

## Low-Power Single/Dual-Supply Dual Comparator with Reference

### FEATURES

- Single or Dual Power Supplies:  
Single: +2.5V to +11V  
Dual:  $\pm 1.25\text{V}$  to  $\pm 5.5\text{V}$
- Internal  $1.182\text{V} \pm 0.75\%$  Reference
- Fully Assembled and Tested
- Push-pull TTL/CMOS-Compatible Outputs
- 2in x 2in 2-layer circuit board

DESIGNATION	QTY	DESCRIPTION
C1	1	$0.1\mu\text{F} \pm 10\%$ capacitors (0805)
R1	1	$20\text{k}\Omega \pm 1\%$ resistor (0805)
R2	1	$2.4\text{M}\Omega \pm 1\%$ resistor (0805)
U1	1	TS9002 Comparator
INA+, INB-, HYST, VDD, OUT_B, OUT_A, REF, GND (7)	14	Test points

**Table 1. Component List**

### DESCRIPTION

The demo board for the TS9002 is a completely assembled and tested circuit board that can be used for evaluating the TS9002. The TS9002 joins Touchstone's TS9001-1/2 analog comparators in the "NanoWatt Analog™" high performance analog integrated circuits portfolio. The TS9002 can operate from single +2.5V to +11V supplies or from  $\pm 1.25\text{V}$  to  $\pm 5.5\text{V}$  dual supplies.

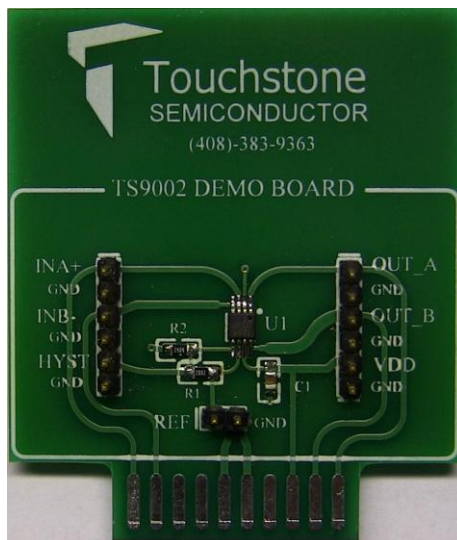
The TS9002 incorporates an internal  $1.182\text{V} \pm 0.75\%$  voltage reference. Without complicated feedback configurations and only requiring two additional resistors, adding external hysteresis via a separate pin is available on the TS9002's HYST pin.

The TS9002 is fully specified over the  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$  temperature range and is available in a 8-pin MSOP package.

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
TS9002DB	Demo Board



**Figure 1. TS9002 Evaluation Board (Top View)**



**Figure 2. TS9002 Evaluation Board (Bottom View)**

## DESCRIPTION

The demo board provides a configuration where only two resistors are required to set the hysteresis band,  $V_{HB}$ , as shown in Figure 3. Resistor R1 is connected between REF and HYST and R2 is connected between HYST and V-. This will increase the trip point for the rising input voltage,  $V_{THR}$ , and decrease the trip point for the falling input voltage,  $V_{THF}$ , by the same amount. If no hysteresis is required, connect HYST to REF. The hysteresis band,  $V_{HB}$ , is voltage across the REF and HYST pin multiplied by a factor of 2. The HYST pin can accept a voltage between REF and REF-50mV, where a voltage of REF-50mV generates the maximum voltage across R1 and thus, the maximum hysteresis and hysteresis band of 50mV and 100mV, respectively. On the board, V-(pin 2) is labeled as GND.

To design the circuit for a desired hysteresis band, consider the equations below to acquire the values for resistors R1 and R2:

$$R1 = \frac{V_{HB}}{(2 \times I_{REF})}$$

$$R2 = \frac{1.182 - \frac{V_{HB}}{2}}{I_{REF}}$$

The TS9002 demo board provides  $R1 = 20k\Omega$  and  $R2 = 2.4M\Omega$ . This sets the hysteresis band to  $V_{HB} = 20mV$ .

## QUICK START PROCEDURES

### Required Equipment

- TS9002DB demo board
- A DC Power Supply, an HP Model HP6624A or equivalent
- A Precision DC Source/Calibrator, a Krohn-Hite Model 526 or equivalent
- A Digital Voltmeter
- A Digital Ammeter
- Oscilloscope Model Agilent DSO1014A or equivalent ( AC input only)
- 1M $\Omega$  oscilloscope probe ( AC input only)

### ➤ Function Generator ( AC test only)

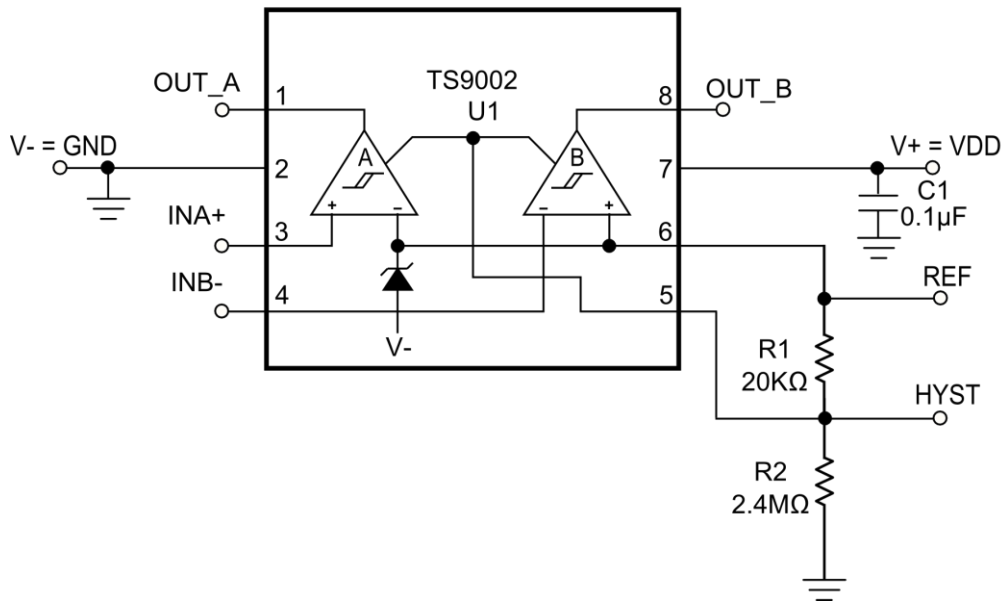
To evaluate the TS9002 comparators, the following steps are to be performed:

- 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 5V and then turn it off.
- 2) Set the DC source/calibrator voltage to 1.182V and turn it off.
- 3) Connect the positive terminal of the DC power supply to the  $V_{DD}$  jumper on the demo board and the negative terminal to the positive terminal of the ammeter. Then, connect the negative terminal of the ammeter to a GND jumper on the demo board.
- 4) Connect the positive terminal of the DC source/calibrator to the INA+ jumper on the demo board and the negative terminal to a GND jumper on the demo board.
- 5) Connect the positive terminal of the DC voltmeter to the OUT\_A jumper on the demo board and the negative terminal to a GND jumper on the demo board.
- 6) Turn on the power supply and the DC source/calibrator and check that the power supply current is approximately 3 $\mu$ A.
- 7) Slowly increase the DC source/calibrator voltage until the output of the comparator switches to approximately 5V. Refer to the voltmeter. The output should switch from a low state to a high state at approximately 1.192V. The power supply current is now approximately 3.6 $\mu$ A
- 8) Now, slowly decrease the DC source/calibrator voltage until the output of the comparator drops to approximately 0V. Refer to the voltmeter. The output should switch from a high state to a low state at approximately 1.172V. The power supply current is approximately 3 $\mu$ A.
- 9) To check the HYST pin voltage or the reference voltage, connect the positive terminal of a voltmeter to the HYST or REF jumper on the demo board and the negative terminal to a GND jumper on the demo board.

10) If testing with an AC input signal is desired, use a function generator and set the offset voltage, amplitude, and frequency to 1.182V, 100mV, and 1kHz, respectively. Connect the positive terminal of the function generator to the INA+ jumper and the negative terminal to the GND jumper on the board.

Then, use the oscilloscope and the oscilloscope probe to monitor the output OUT\_A.

11) If the evaluation of comparator B is desired, follow the previous steps. However, note that the output signal OUT\_B is the inverted version comparator A's output OUT\_A.



**Figure 3. TS9002 Demo Board Circuit**

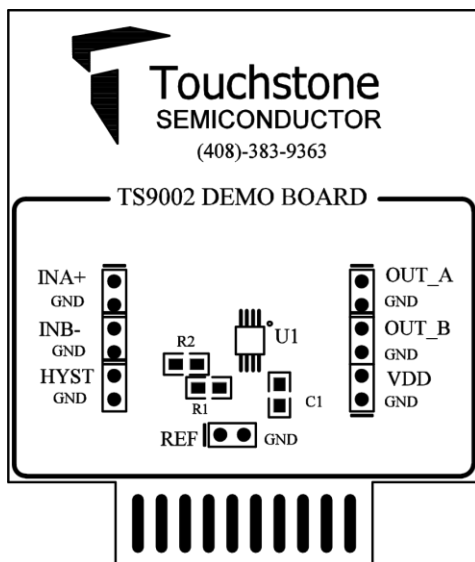


Figure 4. Top Layer Component View

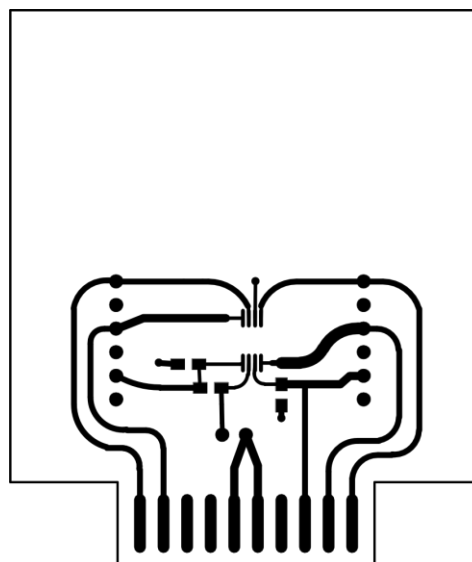


Figure 5. Top Layer Trace View

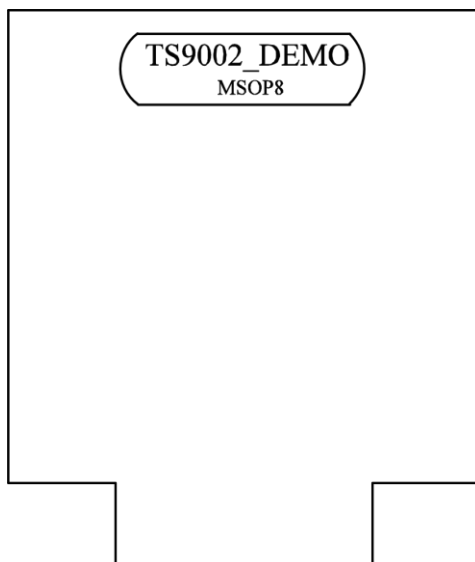


Figure 6. Bottom Layer #1

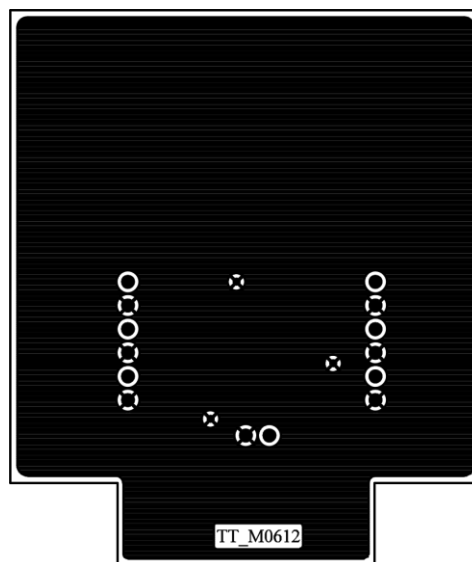


Figure 7. Bottom Layer #2



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