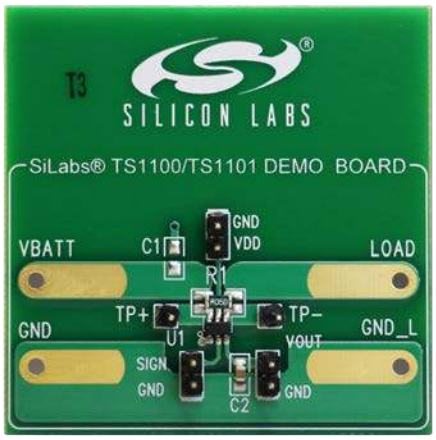
TS1100/01/02/03 Current Sense Amplifier EVB User's Guide

The TS1100/01/02/03 Unidirectional and Bidirectional Current Sense Amplifiers consume a very low 0.68 µA supply current. The TS1100 and TS1101 high-side current sense amplifiers (CSA) combine a 100 µV (max) input offset voltage (VOS) and a 0.6% (max) gain error (GE), with both specifications optimized for any precision current measurement. The TS1102 and TS1103 CSAs combine a 200 µV (max) VOS and a 0.6% (max) GE for cost-sensitive applications. For all high-side current sensing applications, the TS1100/01/02/03 CSAs are self-powered and feature a wide input common-mode voltage range from 2 to 27 V. For the bidirectional CSAs, TS1101 and TS1103, a SIGN comparator digital output is provided that indicates the direction of current flow. All CSAs are specified for operation over the -40 ºC to +105 ºC temperature range.



KEY FEATURES

- R_{SENSE}: 50 mΩ ± 0.5%
- Compatible for All Gain Options
  - 25 V/V
  - 50 V/V
  - 100 V/V
  - 200 V/V

ORDERING INFORMATION

- TS1100-25DB
- TS1100-50DB
- TS1100-100DB
- TS1100-200DB
- TS1101-25DB
- TS1101-50DB
- TS1101-100DB
- TS1101-200DB
- TS1102-25DB
- TS1102-50DB
- TS1102-100DB
- TS1102-200DB
- TS1103-25DB
- TS1103-50DB
- TS1103-100DB
- TS1103-200DB

1. TS1100/02-EVB Description

The evaluation board for the TS1100 or TS1102 is a completely assembled and tested circuit board that can be used for evaluating the current-sense amplifier for all four gain options; i.e., 25 V/V, 50 V/V, 100 V/V, and 200 V/V. The board is configured with an R_{SENSE} = R1 = 60 mΩ resistor. The board has a dedicated RS+ = VBATT, RS– = LOAD, and output voltage OUT = VOUT test points. For additional information, refer to the TS1100/01/02/03 product data sheet.

The demo board includes an optional on-board 0.1µF decoupling capacitor (not installed) at the VBATT input pin and a 47 nF capacitor at the VOUT output pin. Depending on the load current desired, an external resistor or active load is to be connected to the LOAD pin.

Table 1.1. TS1100/02 Component List

Designation	Quantity	Description
U1	1	TS1100-25 / TS1100-50 / TS1100-100 / TS1100-200 / TS1102-25 / TS1102-50 / TS1102-100 / TS1102-200
C1	Not installed	0.1 µF ±10% capacitor (0805)
C2	1	47 nF ±10% capacitor (0805)
R1	1	50 mΩ ± 1% (0805)
VDD, VBATT, VOUT	3	Test Points

2. TS1100/02-EVB Quick Start Procedure

Required Equipment:

- TS1100 or TS1102 demo board
- One dc power supply (HP Model HP6624A or equivalent)
- Two digital voltmeters
- Load resistor or an active load (value varies depending on I_{LOAD} desired)

Table 2.1. Demo Board Test Points

Signal	Eval Board
RS+	VBATT
RS–	LOAD
OUT	VOUT
GND	GND

Table 2.2. Demo Board Test Setup Per Gain Setting

GAIN (V/V)	V_{BATT} (V)	I_{LOAD}(mA)	R_{LOAD}(Ω)	V_{OUT}(V)	MAX V_{SENSE}(mV)
25	6	1600	3.75	2	80
50	6	800	7.5	2	40
100	6	400	15	2	20
200	6	200	30	2	10

To evaluate the TS1100/02 current-sense amplifier circuit, perform the following steps:

1. Before connecting the dc power supply to the demo board, turn on the power supply, set the dc voltage to 6 V, set its short circuit current limit to 10% higher than the maximum load current in the application, and then turn it off.
2. Connect the dc power supply positive terminal to the pad labeled V_{BATT} and its negative terminal to the adjacent pad labeled GND.
3. Connect a digital voltmeter to the test points labeled TP+ and TP– to measure V_{SENSE}.
4. Connect the positive terminal of a second digital voltmeter to the test point labeled V_{OUT} and the negative terminal to the adjacent test point labeled GND.
5. Based on the selective gain option of the current sense amplifier, select the load register or an active load according to the table above. Connect one end of this resistor or active load to the pad labeled LOAD and the other end to the adjacent pad labeled GND.
6. Turn on the power supply and observe the output voltage at V_{OUT}. The expression for the TS1100's output voltage is given by:

$$V_{OUT} = I_{LOAD} \times 50m\Omega \times \frac{R_{OUT}}{R1}$$

where the TS1100's internal ROUT and R1 resistor values are listed in the following table:

Table 2.3. TS1100's Internal Gain Setting Resistors (Typical Values)

Gain (V/V)	R1 (Ω)	ROUT (Ω)
25	400	10K
50	200	10K
100	100	10K
200	100	20K

7. The TS1100's actual output voltage VOUT will depend on the TS100's actual offset voltage VOS, its gain error GE, sense resistor (RSENSE) tolerance of ±1% and the load resistor tolerance/active load accuracy.

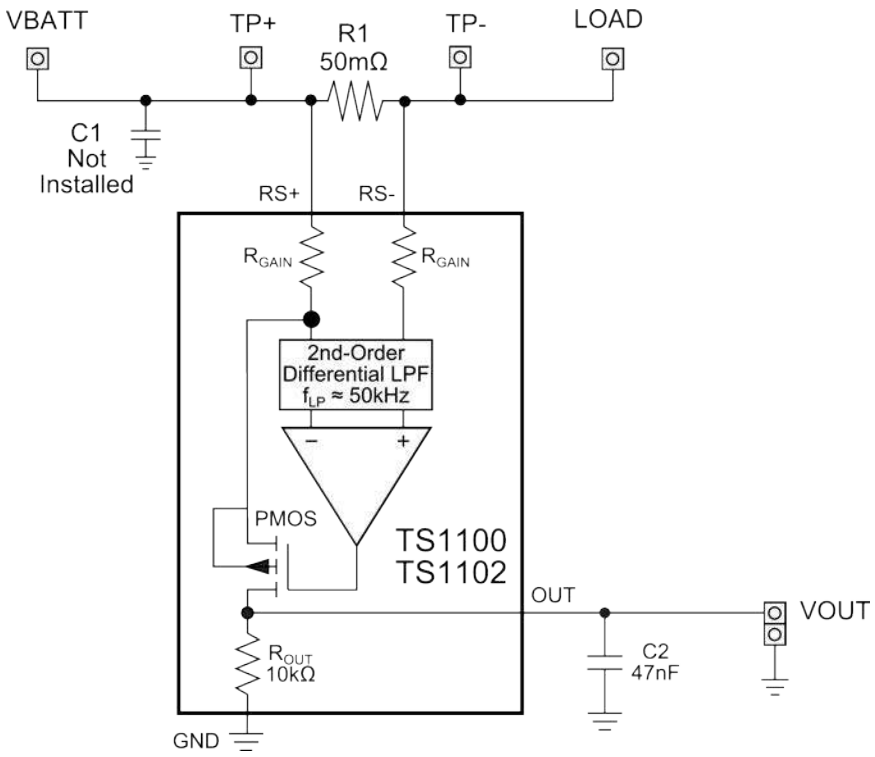


Figure 2.1. TS1100/02 Demo Board Circuit Schematic

3. TS1101/03-EVB Description

The evaluation board for the TS1101 or TS1103 is a completely assembled and tested circuit board that can be used for evaluating the current-sense amplifier for all (4) gain options; i.e., 25V/V, 50V/V, 100V/V, and 200V/V. The board is configured with an R = R1 = 50 mW resistor. The board has a dedicated RS+ = VBATT, RS– = LOAD, and output voltage OUT = VOUT test points. The TS1101 and TS1103 evaluation boards also have VDD and SIGN test points. For additional information, refer to the TS1100/01/02/03 product data sheet.

The demo board includes an optional onboard 0.1 mF decoupling capacitor (not installed) at the VBATT inpujt pin and a 47 nF capacitor at the VOUT output pin. Depending on the load current desired, an external resistor or active load is to be connected at the LOAD pin.

Because the TS1101 and TS1103 are bidirectional current-sense amplifiers, their demo boards can be set up to sense current in both directions. Please refer to Table 4.2 VBATT and LOAD Test Point Connections Per ILOAD Direction on page 5 for the proper connections fo VBATT and LOAD test points. The direction of the current is known based on the voltage level of the SIGN pin. If VRS+ > VRS–, the SIGN pin is a logic HIGH or VDD voltage. If VRS– > VRS+, the SIGN pin is a logic LOW or GND voltage. A VDD test pint is available and powers the internal comparator that monitors the direction of the load current. The output voltage of the comparator is the voltage on the SIGN pin.

Table 3.1. TS1101/03 Component List

Designation	Quantity	Description
U1	1	TS1101-25 / TS1101-50 / TS1101-100 / TS1101-200 /TS1103-25 /TS1103-50 / TS1103-100 / TS1103-200
C1	Not installed	0.1 µF ±10% capacitor (0805)
C2	1	47 nF ±10% capacitor (0805)
R1	1	50 mΩ ± 1% (0805)
VDD, VBATT, VOUT, SIGN, LOAD	5	Test Points

4. TS1101/03-EVB Quick Start Procedure

Required Equipment:

- TS1101 or TS1103 demo board
- One dc power supply (HP Model HP6624A or equivalent)
- Three digital voltmeters
- Load resistor or an active load (value varies depending on I_{LOAD} desired)

Table 4.1. Demo Board Test Points

Signal	Demo Board
RS+	VBATT
RS–	LOAD
OUT	VOUT
GND	GND
VDD	VDD
SIGN	SIGN

Table 4.2. VBATT and LOAD Test Point Connections Per ILOAD Direction

Test Point	$V_{RS+}>V_{RS-}$	$V_{RS-}>V_{RS+}$
VBATT	input voltage	load
LOAD	load	ipnut voltage

Table 4.3. Demo Board Test Setup Per Gain Setting

GAIN (V/V)	V_{BATT} (V)	I_{LOAD}(mA)	V_{DD} (V)	R_{LOAD}(Ω)	V_{OUT}(V)	MAX V_{SENSE}(mV)
25	6	1600	1.8	3.75	2	80
50	6	800	1.8	7.5	2	40
100	6	400	1.8	15	2	20
200	6	200	1.8	30	2	10

To evaluate the TS1101/03 bi-directional current-sense amplifier circuit, perform the following steps:

1. Before connecting the dc power supply to the demo board, turn on the power supply, set the dc voltage to 6 V on one output and the other to 1.8 V. Set the short circuit current limit on each output to 10% higher than the maximum load current in the application, and then turn it off.
2. For applications where $V_{RS+} > V_{RS-}$, connect the 6 V dc power supply positive terminal to the test point VBATT and its negative terminal to the test point GND. Connect the 1.8 V power supply positive terminal to the test point VDD and its negative terminal to the test point GND. See Table 4.2 VBATT and LOAD Test Point Connections Per ILOAD Direction on page 5 for applications where $V_{RS-} > V_{RS+}$.
3. Connect a digital voltmeter to the test points TP+ and TP- to measure V_{SENSE}.
4. Connect the positive terminal of a second digital voltmeter to the test point VOUT and the negative terminal to the test point GND.
5. To monitor the direction of the current, connect the positive terminal of a third digital voltmeter to the test point SIGN and the negative terminal to the test point GND.
6. Based on the selected gain option of the current sense amplifier, select the load resistor or an active load according to Table 4.3 Demo Board Test Setup Per Gain Setting on page 5. Connect one end of this resistor or active load to the test point LOAD and the other end to the test point GND.

7. Turn on the power supply and observe the output voltage at VOUT. The expression for the TS1101/03's output voltage is given by:

$$V_{OUT} = I_{LOAD} \times 50m\Omega \times \frac{R_{OUT}}{R_{GAIN[A/B]}}$$

where the TS1101/03's internal R_{OUT} and $R_{GAIN[A/B]}$ resistor values are listed in the following table:

Table 4.4. TS1101's Internal Gain Setting Resistors (Typical Values)

Gain (V/V)	R1 (Ω)	ROUT (Ω)
25	400	10K
50	200	10K
100	100	10K
200	100	20K

8. The TS1101/03's actual output voltage VOUT will depend on the TS1101/03's actual offset voltage VOS, its gain error GE, sense resistor (RSENSE) tolerance of ±1%, and the load resistor tolerance/active load accuracy.

Note: For applications where $V_{RS-} > V_{RS+}$, connect test points VBATT and LOAD based on Table 4.2 VBATT and LOAD Test Point Connections Per ILOAD Direction on page 5, and follow the steps above.

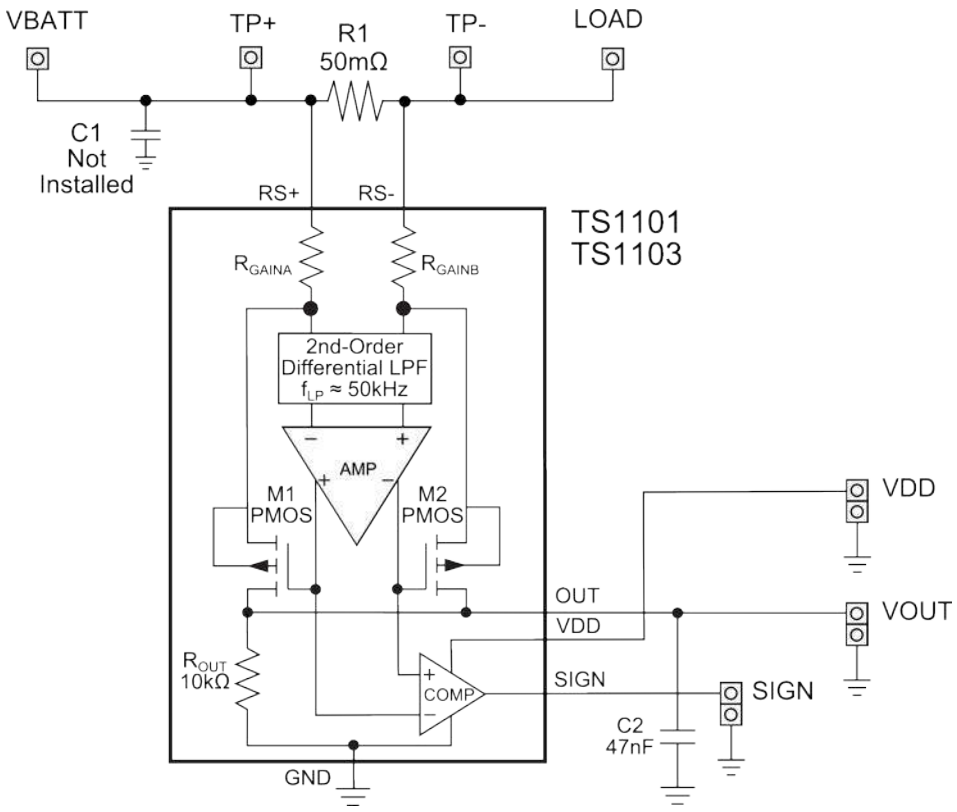
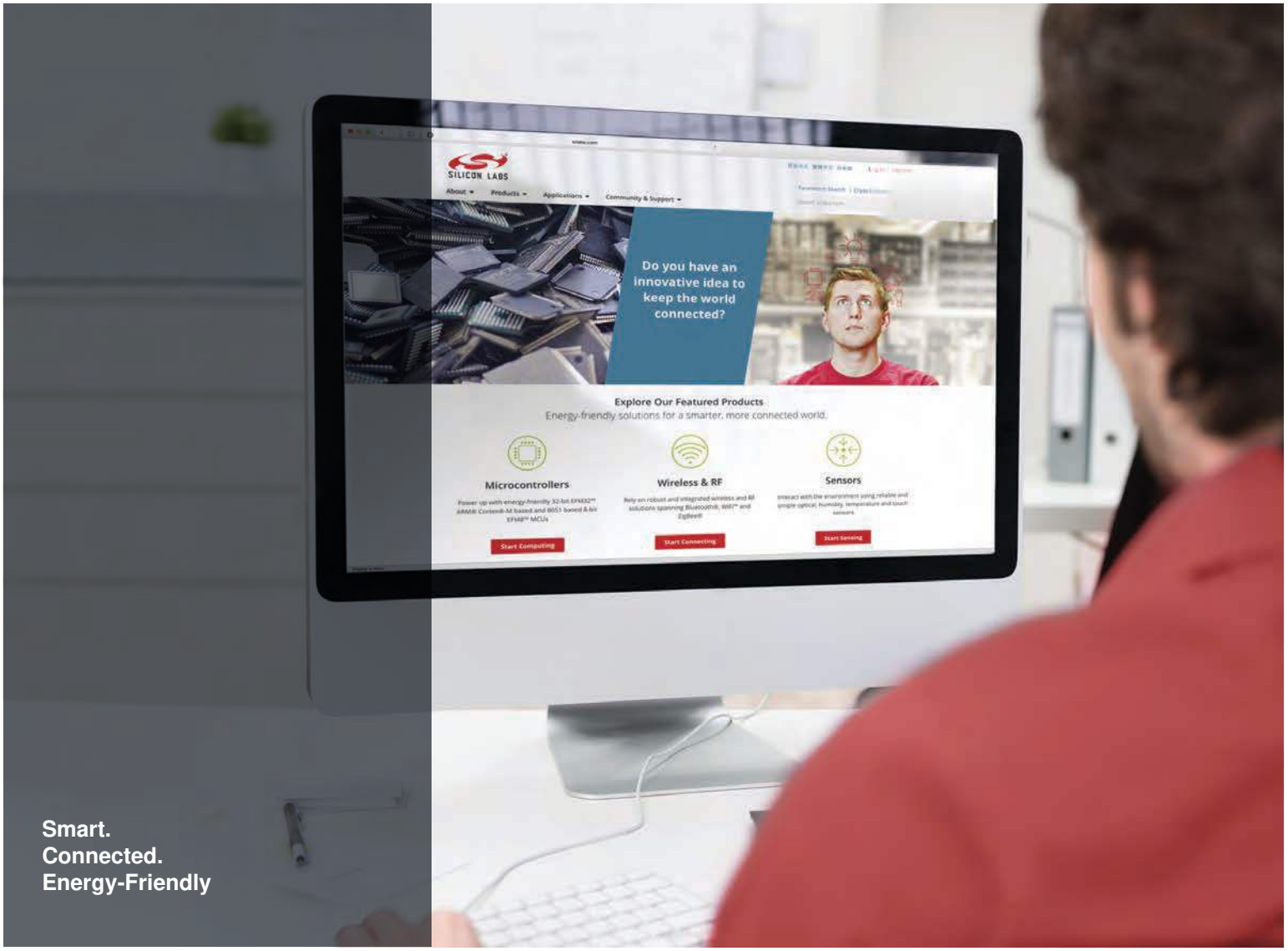


Figure 4.1. TS1101/03DB Demo Board Circuit Schematic



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