provides two configurations for evaluating the TS1005 operational amplifier in one single PCB board, namely a non-inverting configuration located on the left-hand side of the board and an inverting configuration located on the right-hand side of the board. In both cases, the input to each circuit is AC-coupled. The demo board provides a re-biasing scheme at one-half the power supply or  $V_{DD}/2$  for the inverting configuration and at  $V_{DD}/4$  for the non-inverting configuration.

The TS1005 demo board provides a dedicated power supply for the non-inverting circuit and a dedicated power supply for the inverting circuit. This provides the user the flexibility of evaluating one circuit at a time or both at the same time.

In both the non-inverting and the inverting configuration, the AC-coupling capacitor creates a high pass filter. The resulting cut-off frequency,  $f_c$ , is given as:

$$f_c = \frac{1}{2\pi RC}$$

In the non-inverting circuit,  $R=R5=1M\Omega$  and  $C=C5=0.1\mu F$ . In the inverting case,  $R=R10=1M\Omega$  and  $C=C1=0.1\mu F$ . In both cases, these component values generate a high-pass cut-off frequency of 1.6Hz.

## Default Configurations

### Non-Inverting configuration

In the non-inverting configuration, the circuit's transfer function is given by the following equation:

$$\frac{V_{OUT}}{V_{IN}} = 1 + \frac{R4}{R3}$$

With  $R4=2M\Omega$  and  $R3=2M\Omega$  the circuit signal gain is 2 with a circuit bandwidth of 10kHz. This results in an overall circuit bandwidth range of 1.6Hz to 10kHz.

### Inverting configuration

In an inverting configuration, the circuit's transfer function is given by the following equation:

$$\frac{V_{OUT}}{V_{IN}} = - \frac{R6}{R10}$$

In this case,  $R6=1M\Omega$  and  $R10=1M\Omega$ . This results in a signal gain of -1 with a circuit bandwidth of 10kHz and an overall circuit bandwidth range of 1.6Hz to 10kHz.

## Quick Start Procedures

### Required Equipment

- TS1005 demo board
- DC Power Supply, Single or Dual Output
- Function Generator
- 4-channel Oscilloscope
- Two  $1M\Omega$  oscilloscope probes

### Non-Inverting Configuration

In order to evaluate the TS1005 operational amplifier in the non-inverting configuration, the following steps are to be performed:

- 1) Before connecting the DC power supply to the demo board power test points, turn on the power supply and set the DC voltage to 5.5V and then turn it off.
- 2) Set the function generator frequency to 500Hz and output level with a  $V_{OH} = 2.35V$  and a  $V_{OL} = 2.15V$ . This sets the input signal swing to  $200mV_{PP}$ , centered at 2.25V.
- 3) In order to monitor the input and output signal, select two channels on the oscilloscope and set the vertical voltage scale and the vertical position on each channel to  $100mV/DIV$  and  $-2.25V$ , respectively. Set the horizontal time scale to  $500\mu s/DIV$ .
- 4) Connect the positive terminal of the DC power supply to  $V_{DD}$  and the ground terminal to GND.

- 5) Connect the signal output of the function generator to  $V_{in}$  and the ground terminal to GND.
- 6) To monitor the input, connect the signal terminal of one of the oscilloscope probes to  $V_{in}$  and the ground terminal to GND. To monitor the output, use the second probe to connect the signal terminal to  $V_{OUT}$  and the ground terminal to GND.
- 7) Turn on the power supply and check that the power supply current is approximately  $4.3\mu A$ .
- 8) Turn on the function generator.
- 9) Observe the input and output signal. The output signal is an amplified version of the input signal with an output swing of approximately  $400mV_{PP}$ , corresponding to a signal gain of two.

## Inverting Configuration

In order to evaluate the TS1005 operational amplifier in the inverting configuration, the following steps are to be performed:

- 1) Before connecting the DC power supply to the demo board, turn on the power supply and set the DC voltage to 5.5V and then turn it off.
- 2) Set the function generator output frequency to 500Hz and output level with a  $V_{OH} = 2.35V$  and a  $V_{OL} = 2.15V$ . This sets the input swing to  $200mV_{PP}$ , centered at 2.25V.

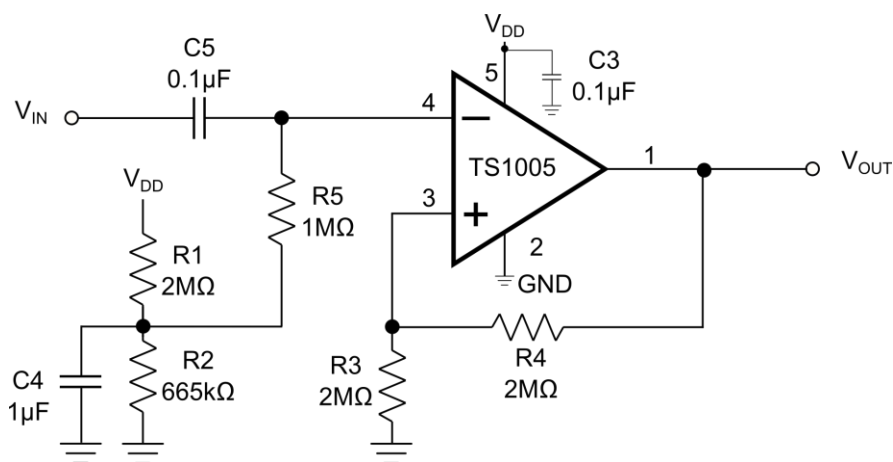


Figure 3. Non-Inverting Configuration

- 3) In order to monitor the input and output signal, select two channels on the oscilloscope and set the vertical voltage scale and the vertical position on each channel to  $100mV/DIV$  and  $-2.25V$ , respectively. Set the horizontal time scale to  $500\mu s/DIV$ .
- 4) Connect the positive terminal of the DC power supply to VDD and the ground terminal to GND.
- 5) Connect the signal output of the function generator to  $V_{in}$  and the ground terminal to GND.
- 6) To monitor the input, connect the signal terminal of one of the oscilloscope probes to  $V_{in}$  and the ground terminal to GND. To monitor the output, use the second probe to connect the signal terminal to  $V_{OUT}$  and the ground terminal to GND.
- 7) Turn on the power supply and check that the power supply current is approximately  $3.8\mu A$ .
- 8) Turn on the function generator.
- 9) Observe the input and output signal. The output signal is an inverted version of the input signal and the swing should be  $200mV_{PP}$ .



Figure 4. TS1005DB Evaluation Board

# TS1005 Op Amp Demo Board

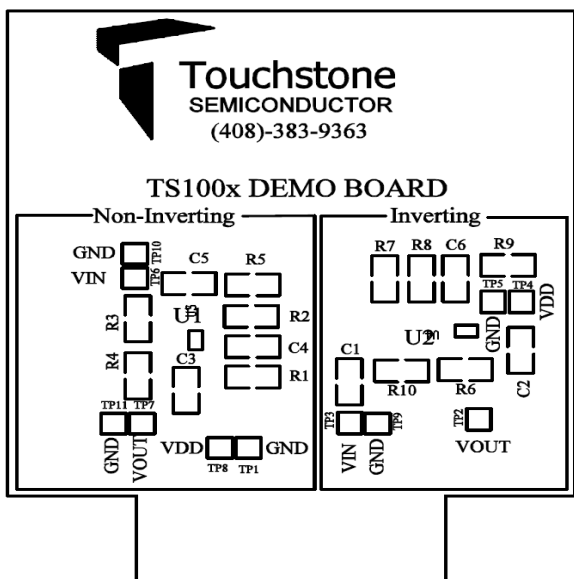


Figure 5. TS1005DB-SOT  
Top Layer #1

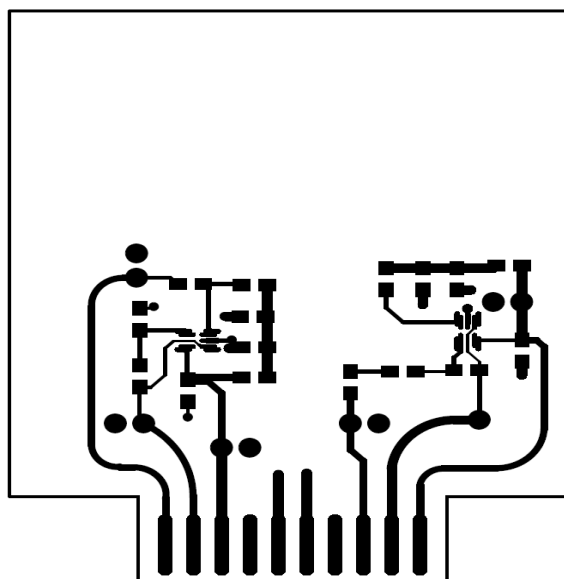


Figure 6. TS1005DB-SOT  
Top Layer #2

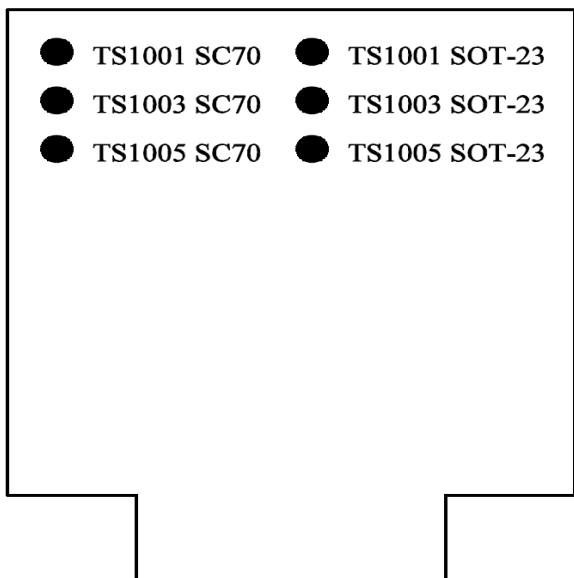


Figure 7. TS1005DB-SOT  
Bottom Layer (GND) #1

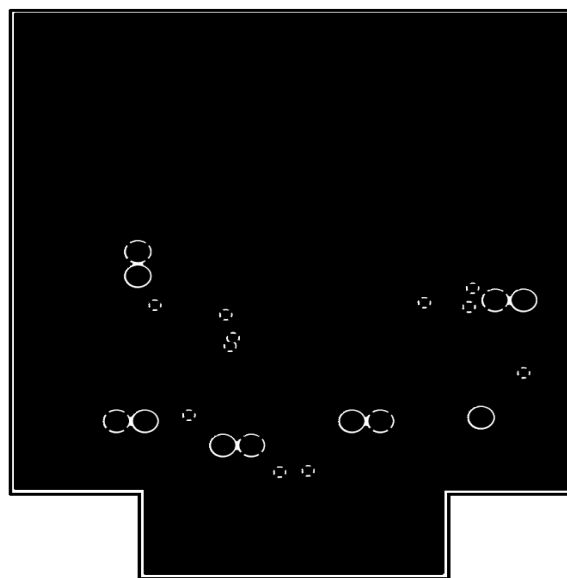


Figure 8. TS1005DB-SOT  
Bottom Layer (GND) #2

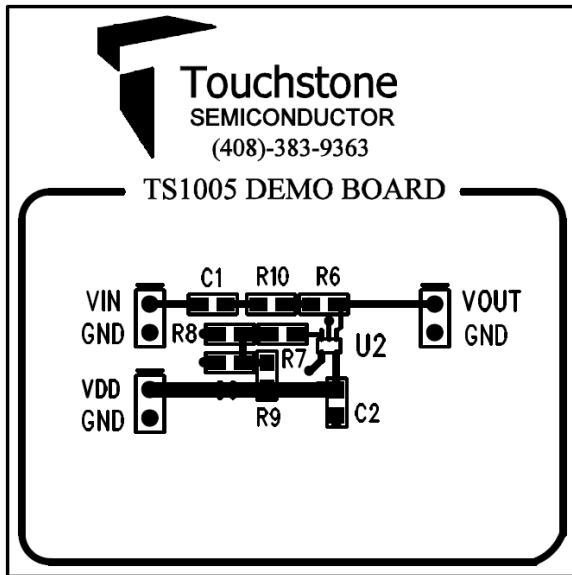


Figure 9. TS1005DB  
Top Layer #1

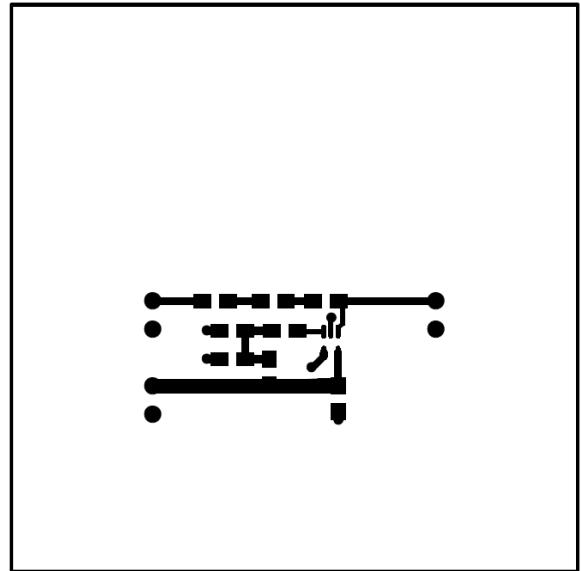


Figure 10. TS1005DB  
Top Layer #1

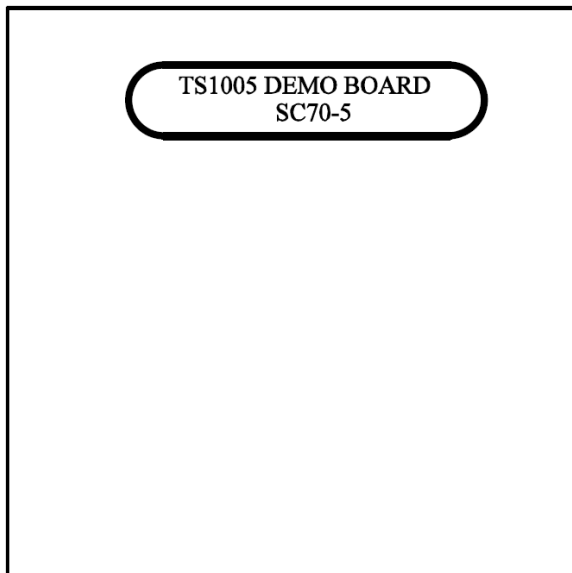


Figure 11. TS1005DB  
Bottom Layer (GND) #1

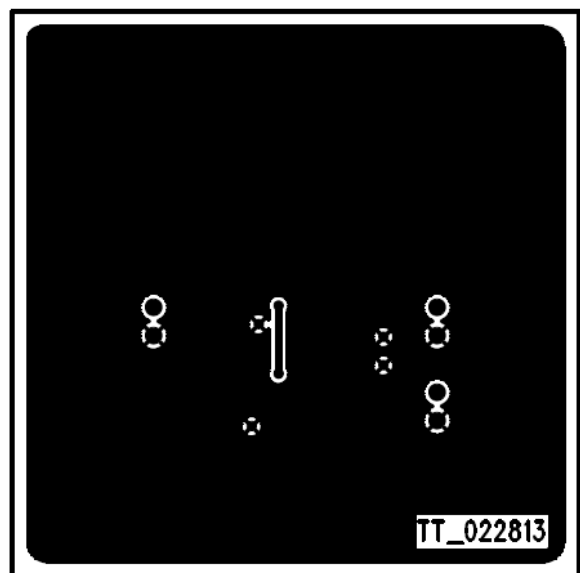


Figure 12. TS1005DB  
Bottom Layer (GND) #2

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