User's Guide for the LMP90100 Evaluation Board with Sensor AFE Software

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1.0. Introduction

The LMP90100 Design Kit (consisting of the LMP90100 Evaluation Board, the SPIO-4 Digital Controller Board, the Sensor AFE software, and this user's guide) is designed to ease evaluation and design-in of National Semiconductor's LMP90100 24-bit Fully Programmable Low Power ΣΔ ADC with True Continuous Background Calibration.

Data capturing and static evaluations are simplified by connecting the SPIO-4 Digital Controller Board (SPIO-4 board) to a PC via USB and running the Sensor AFE software. The data capture board will generate the SPI signals to communicate to and capture data from the LMP90100. The user will also have the option to evaluate the LMP90100 without using the SPIO-4 board or the Sensor AFE software.

The LMP90100 will digitize the analog input, and the software will display these results in time domain and histogram. The software also allows customers to write to and read from registers, to calibrate the device or the system's gain, offset, and scale settings, and most importantly, to configure and learn about the LMP90100.

This document describes the connection between the boards and PC, provides a quick start for a DC, shorted input, 3-wire RTD, and thermocouple/temperature sensor applications. This document also

describes how to evaluate the LMP90100 with and without the SPIO-4 board and provides the schematic, board layouts, and BOM.

2.0. Equipment

1. LMP90100 evaluation board (NSID: LMP90100EB)
2. SPIO-4 digital controller board (NSID: SPIO-4)
3. Power supplies (optional) to source VA, VIO, VREFP, or VIN.
4. Multimeter
5. PC with Sensor AFE software
6. 3-wire RTD (optional)
7. Thermocouple (optional)

2.1. Connection Diagram

Figure 1 shows the connection between the LMP90100 Evaluation Board (LMP90100EB), SPIO-4 board, and a personal computer with the LMP90100 Sensor AFE software. LMP90100 can be powered using external power supplies or from the SPIO-4 board.

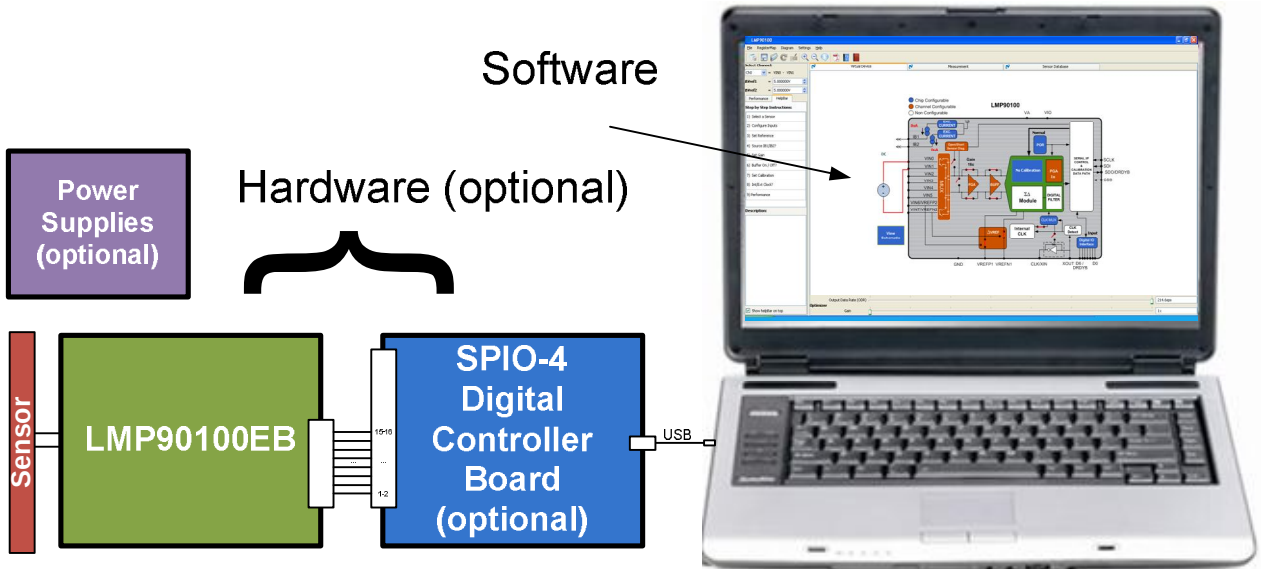


Figure 1 – Connection Diagram

2.2. Board Assembly

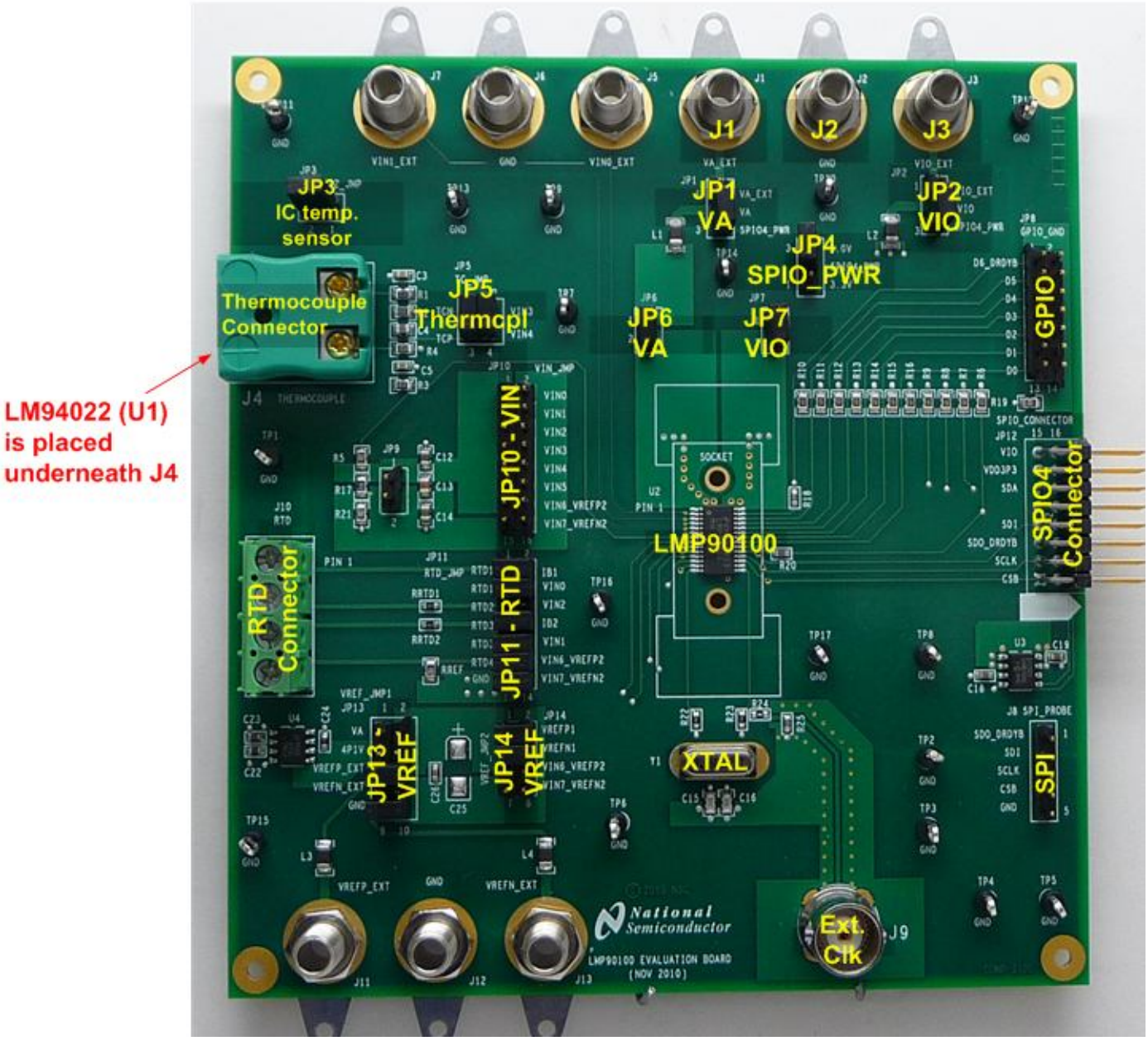


Figure 2 – LMP90100 Evaluation Board Assembly

3.0. Example #1: Quick Start – DC Reading

The following procedures show a quick method to assemble the LMP90100EB and perform a quick DC voltage reading.

A. LMP90100 EB Jumper Connections

1. The jumpers for this example application can be seen in Figure 3 and Table 1. Jumpers not shown can be left unpopulated.
2. The SPIO-4 board is properly setup out of the box (no assembly required).
3. The schematic for the LMP90100EB can be seen Figure 33.

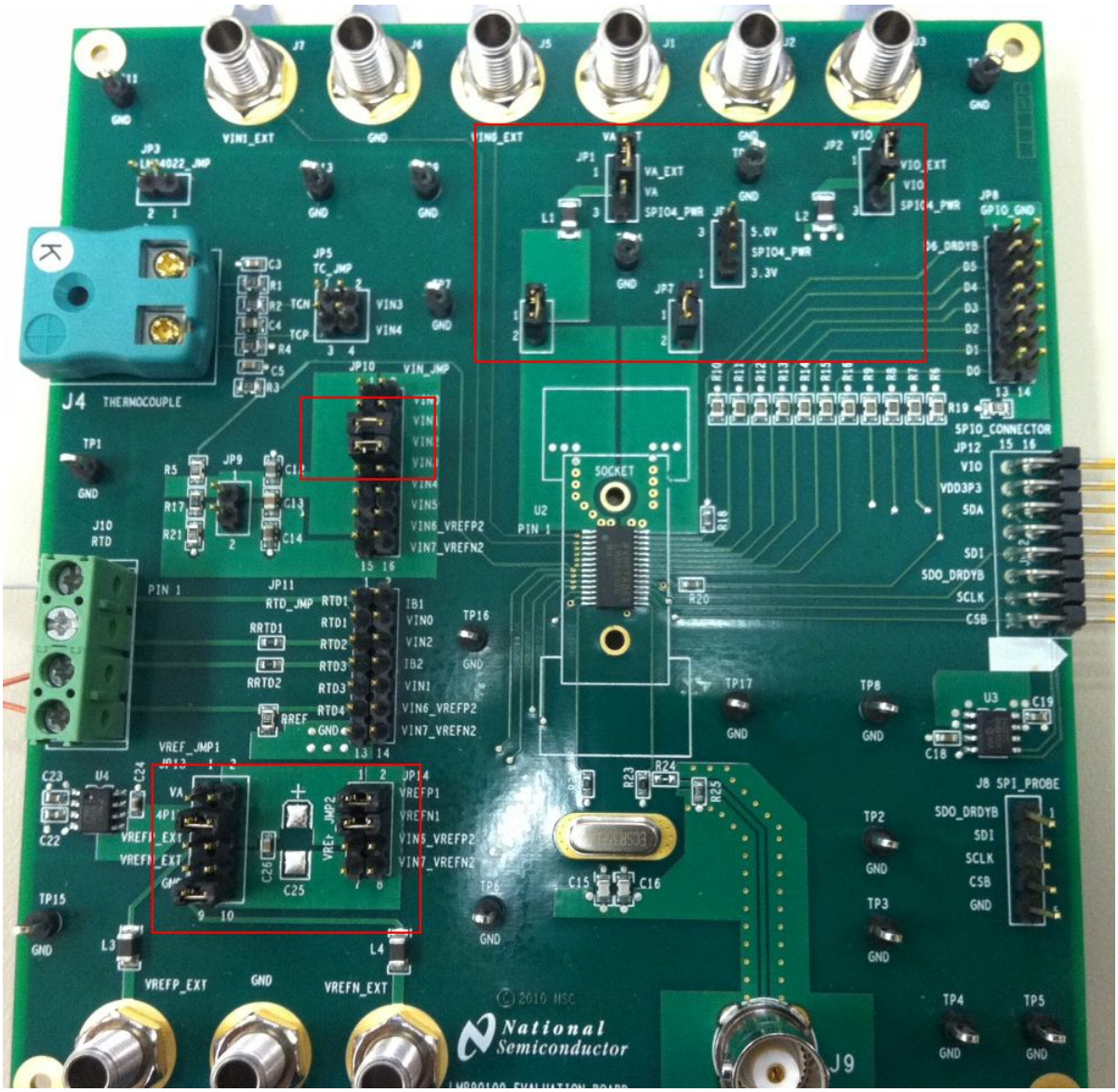


Figure 3 – Jumper Settings (Default) for the DC Test

Jumpers	Pin	Purpose
JP1: VA_EXT	P1-P2	Source VA externally
JP2: VIO_EXT	P1-P2	Source VIO externally
JP6	P1-P2	Connect VA supply to the LMP90100
JP7	P1-P2	Connect VIO supply to the LMP90100
JP10: VIN_JMP	P5-P6	Connect a DC input to VIN2
JP10: VIN_JMP	P7-P8	Connect a DC input to VIN3
JP13: VREF_JMP1	P3-P4	VREFP1 = 4.1V from U4 (LM4140)
JP13: VREF_JMP1	P9-P10	VREFN1 = ground
JP14: VREF_JMP2	P1-P2	Connect VREFP1 source to the LMP90100
JP14: VREF_JMP2	P3-P4	Connect VREFN1 source to the LMP90100

Table 1 - Jumpers for DC Measurement

B. Installing/Opening the Software - follow section 9.0 to install and open the LMP90100 Sensor AFE software.

C. Connecting and Powering the Boards – these steps have to be done in this order.

1. Connect a 5.0V power supply to **J1** (VA_EXT) and GND (J2). Don't turn on the power supply yet.
2. Connect a 5.0V power supply to **J3** (VIO_EXT) and GND (J2). Don't turn on the power supply yet.
3. **Turn on** the power supply that is sourcing VA (J1), and then turn on the power supply that is sourcing VIO (J3).
4. Connect the LMP90100EB's **JP12** to SPIO-4 Board's **J6** (pins 1-16). See Figure 4.

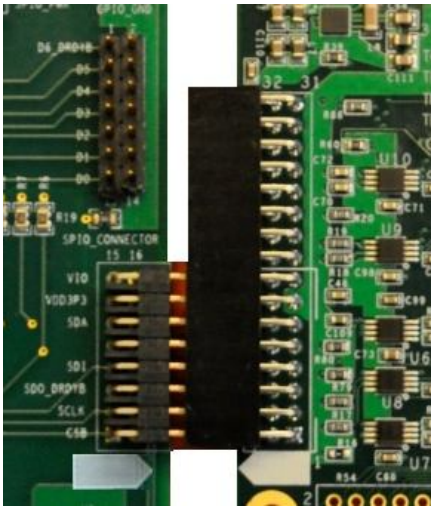


Figure 4 – LMP90100EB-to-SPIO-4 Board Connection

5. Connect SPIO-4 board to a PC via **USB.**
6. Use a multimeter to measure LMP90100EB's JP6, JP7; they should all be approximately 5V. If they are not, check your power supplies and jumpers. Measure JP14.P2; it should be approximately 4.1V. If it's not, check your jumpers and U4.

D. Configuring the LMP90100 Using the Sensor AFE Software

Follow the step-by-step instructions under the **"HelpBar"** mini-tab (left hand side of the GUI) to configure the LMP90100 for this example. These step-by-step instructions are discussed in details below, and the recommended configuration should look similar to Figure 4.

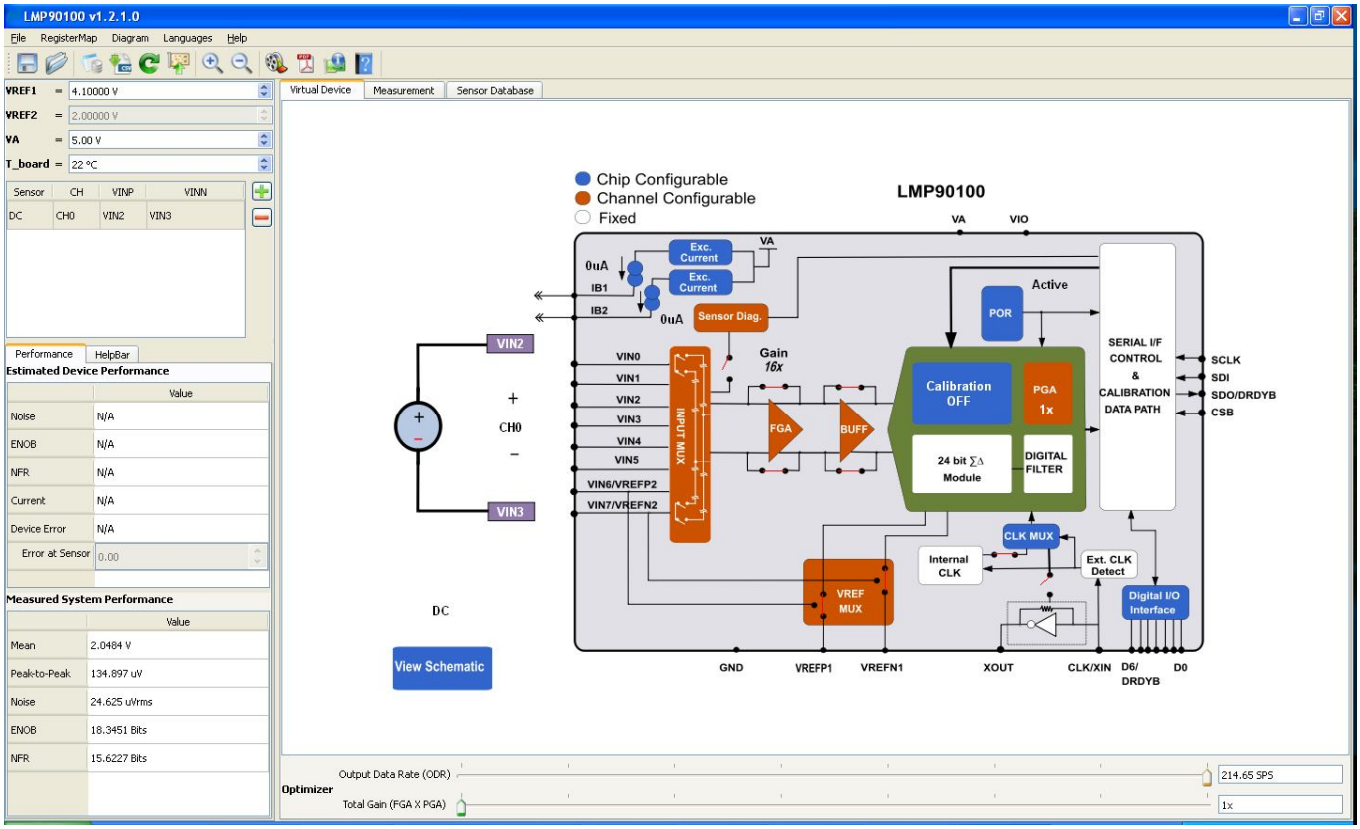


Figure 5 - Recommended LMP90100 Configuration for a DC Reading

1. Step 1: Select a Sensor - select **"DC" → "DC"** since the input source is not a sensor.

2. Step 2: Configure Inputs – click on the **"INPUT MUX"** block to set "**VINP = 000: VIN2"** and "**VINN = 001: VIN3".** Since VIN0 = (3/4) VREF1 and VIN1 = (1/4) VREF1, the measurement across this channel will be (1/2) VREF1.

3. Step 3: Source IB1/IB2? – *this step can be ignored because neither IB1 nor IB2 is connected to the inputs.*

4. Step 4: Select Reference – click on the "**VREF MUX"** block to choose **"VREF_SEL = 0: VREF1".** Make sure the **VREF1** value on the upper left hand side of the GUI is 4.1V (default).

5. Step 5: Set Gain – since VIN = (1/2) VREF1, the maximum gain that can be set is 2 (with buffer disabled). If the buffer is enabled, then the output might rail and enable the "OFLO_FLAGS" flag. In this case, set the gain to 1. Click on the **"FGA"** block**, "PGA"** block**,** or the "**Gain"** slider to select the gain.

6. Step 6: Set Buffer – click on the **"BUFF"** block to include or exclude the buffer from the signal path.

7. Step 7: Set Calibration - click on the **"No Calibration"** block to enable or disable calibration. Refer to the LMP90100 datasheet to more information on the LMP90100's background calibration types and modes.

8. Step 8: Int/Ext CLK? – click on the **"CLK MUX"** block and make sure the internal clock is selected.

9. Step 9: Performance - click on the **"Performance"** mini-tab. This tab displays the Estimated Device Performance base on the block diagram that you've configured, as well as the Measured System Performance if you've connected a board and ran the LMP90100.

E. Capturing Data

1. Click on the **"Measurement"** tab and set the **"Scan Mode"** as follows:

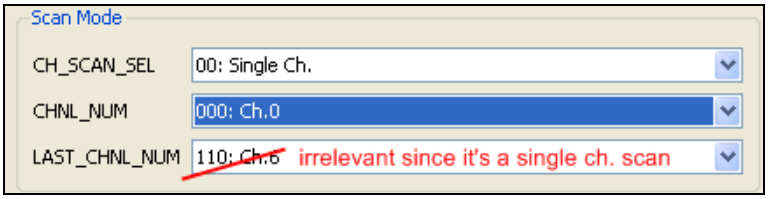


Figure 6 - Scan Mode Settings

2. Under the **"Output Format"** field, select Display as "**Output Voltage (V)"**
3. Under the **"Stop Condition"** field, select Run as **"1000"** samples.
4. Click on the **"Run"** button to view the output voltage results. A reading of approximately ½(VREF1) should be plotted as seen in Figure 7.

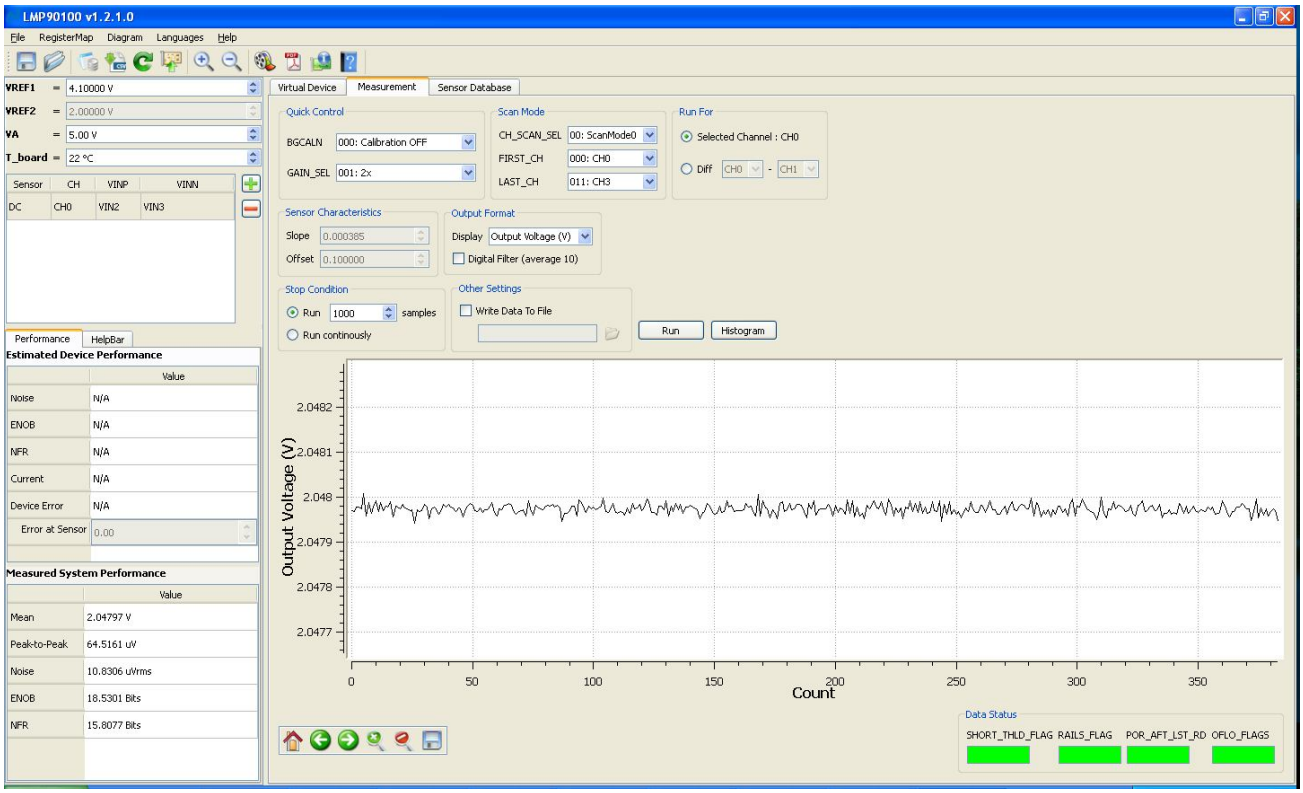


Figure 7 - Results for Example #1 - DC Reading

4.0. Example #2: Shorted Input and Calibration Test

This example demonstrates LMP90100's ability to calibrate for offset error.

A. LMP90100 EB Jumper Connections

1. Connect the LMP90100EB jumpers like the jumpers shown in the figure and table below. Jumpers not mentioned can be left unconnected..
2. The SPIO-4 board is properly setup out of the box (no assembly required).
3. The schematic for the LMP90100EB can be seen Figure 33.

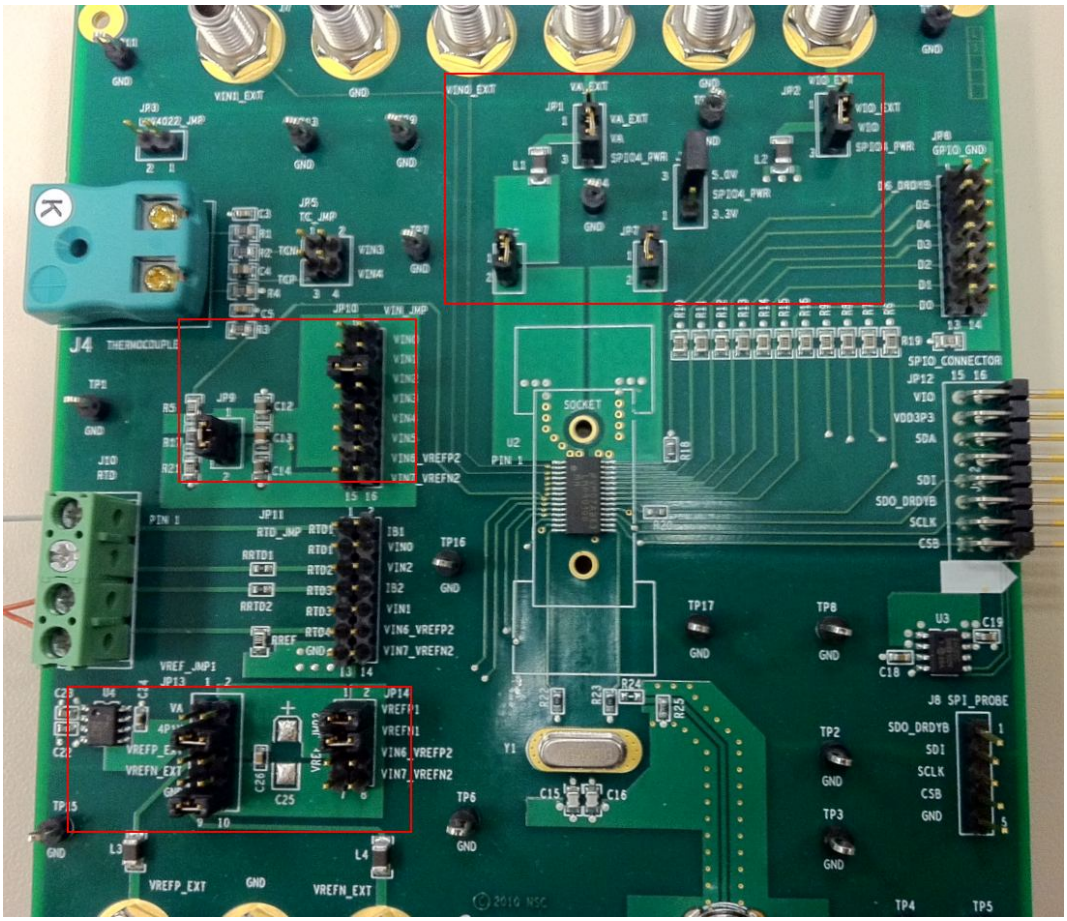


Figure 8 – LMP90100EB Jumper Settings for the Shorted input and Calibration Test

Jumpers	Pin	Purpose
JP1: VA_EXT	P2-P3	Source VA with the 5.0V from the SPIO-4 board.
JP2: VIO_EXT	P2-P3	Source VIO with the 5.0V from the SPIO-4 board.
JP4	P2-P3	Get 5.0V from the SPIO-4 board
JP6	P1-P2	Connect VA supply to the LMP90100
JP7	P1-P2	Connect VIO supply to the LMP90100
JP9	P1-P2	Force the odd pins of JP10 to be midscale (VREF1/2)
JP10: VIN_JMP	P5-P6	Connect a DC (midscale) voltage to VIN2
JP13: VREF_JMP1	P3-P4	VREFP1 = 4.1V from U4 (LM4140)
JP13: VREF_JMP1	P9-P10	VREFN1 = ground

JP14: VREF_JMP2	P1-P2	Connect VREFP1 source to the LMP90100
JP14: VREF_JMP2	P3-P4	Connect VREFN1 source to the LMP90100

Table 2 - Jumpers for the Shorted Input Measurement

B. Installing/Opening the Software – skip this step if it's already done. If not, follow section 9.0 to install and open the LMP90100 Sensor AFE software.

C. Connecting and Powering the Boards

1. Connect the LMP90100EB to the SPIO-4 board as seen in Figure 4.
2. Connect SPIO-4 board to a PC via **USB.**
3. Use a multimeter to measure LMP90100EB's JP6 and JP7; they should all be approximately 5V, and JP14.P2 should be 4.1V. If they are not, check your power supplies and jumpers.

D. Configuring the LMP90100 Using the Sensor AFE Software

Follow the step-by-step instructions under the **"HelpBar"** mini-tab (left hand side of the GUI) to configure the LMP90100 for this example. These step-by-step instructions are discussed in details below, and the recommended configuration should look similar to figure 9.

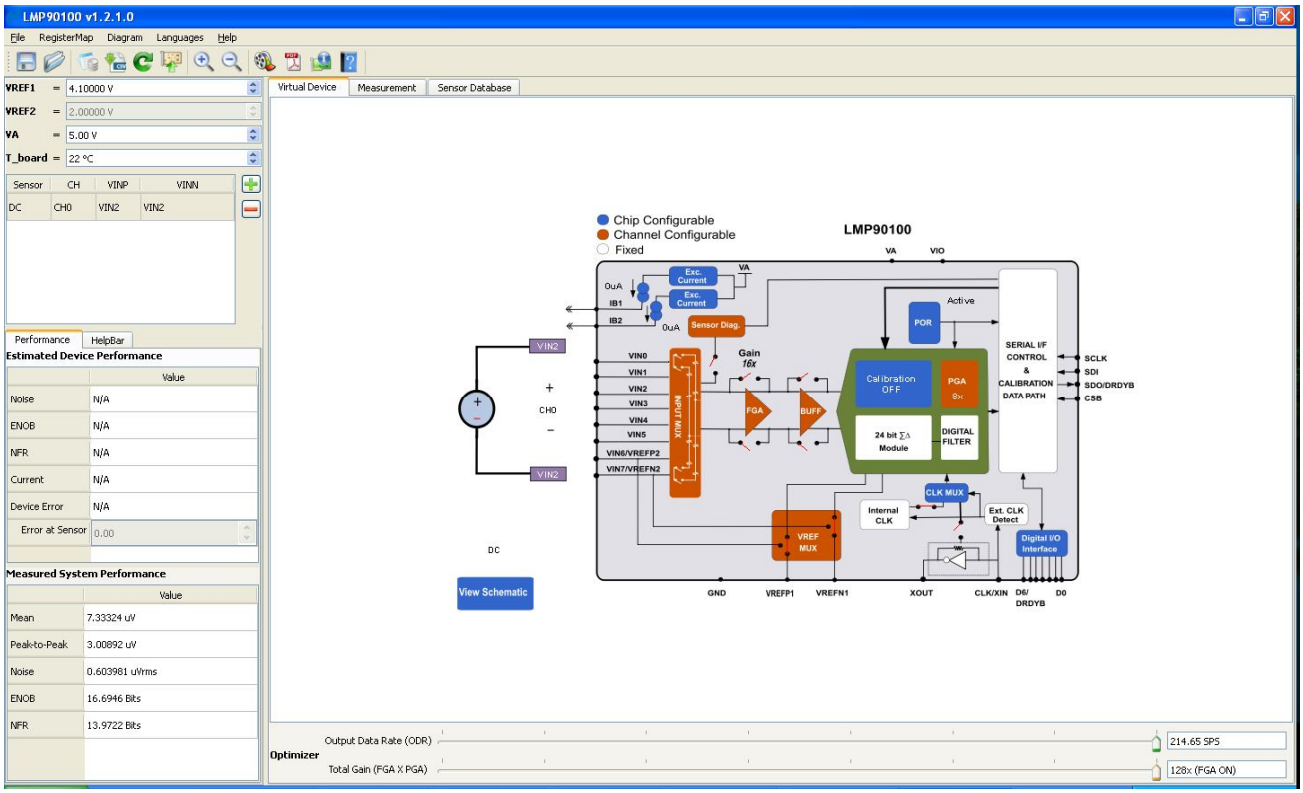


Figure 9 - Recommended LMP90100 Configuration for the Shorted Input and Calibration Test

1. Step 1: Select a Sensor - select **"DC" → "DC"** since the input source is a DC voltage

2. Step 2: Configure Inputs – click on the **"INPUT MUX"** block to set "**VINP = 000: VIN2"** and "**VINN = 000: VIN2".** Since VINP = VINN, a reading of approximately 0V should be read.

3. Step 3: Source IB1/IB2? – *this step can be ignored because neither IB1 nor IB2 is connected to the inputs.*

4. Step 4: Select Reference – click on the "**VREF MUX"** block to choose **"VREF_SEL = 0: VREF1".** On the left hand side of the GUI, change the VREF1 (left hand side of the GUI) value to 4.1V.

5. Step 5: Set Gain – since VIN ≈ 0V, the maximum gain that can be set is 128x. Click on the **"FGA"** block**, "PGA"** block**,** or the "**Gain"** slider to select the gain.

6. Step 6: Set Buffer – click on the **"BUFF"** block to include or exclude the buffer from the signal path.

7. Step 7: Set Calibration - the purpose of this example is to show how the LMP90100 removes the offset error using background calibration. Initially, disable the calibration by selecting "**000: No Calibration"** under the **"No Calibration"** block.

   Refer to the LMP90100 datasheet to more information on the LMP90100's background calibration types and modes.

8. Step 8: Int/Ext CLK? – click on the **"CLK MUX"** block and make sure the internal clock is selected.

9. Step 9: Performance - click on the **"Performance"** mini-tab. This tab displays the Estimated Device Performance base on the block diagram that you've configured, as well as the Measured System Performance if you've connected a board and ran the LMP90100.

E. Capturing Data without Calibration

1. Click on the **"Measurement"** tab and set the **"Scan Mode"** as follows:

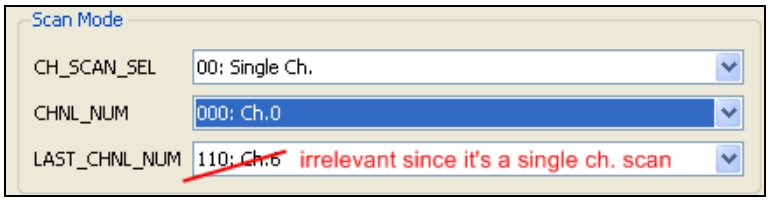


Figure 10 - Scan Mode Settings

2. Under the **"Output Format"** field, select Display "**Output Voltage (V)"**
3. Under the **"Stop Condition"** field, select Run **"500"** samples.
4. Click on the **"Run"** button to view the output voltage results. A reading in the hundreds of uV should be plotted similar to Figure 11.

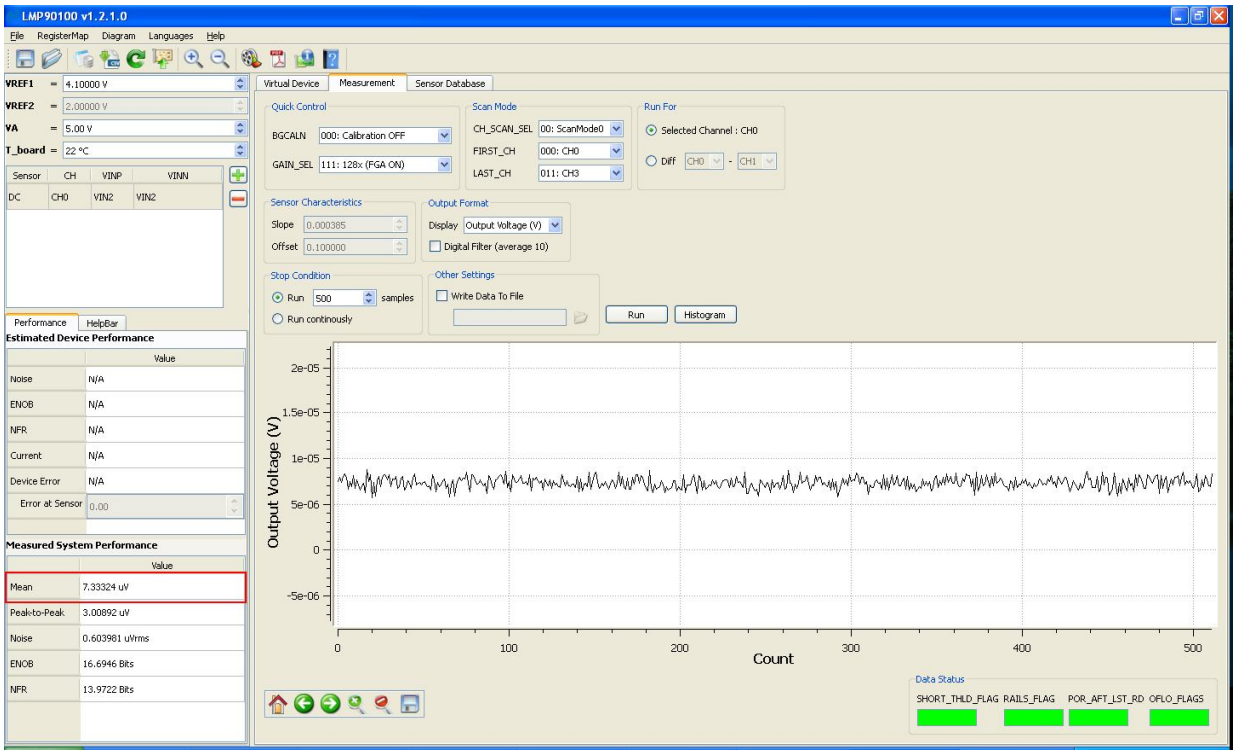


Figure 11 - Results for Shorted Input Test without Calibration

F. Capturing Data with Calibration

1. In the **"Measurement"** tab, go to "**Quick Control → BGCAL_MODE"** and change the background calibration to **"001: Offset Cor / Gain Est".**
2. Click on the **"Run"** button again to view the output voltage results. A mean output reading closer to 0V should be plotted similar to Figure 12. This decrease in the mean output reading demonstrates the LMP90100 offset calibration feature.

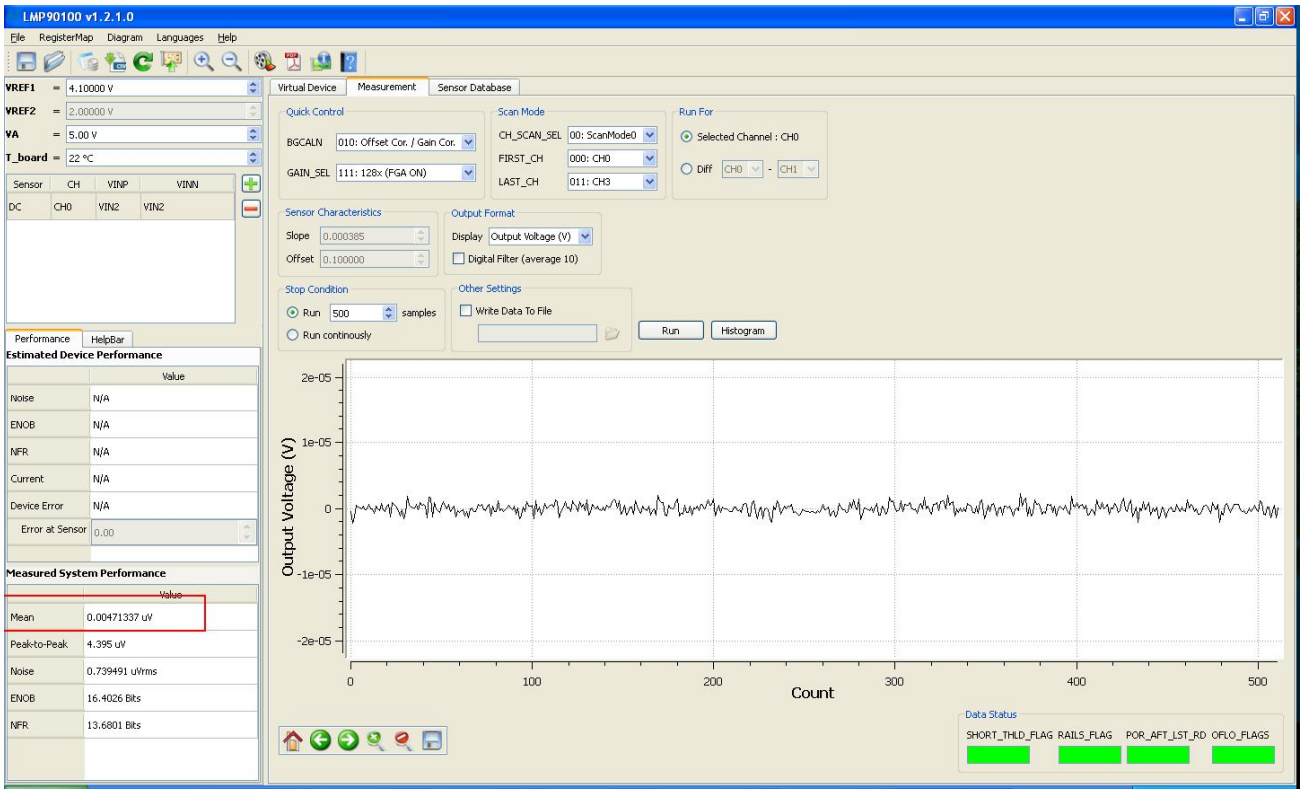


Figure 12 - Results for Shorted Input Test with Calibration

5.0. Example #3 - 3-wire RTD Application

A 3-wire RTD has a typical configuration shown in Figure 13. This section will explain how to configure the LMP90100EB and software tool to evaluate a 3-wire RTD.

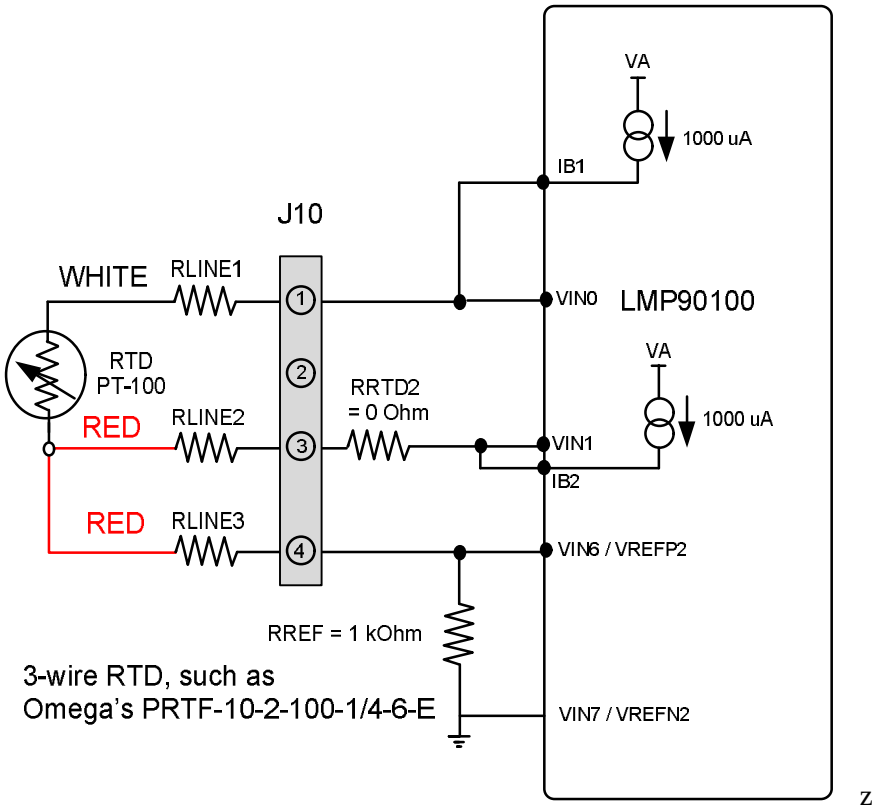


Figure 13 - 3-Wire RTD Configuration

A. LMP90100EB Jumper Connections

1. The jumper settings for this application are shown below. The jumpers not mentioned can be left unconnected.
2. The SPIO-4 board is properly setup out of the box (no assembly required).
3. The schematic for the LMP90100EB can be seen Figure 33.

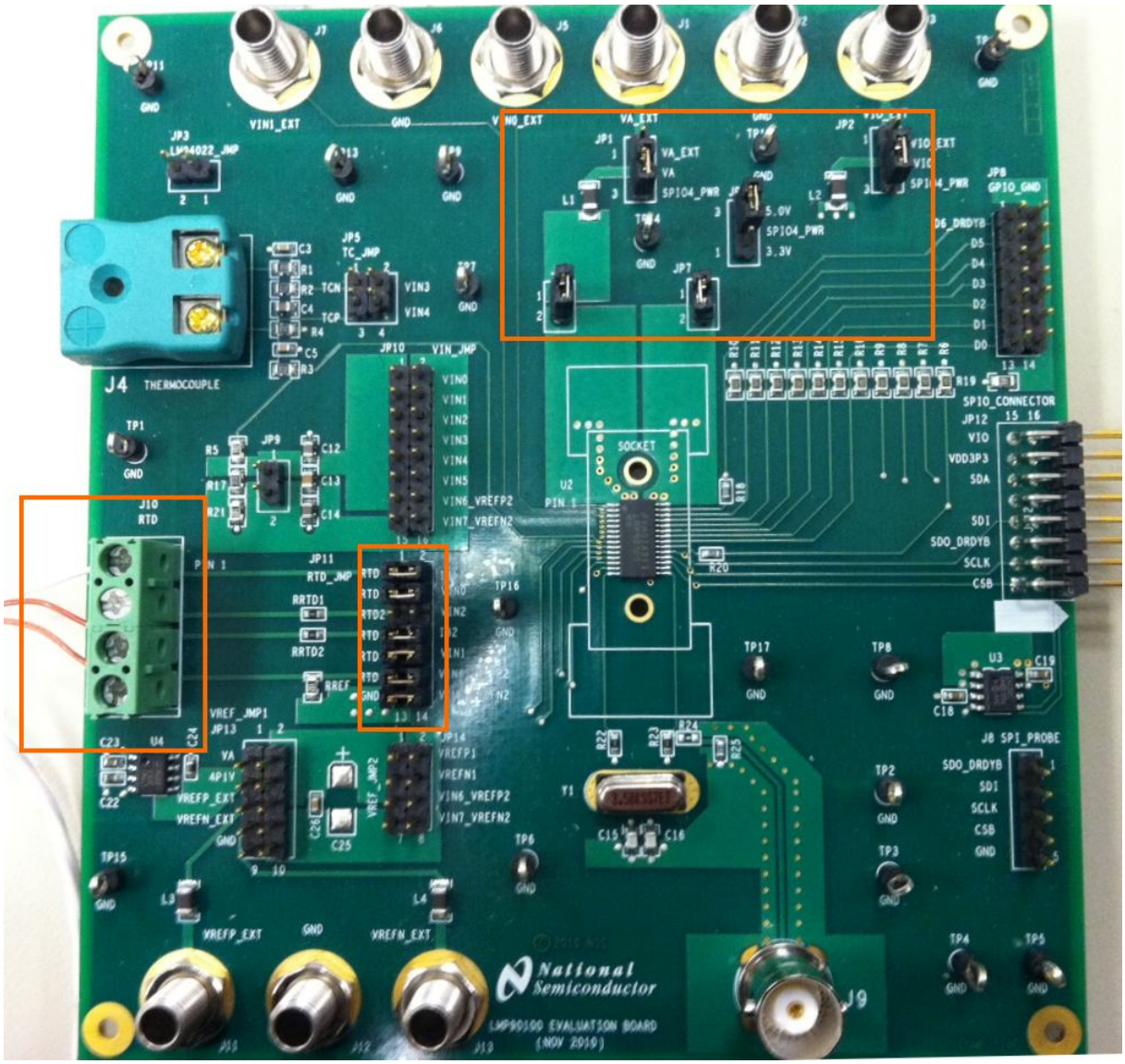


Figure 14 – Jumper Settings (Default) for the 3-wire RTD Example

Jumpers	Pin	Purpose
JP1: VA_EXT	P2-P3	Source VA with the 5.0V from the SPIO-4 board.
JP2: VIO_EXT	P2-P3	Source VIO with the 5.0V from the SPIO-4 board.
JP4	P2-P3	Get 5.0V from the SPIO-4 board
JP6	P1-P2	Connect VA supply to the LMP90100
JP7	P1-P2	Connect VIO supply to the LMP90100
JP11: RTD_JMP	P1-P2	Connect IB1 to the RTD
JP11: RTD_JMP	P3-P4	Connect the RTD to VIN0
JP11: RTD_JMP	P7-P8	Connect IB2 to the RTD
JP11: RTD_JMP	P9-P10	Connect the RTD to VIN1
JP11: RTD_JMP	P11-P12	Connect the RTD to VREFP2
JP11: RTD_JMP	P13-P14	Connect VREFN2 to ground

Table 3 – LMP90100EB Jumpers for the RTD Application

B. Installing/Opening the Software – skip this step if it's already done. If not, follow section 9.0 to install and open the LMP90100 Sensor AFE software.

C. Connecting and Powering the Boards

1. Connect the LMP90100EB to the SPIO-4 board as seen in Figure 4.
2. Connect SPIO-4 board to a PC via **USB.**
3. Use a multimeter to measure LMP90100EB's JP6 and JP7; they should all be approximately 5.0V. If they are not, check your power supplies and jumpers.

D. Connecting the Sensor to the LMP90100EB

1. Connect a 3-wire RTD to J10 as seen in the image below. The white wire should be at J10.P1, and the red wires should be at J10.P3 and J10.P4.

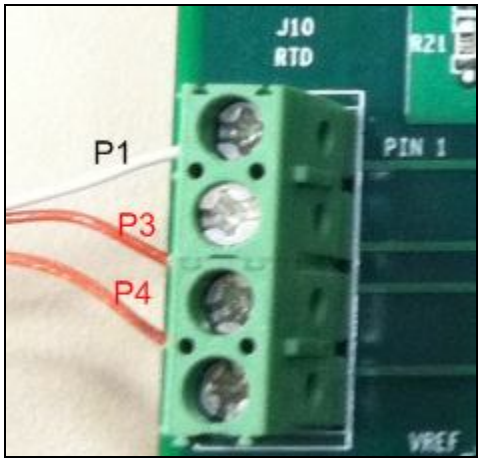


Figure 15 – Jumper Settings (Default) for the 3-wire RTD Example

E. Configuring the LMP90100 Using the Sensor AFE Software

Follow the step-by-step instructions under the **"HelpBar"** mini-tab (left hand side of the GUI) to configure the LMP90100 for this example. These step-by-step instructions are discussed in details below, and the recommended configuration should look similar to Figure 16.

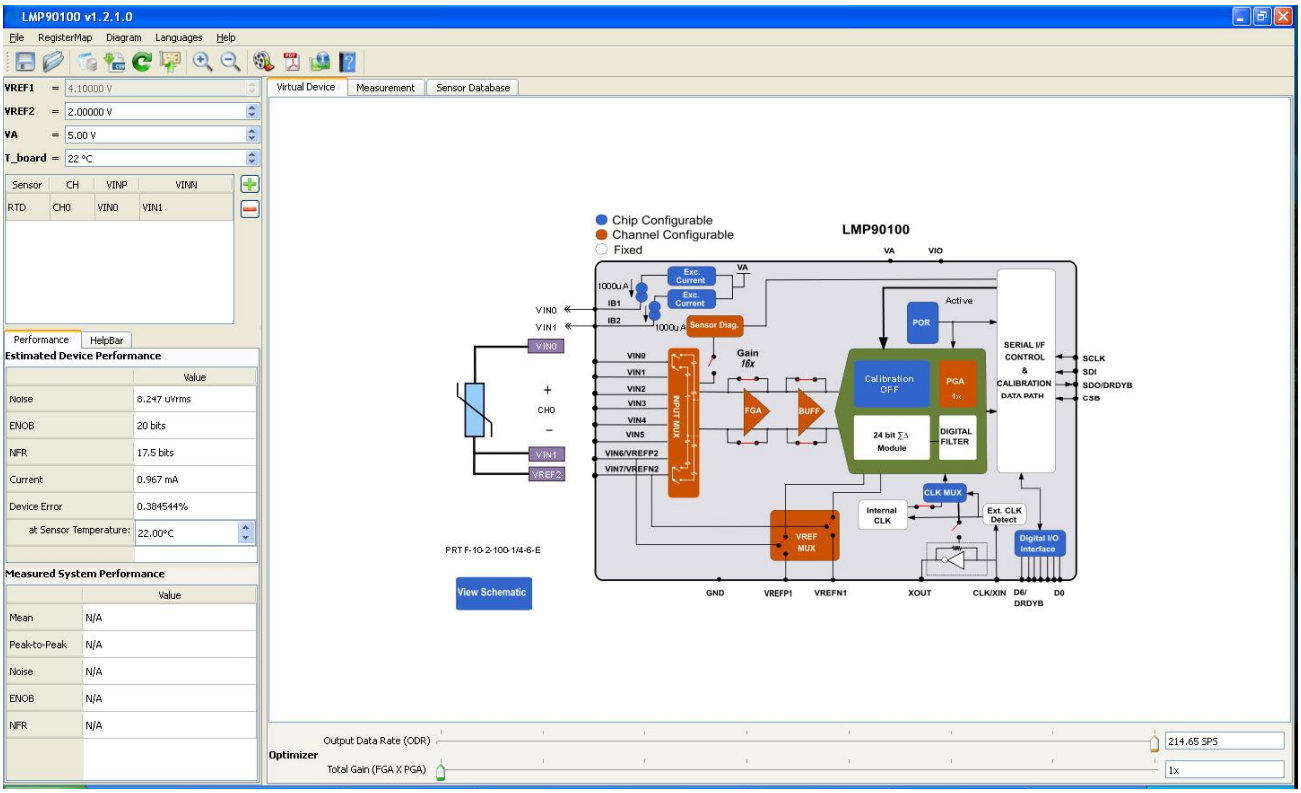


Figure 16 - Recommended LMP90100 Configuration for a PT-100 RTD Reading

1. Step 1: Select a Sensor - select **"RTD" → "PRTF-10-2-100-1/4-6-E"**.

2. Step 2: Configure Inputs – click on the **"INPUT MUX"** block to set "**VINP = 000: VIN0"** and "**VINN = 001: VIN1".** Click on the **"View Schematic" (or "Eval. Board Settings")** button located next to the block diagram. This should open up a PDF of the schematic and calculation for this 3-wire RTD example.

3. Step 3: Source IB1/IB2? – click on the **"EXC. Current"** block to set **"RTD_CUR_SEL = 1010: 1000 uA"**.

4. Step 4: Select Reference – click on the "**VREF MUX"** block to choose **"VREF_SEL = 1: VREF2".** Make sure the value for VREF2 (upper left hand side of the GUI) is 2.0V = [RREF * (IB1+IB2)] = [1k * (1mA + 1mA)].

5. Step 5: Set Gain – since VIN = 0.109 V at room temperature for IB1 = IB2 = 1000 uA, the maximum gain can be 16x. Click on the **"FGA"** block**, "PGA"** block**,** or the "**Gain"** slider to select the gain. *(For this exercise, the gain can be set to 1x).*

6. Step 6: Set Buffer – click on the **"BUFF"** block to include or exclude the buffer from the signal path. *(For this exercise, the buffer can be disabled).*

7. Step 7: Set Calibration - click on the **"No Calibration"** block to enable or disable calibration. Refer to the LMP90100 datasheet to more information on the LMP90100's background calibration types and modes. *(For this exercise, the calibration can be OFF).*

8. Step 8: Int/Ext CLK? – click on the **"CLK MUX"** block and make sure the internal clock is selected.

9. Step 9: Performance - click on the **"Performance"** mini-tab. This tab displays the Estimated Device Performance base on the block diagram that you've configured, as well as the Measured System Performance if you've connected a board and ran the LMP90100.

F. Capturing Data

1. Click on the **"Measurement"** tab and set the **"Scan Mode"** as follows:

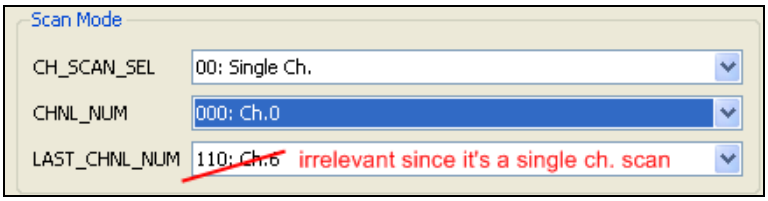
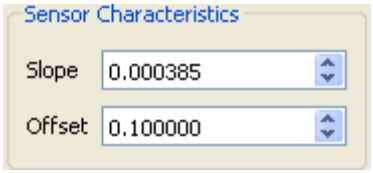


Figure 17 - Scan Mode Settings

2. Under the **"Output Format"** field, select Display "**Temperature (°C)"**
3. Make sure the **"Sensor Characteristics"** is set as:



4. Under the **"Stop Condition"** field, select **"Run Continuously"**.
5. Click on the **"Run"** button to view the output temperature reading. A reading of approximately 23°C to 25°C (room temperature) should be plotted.

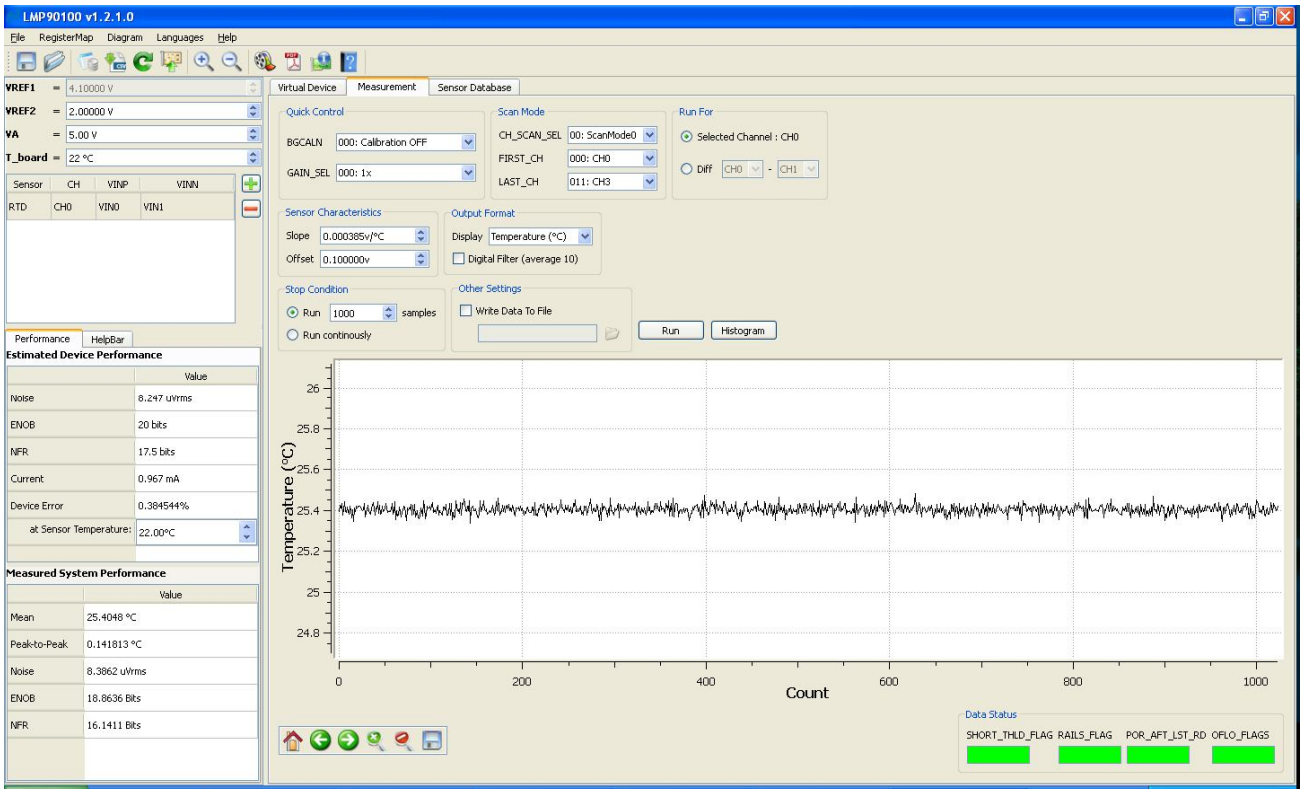


Figure 18 – Reading of Room Temperature Using the 3-Wire RTD

6.0. Example #4: Thermocouple and LM94022 Application

The thermocouple and temperature sensor schematic of the LMP90100 Evaluation Board are shown in Figure 19. The temperature sensor is a LM94022 and is located under the thermocouple connector (J4) to provide cold junction compensation. The thermocouple connector (J4) is made for use with a type K thermocouple. This section will explain how to configure the LMP90100EB for the thermocouple and IC temperature sensor applications.

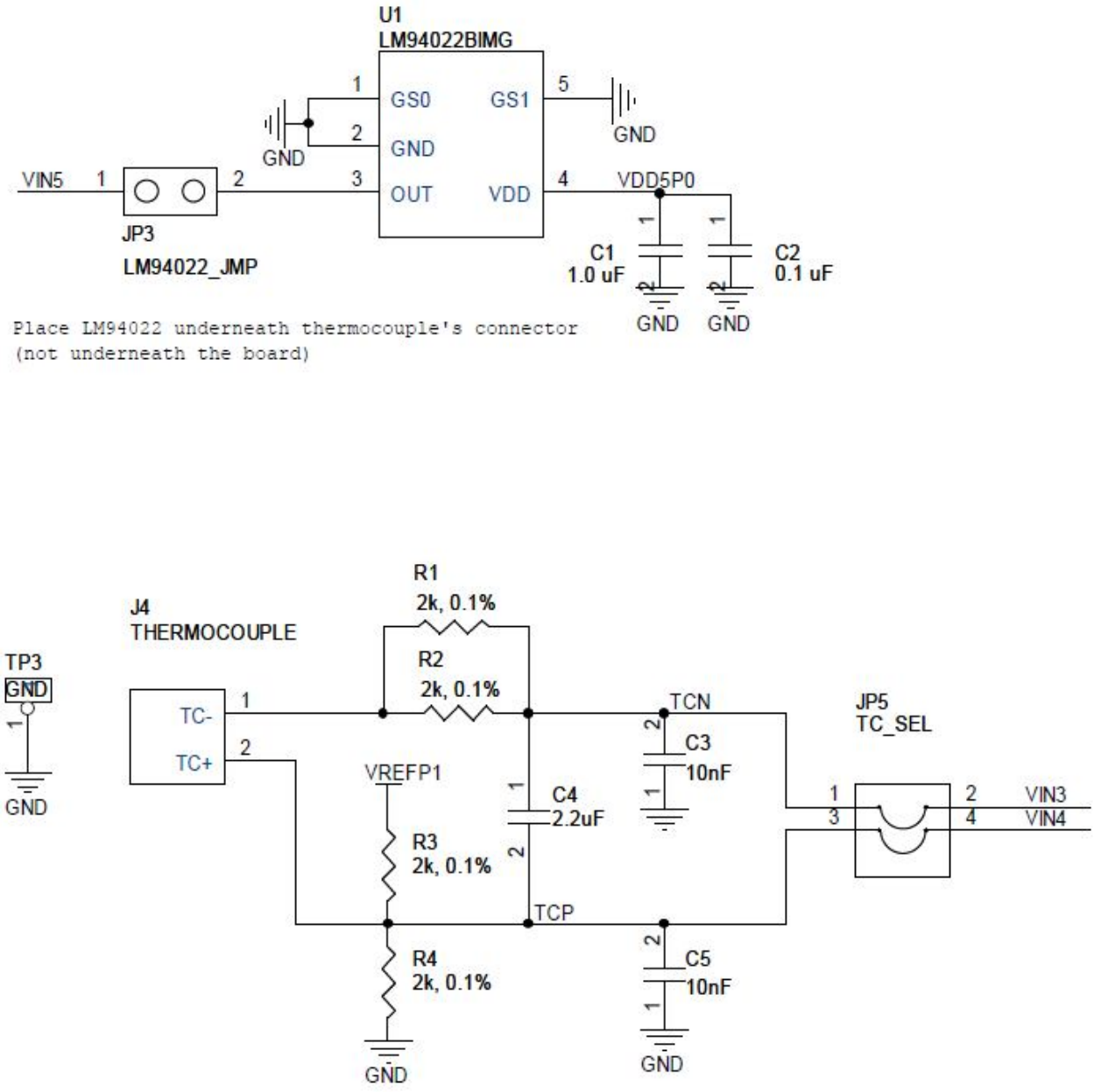


Figure 19 – Thermocouple and Temperature Sensor Schematic

A. LMP90100EB Jumper Connections:

1. The figure and table below show the LMP90100 evaluation board jumper settings for this thermocouple application. The jumpers not mentioned can be left unconnected.
2. The SPIO-4 board is properly setup out of the box (no assembly required).
3. The schematic for the LMP90100EB can be seen Figure 33.

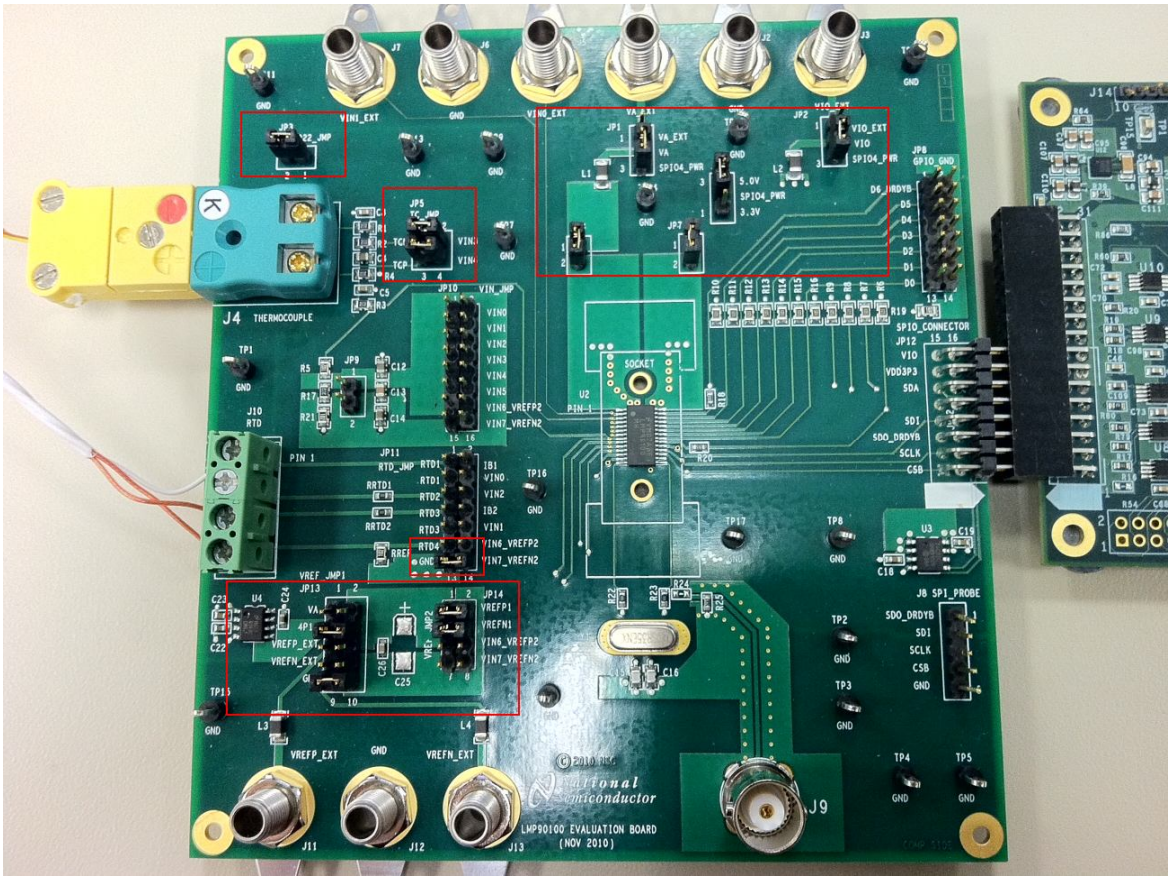


Figure 20 – Jumper Settings for the Thermocouple and LM94022 Example

Jumpers	Pin	Purpose
JP1: VA_EXT	P2-P3	Source VA with the 5.0V from the SPIO-4 board.
JP2: VIO_EXT	P2-P3	Source VIO with the 5.0V from the SPIO-4 board.
JP4	P2-P3	Get 5.0V from the SPIO-4 board
JP6	P1-P2	Connect VA supply to the LMP90100
JP7	P1-P2	Connect VIO supply to the LMP90100
JP5: TC_JMP	P1-P2	Connect TCN to VIN3
JP5: TC_JMP	P3-P4	Connect TCP to VIN4
JP3: LM94022_JMP	P1-P2	Connect the output of LM94022 to VIN5
JP13: VREF_JMP1	P3-P4	VREFP1 = 4.1V from U4 (LM4140)
JP13: VREF_JMP1	P9-P10	VREFN1 = ground
JP14: VREF_JMP2	P1-P2	Connect VREFP1 source to the LMP90100
JP14: VREF_JMP2	P3-P4	Connect VREFN1 source to the LMP90100

Table 4 – LMP90100EB Jumpers for the RTD Application

B. Installing/Opening the Software – skip this step if it's already done. If not, follow section 9.0 to install and open the LMP90100 Sensor AFE software.

C. Connecting and Powering the Boards

1. Connect the LMP90100EB to the SPIO-4 board as seen in Figure 4.
2. Connect SPIO-4 board to a PC via **USB.**
3. Use a multimeter to measure LMP90100EB's JP6, JP7, and JP14.P2; they should all be approximately 5V. If they are not, check your power supplies and jumpers.

D. Connect a K type thermocouple to J4. Note that the thermocouple's positive input (TCP) = VIN4 and negative input (TCN) = VIN3.

G. Configuring the LMP90100 for the Thermocouple Using the Sensor AFE Software

Follow the step-by-step instructions under the **"HelpBar"** mini-tab (left hand side of the GUI) to configure the LMP90100 for the thermocouple. These step-by-step instructions are discussed in details below, and the recommended configuration should look similar to Figure 21.

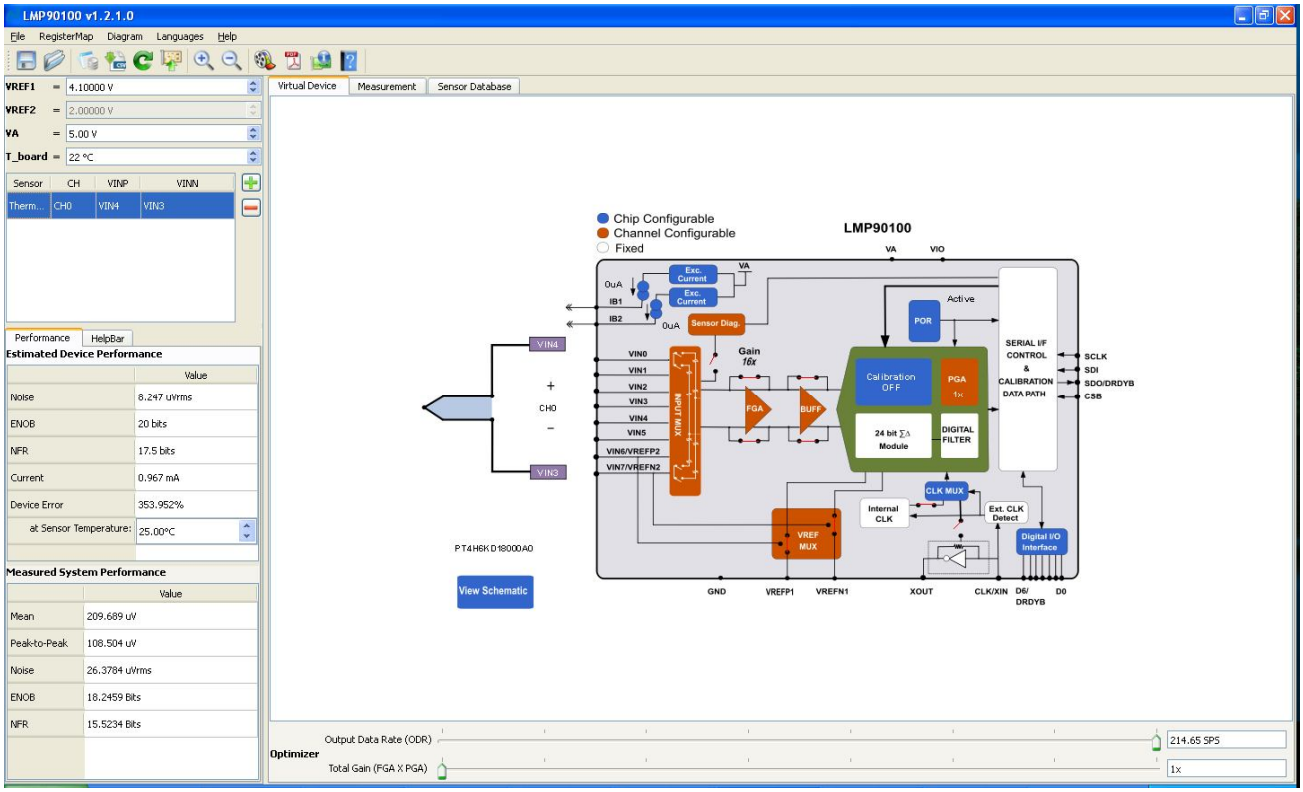


Figure 21 - Recommended LMP90100 Configuration for a Thermocouple

1. Step 1: Select a Sensor - select **"Thermocouple"** → ***select the thermocouple of your choice or add your own thermocouple by clicking on "New"***.

2. Step 2: Configure Inputs – click on the **"INPUT MUX"** block to set "**VINP = 100: VIN4"** and "**VINN = 011: VIN3".** Click on the **"View Schematic" (or "Eval. Board Settings** button located next to the block diagram. This should open up a PDF of the schematic for a thermocouple.

3. Step 3: Source IB1/IB2? – *this step can be ignored because neither IB1 nor IB2 is connected to the inputs.*

4. Step 4: Select Reference – click on the "**VREF MUX"** block to choose **"VREF_SEL = 0: VREF1".** Make sure the value for VREF1 = 4.1V.

5. Step 5: Set Gain – since the differential junction across a thermocouple is low, the maximum gain can be 128x. Click on the **"FGA"** block**, "PGA"** block**,** or the "**Gain"** slider to select the gain.

6. Step 6: Set Buffer – click on the **"BUFF"** block to include or exclude the buffer from the signal path.

7. Step 7: Set Calibration - click on the **"No Calibration"** block to enable or disable calibration. Refer to the LMP90100 datasheet to more information on the LMP90100's background calibration types and modes.

8. Step 8: Int/Ext CLK? – click on the **"CLK MUX"** block and make sure the internal clock is selected.

9. Step 9: Performance - click on the **"Performance"** mini-tab. This tab displays the Estimated Device Performance base on the block diagram that you've configured, as well as the Measured System Performance if you've connected a board and ran the LMP90100.

H. Configuring the LMP90100 for the LM94022 Using the Sensor AFE Software

Follow the step-by-step instructions under the **"HelpBar"** mini-tab (left hand side of the GUI) to configure the LMP90100 for the LM94022 IC sensor. These step-by-step instructions are discussed in details below, and the recommended configuration should look similar to Figure 22.

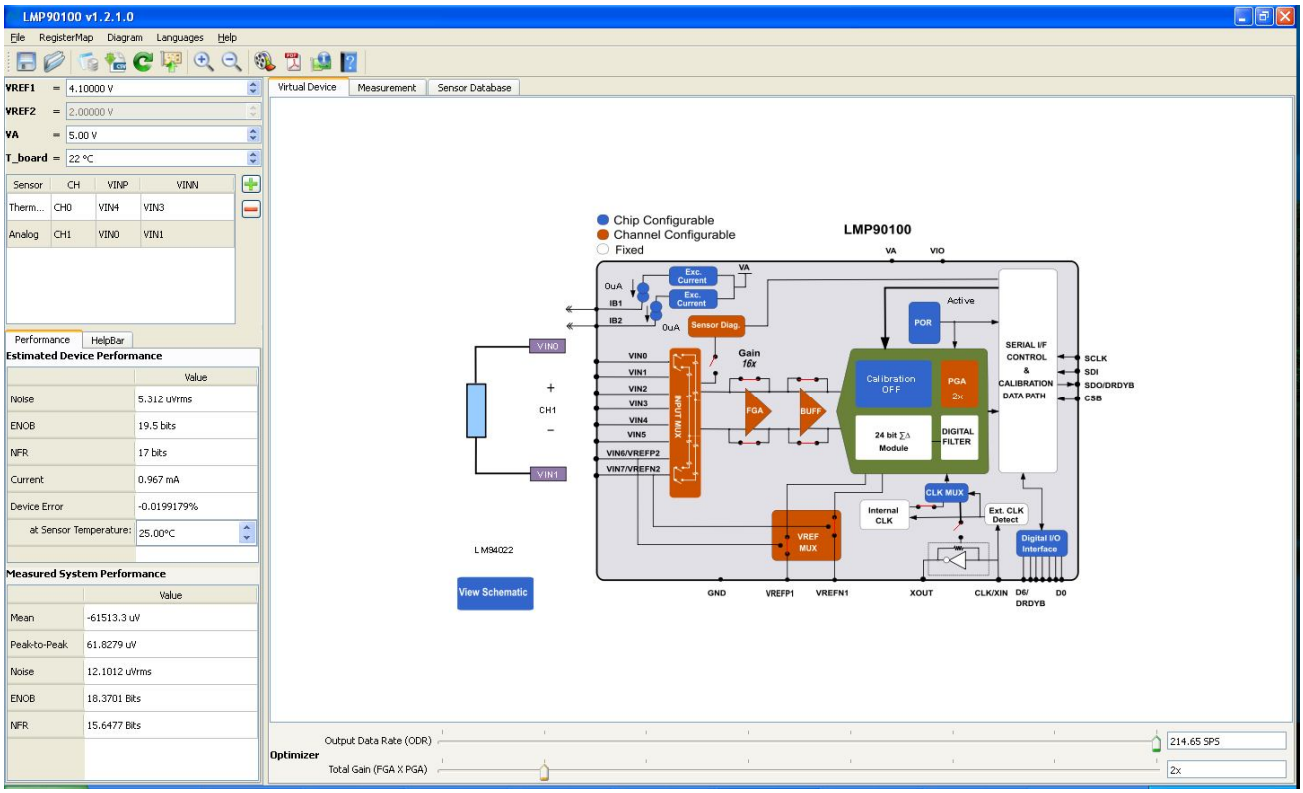


Figure 22 - Recommended LMP90100 Configuration for the LM94022

1. Step 1: Select a Sensor – click on the **"+"** button to enter the "**Sensor Database"** tab. Select **"Analog" → "LM94022"**.

2. Step 2: Configure Inputs – click on the **"INPUT MUX"** block to set "**VINP = 101: VIN5"** and "**VINN = 111: VIN7".** Click on the **"View Schematic" (or "Eval. Board Settings** button located next to the block diagram. This should open up a PDF of the schematic of the thermocouple and LM94022 application.

   Now that the LM94022 is added, the sensor window should look like the figure below.

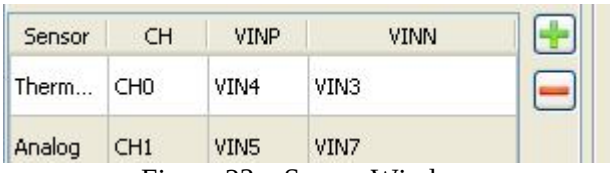


Figure 23 – Sensor Window

3. Step 3: Source IB1/IB2? – *this step can be ignored because neither IB1 nor IB2 is connected to the inputs.*

4. Step 4: Select Reference – click on the "**VREF MUX"** block to choose **"VREF_SEL = 0: VREF1".** Make sure the value for VREF1 = 4.1V.

5. Step 5: Set Gain – click on the **"FGA"** block**, "PGA"** block**,** or the "**Gain"** slider to select the gain.

6. Step 6: Set Buffer – click on the **"BUFF"** block to include or exclude the buffer from the signal path.

7. Step 7: Set Calibration - click on the **"No Calibration"** block to enable or disable calibration. Refer to the LMP90100 datasheet to more information on the LMP90100's background calibration types and modes.

8. Step 8: Int/Ext CLK? – click on the **"CLK MUX"** block and make sure the internal clock is selected.

9. Step 9: Performance - click on the **"Performance"** mini-tab. This tab displays the Estimated Device Performance base on the block diagram that you've configured, as well as the Measured System Performance if you've connected a board and ran the LMP90100.

F. Capturing Data

1. Click on the **"Measurement"** tab and set the **"Scan Mode"** as follows:

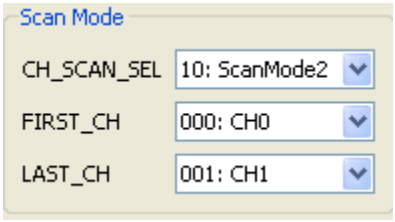


Figure 24 - Scan Mode Settings

2. Under the **"Output Format"** field, select Display "**Voltage (V)"**
3. Under the **"Run For"** field, plot the "Selected Channel"
4. Under the **"Stop Condition"** field, select Run **"1000 Samples".**
5. Click on the **"Run"** button to capture data.
6. Consult a K type thermocouple chart to determine the temperature between the thermocouple connector and the end of the thermocouple. A reading close to 0V should be plotted.

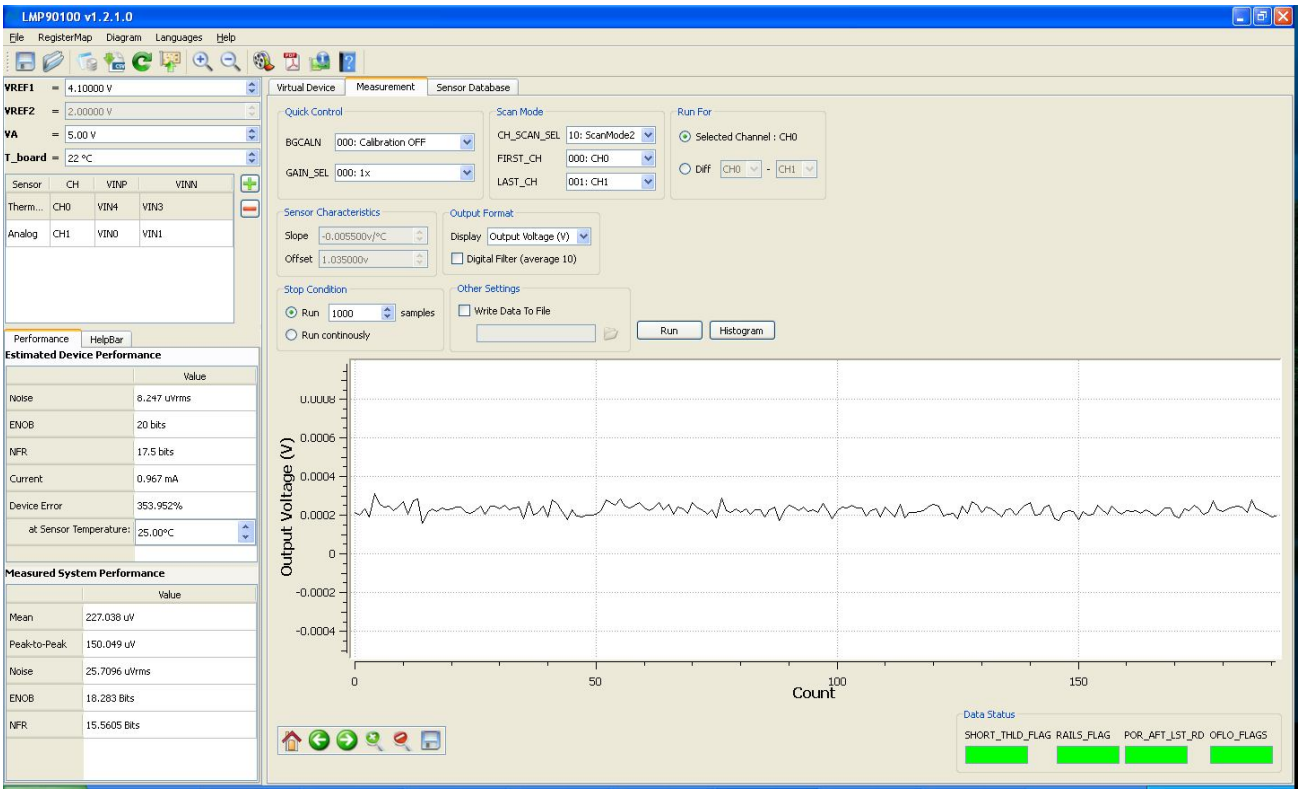


Figure 25 – Thermocouple Reading

7. See the LM94022 Transfer Table starting on page 9 of its datasheet to determine the temperature of the temperature sensor. In this application, the LM94022 is set up with GS = 00. Thus at room temperature, a reading of approximately 0.9V should be read.

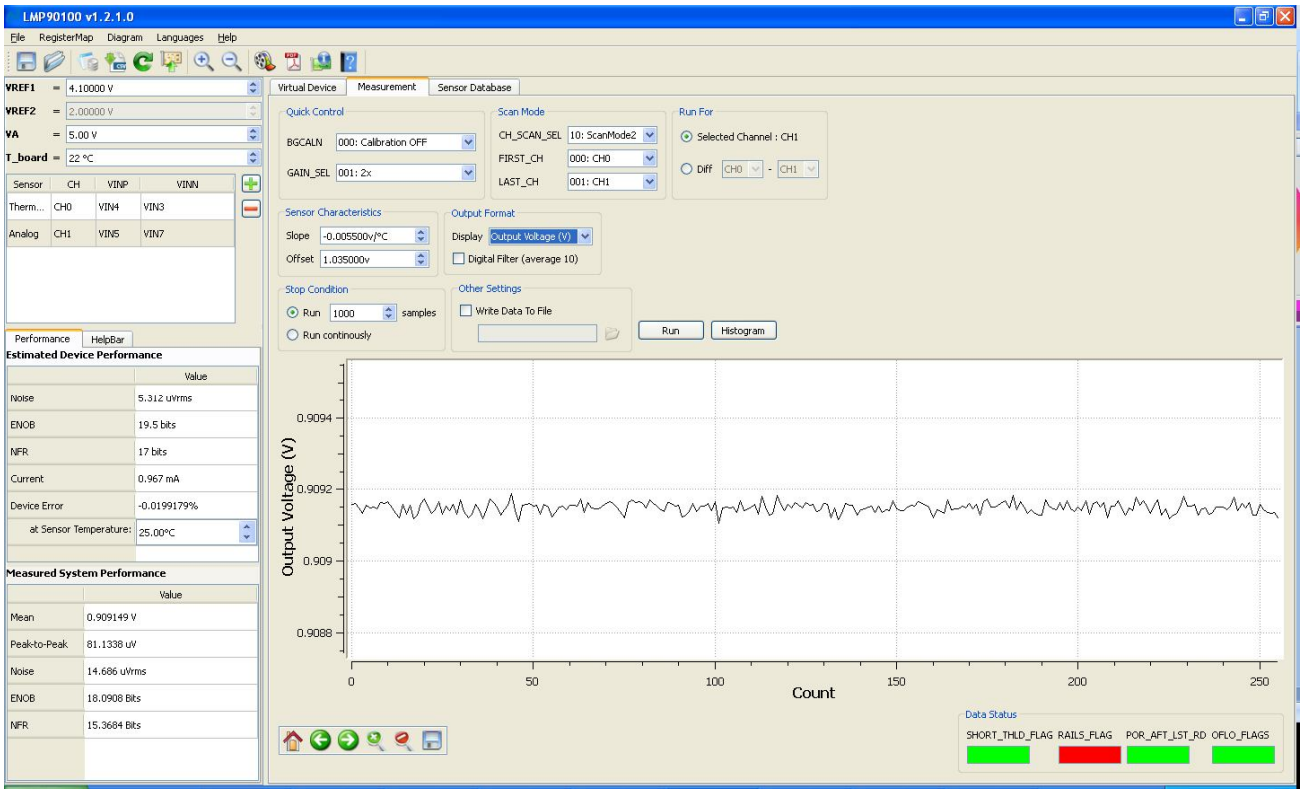


Figure 26 – Analog Temp Sensor Reading

7.0. Powering the LMP90100EB

There are two ways in which VA and VIO can be sourced: external supplies or SPIO-4 power.

If using external power supplies to source VA and VIO, then do the following:

1. Connect an external power supply to J1 for VA. Jumper pins 1 and 2 of JP1 to select this option.
2. Connect an external power supply to J2 for VIO. Jumper pins 1 and 2 of JP2 to select this option.
3. Jumper JP6 to connect the external power to VA.
4. Jumper JP7 to connect the external power to VIO.

If using the SPIO-4 power to source VA and VIO, then do the following:

1. Jumper pins 1 and 2 of JP4 to select 3.3V for VA and VIO, or jumper pins 2 and 3 of JP4 to select 5.0V for VA and VIO.
2. Jumper pins 2 and 3 of JP1 to select the SPIO-4 power for VA.
3. Jumper pins 2 and 3 of JP2 to select the SPIO-4 power for VIO.
4. Jumper JP6 to connect the SPIO-4 power to VA.
5. Jumper JP7 to connect the SPIO-4 power to VIO.

The schematic for the LMP90100EB can be seen in Figure 33.

8.0. Evaluating the LMP90100 without the SPIO-4 Board.

The SPIO-4 digital controller board is used to generate the SPI signals to communicate to the LMP90100. Without the SPIO-4 board, the Sensor AFE software for the LMP90100 cannot be used to capture and analyze data from the LMP90100EB.

If the SPIO-4 board is not available but LMP90100 evaluation is desirable, then connect your own SPI signals to J8 of the LMP90100EB as seen below.

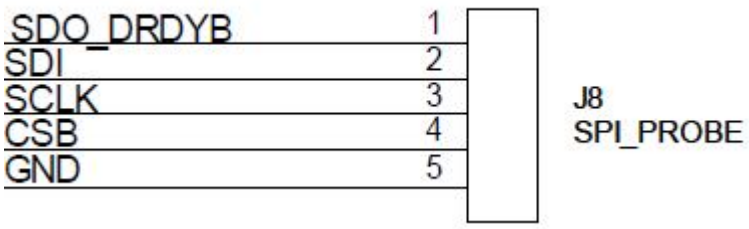


Figure 27 - LMP90100EB's J8 for SPI Signals

Refer to the LMP90100 datasheet for more information on the LMP90100's SPI protocol.

9.0. Installing the LMP90100 Sensor AFE Software

Each Sensor AFE product will have its own software. To access the Sensor AFE software for LMP90100, follow the steps below.

1. **Getting the Zip Files**
   - **a.** You can find the latest downloadable Sensor AFE software at http://www.national.com/analog/sensing/sensor_afe#tools
   - **b.** Download the zip file onto your local hardrive. Unzip this folder.

2. **Installing the Driver** - skip this step if you don't have the LMP90100EB and SPIO4 digital controller board.
   - **a.** Connect the LMP9100EB to SPIO4 board
   - **b.** Connect the SPIO4 board to your PC.
   - **c.** Follow the steps below to install the driver:

Figure 28 - Click on "No, not this time"

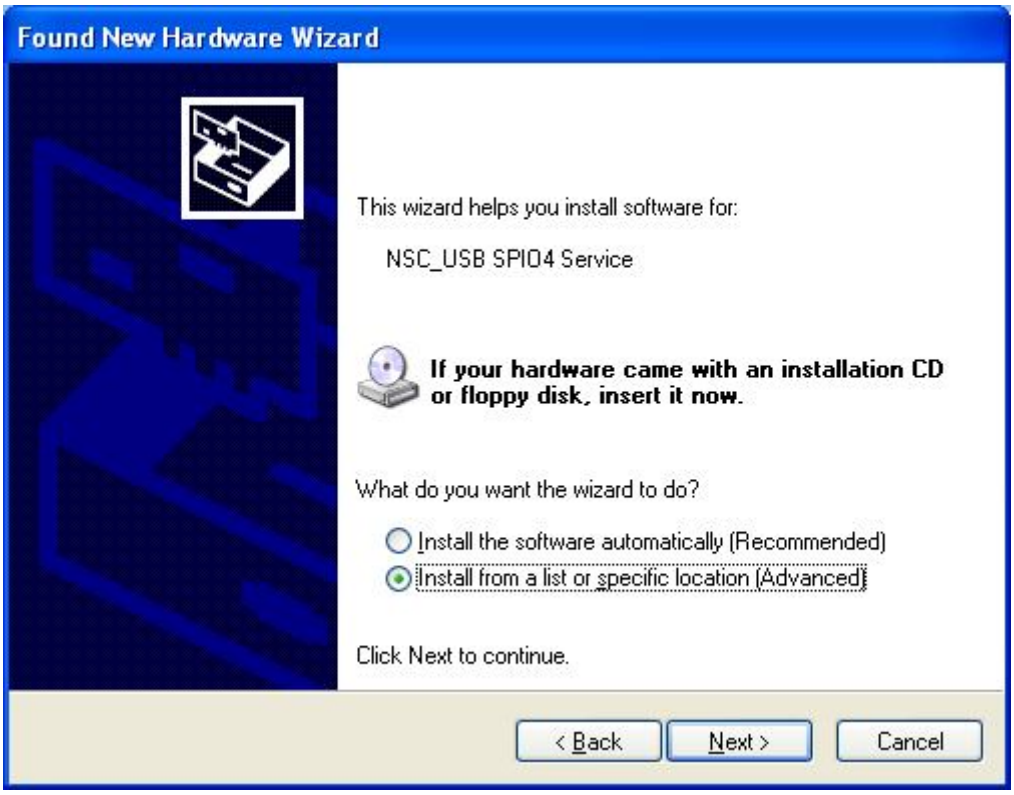


Figure 29 – Choose to "install from a list or specific location (Advanced)"

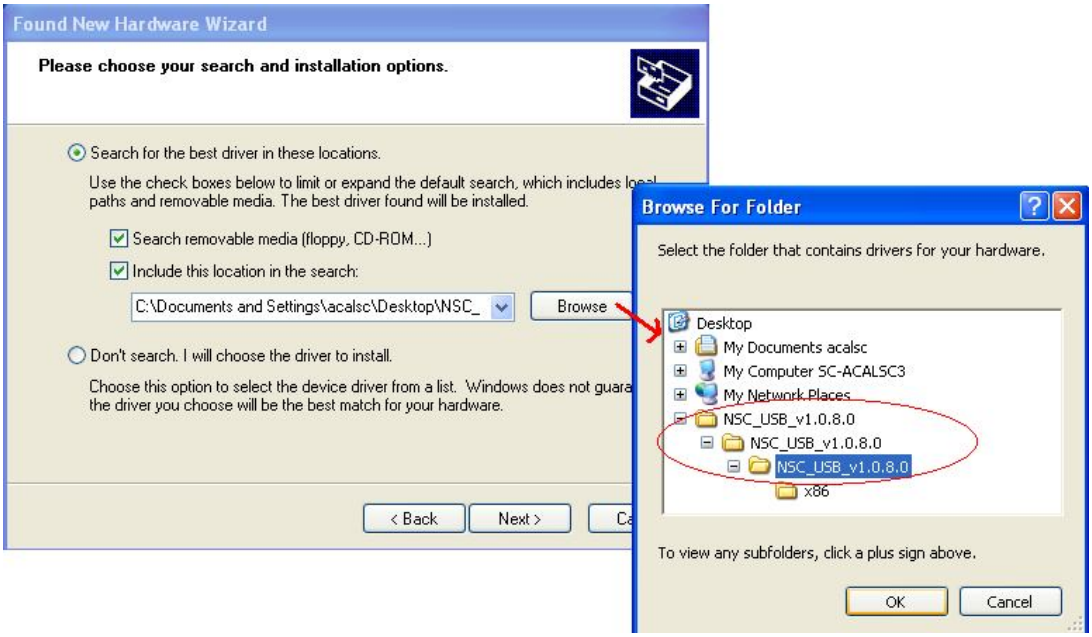


Figure 30 – Find the driver in the "NSC_USB_v1.0.8.0" folder (it should be located in the unzipped folder)

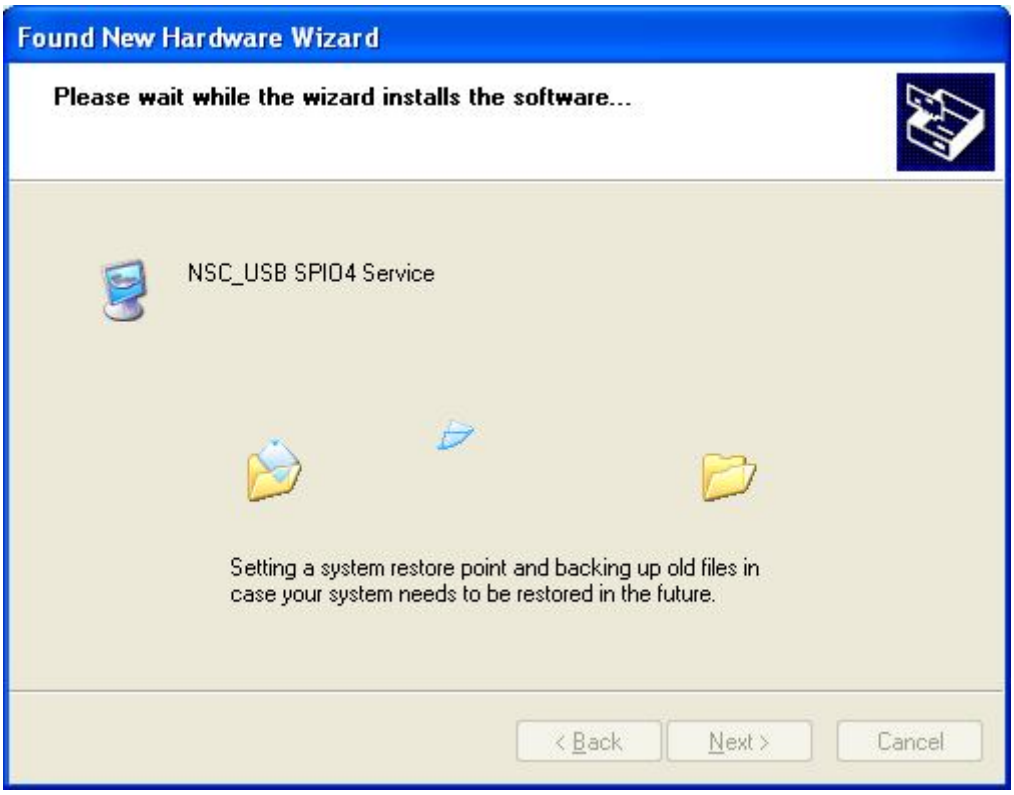


Figure 31 – Waiting for the computer to install the driver

Figure 32 – Installation is complete

3. Open the un-zipped folder and click on "**lmp90100.exe**" to start the software. If you don't have the boards, you'll get an error message. Ignore that error message and click "Ok" to continue.

10.0. Schematic

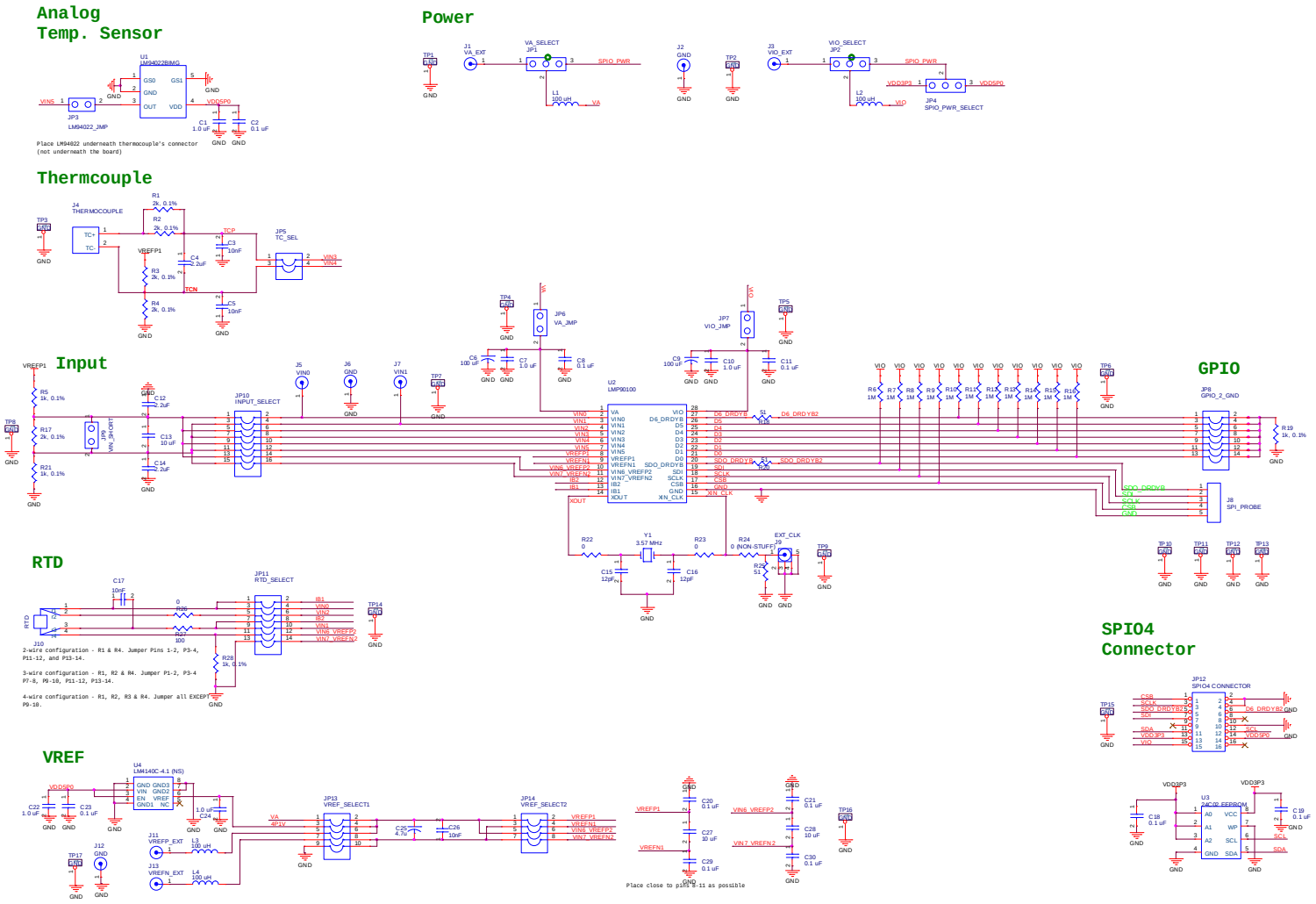


Figure 33 - LMP90100EB Schematic

11.0. Layout

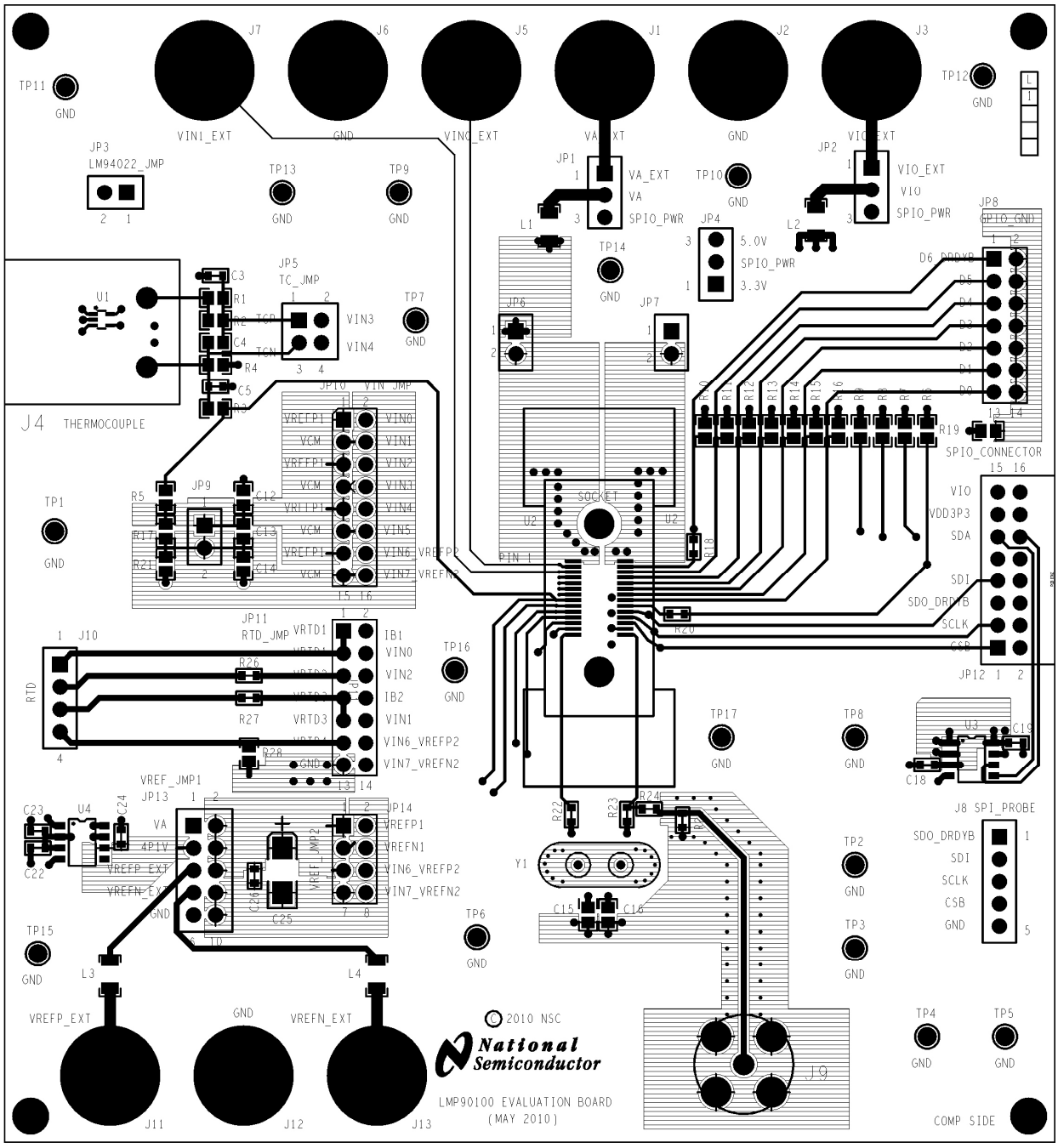


Figure 34 - Layout – Top Layer

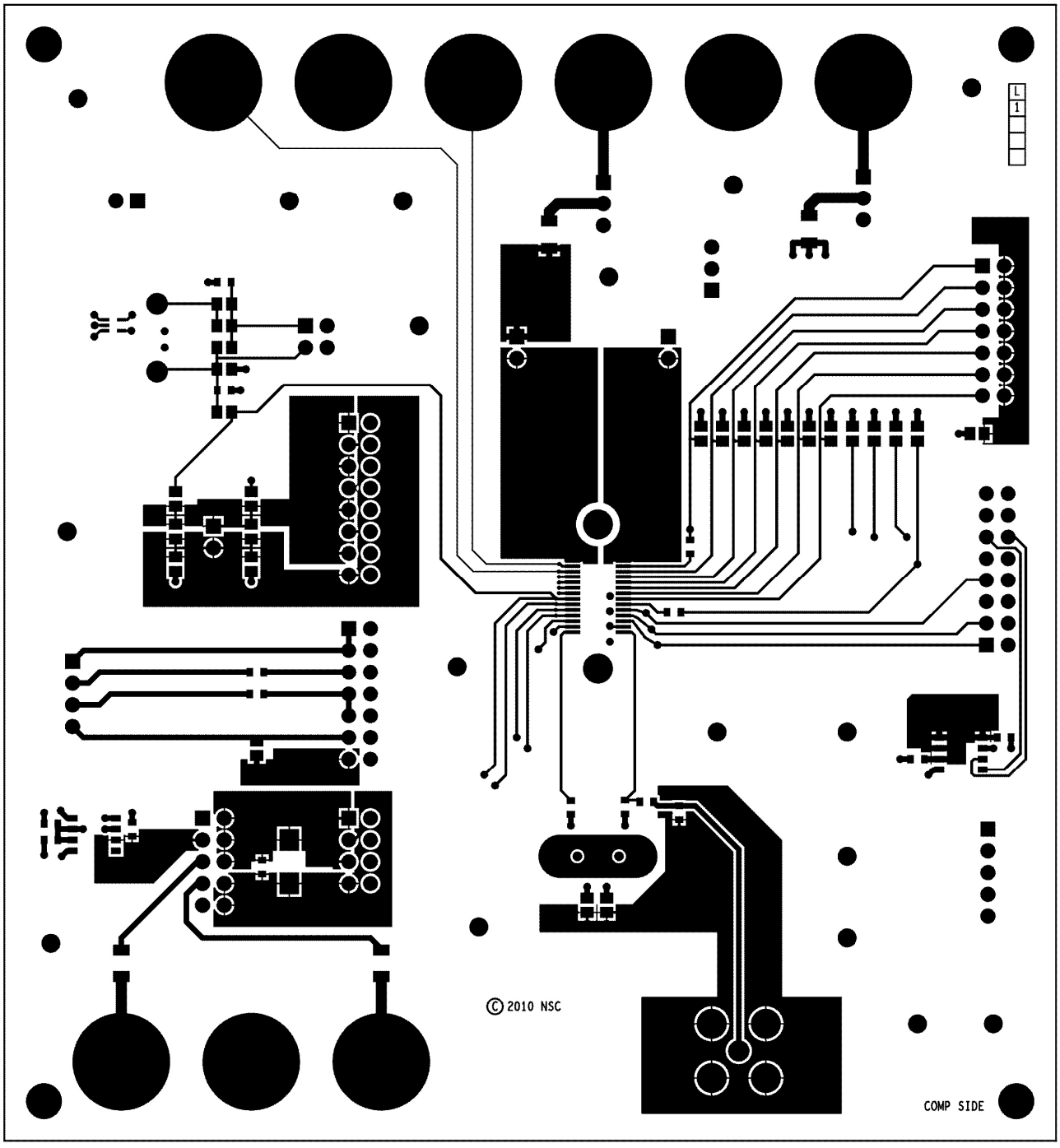


Figure 35 - Layout 3rd Layer

12.0. BOM

Item	Quantity	Reference	Value	Description	Source	Source Part #
1	5	C1,C7,C10,C22,C24	1.0 uF	CAP CER 1.0UF 10V Y5V 0603	Digikey	490-1585-1-ND
2	10	C2,C8,C11,C18,C19,C20,	0.1 uF	CAP CER .1UF 0603	Digikey	490-4779-1-ND
		C21,C23,C29,C30				
3	4	C3,C5,C17,C26	10nF	CAP CER 10000PF 50V 10% X7R 0603	Digikey	490-1512-1-ND
4	3	C4,C12,C14	2.2uF	CAP CER 2.2UF 10V Y5V 0805	Digikey	490-1743-1-ND
6	3	C13,C27,C28	10 uF	CAP CER 10UF 10V Y5V 0805	Digikey	445-1371-1-ND
7	2	C15,C16	12pF	CAP 12PF 50V CERM CHIP 0805 SMD	Digikey	PCC120CNCT-ND
9	1	JP1	VA_SELECT	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
10	1	JP2	VIO_SELECT	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
11	1	JP3	LM94022_JMP	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
12	1	JP4	SPIO4_PWR_SELECT	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
13	1	JP5	TC_SEL	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
14	1	JP6	VA_JMP	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
15	1	JP7	VIO_JMP	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
16	1	JP8	GPIO_2_GND	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
17	1	JP9	VIN_SHORT	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
18	1	JP10	INPUT_SELECT	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
19	1	JP11	RTD_SELECT	CONN HEADER .100 SINGL STR 36POS	Sullins Connector	S1011E-36-ND
20	1	JP12	SPIO4 CONNECTOR	CONN HEADR BRKWAY .100 80POS R/A	Digikey	A34278-40-ND
21	1	JP13	VREF_SELECT1	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
22	1	JP14	VREF_SELECT2	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
23	1	J1	VA_EXT	CONN JACK BANANA UNINS PANEL MOU	Digikey	J147-ND
24	3	J2,J6,J12	GND	CONN JACK BANANA UNINS PANEL MOU	Digikey	J147-ND
25	1	J3	VIO_EXT	CONN JACK BANANA UNINS PANEL MOU	Digikey	J147-ND

26	1	J4	THERMOCOUPLE	THERMOCOUPLE CLASS K SOCKET	RS Mobile	381-7564
27	1	J5	VIN0	CONN JACK BANANA UNINS PANEL MOU	Digikey	J147-ND
28	1	J7	VIN1	CONN JACK BANANA UNINS PANEL MOU	Digikey	J147-ND
29	1	J8	SPI_PROBE	CONN HEADER .100 SINGL STR 36POS	Digikey	S1011E-36-ND
30	1	J9	EXT_CLK	CONN BNC FEM JACK PC MNT STRGHT	Digikey	ACX1051-ND
31	1	J10	RTD	TERM BLOCK PCB 4POS 5.0MM GREEN	Digikey	277-1579-ND
32	1	J11	VREFP_EXT	CONN JACK BANANA UNINS PANEL MOU	Digikey	J147-ND
33	1	J13	VREFN_EXT	CONN JACK BANANA UNINS PANEL MOU	Digikey	J147-ND
34	4	L1,L2,L3,L4	100 uH	INDUCTOR 100UH 140MA 10% SMD	Digikey	587-2038-1-ND
35	4	R5,R19,R21,RREF	1k, 0.1%	RES 1.0K OHM 1/8W .1% 0805 SMD	Digikey	RG20P1.0KBCT-ND
36	4	RRTD1,RRTD2,R22,R23	0	RES 0.0 OHM 1/10W 0603 SMD	Digikey	RMCF1/160RCT-ND
37	5	R1,R2,R3,R4,R17	2k, 0.1%	RES 2.0K OHM 1/8W .1% 0805 SMD	Digikey	P2.0KDACT-ND
38	11	R6,R7,R8,R9,R10,R11,R12,	1M	RES 1.0M OHM 1/8W 5% 0805 SMD	Digikey	RHM1.0MARCT-ND
		R13,R14,R15,R16				
39	3	R18,R20,R25	51	RES 51 OHM 1/10W 5% 0603 SMD	Digikey	P51GCT-ND
41	17	TP1,TP2,TP3,TP4,TP5,TP6,	GND	TEST POINT PC MULTI PURPOSE BLK	Digikey	5011K-ND
		TP7,TP8,TP9,TP10,TP11,				
		TP12,TP13,TP14,TP15,TP16,				
		TP17				
42	1	U1	LM94022BIMG	ANALOG TEMPERATURE SENSOR	NSC	LM94022BIMG
43	1	U2	LMP90100	LMP90100	NSC	LMP90100
44	1	U3	24C02 EEPROM	EEPROM 256x8	Mouser	579-24C02CSN
45	1	U4	LM4140C-4.1	4.1 V Voltage Reference	NSC	LM4140C-4.1
46	1	Y1	3.57 MHz	CRYSTAL 3.579545 MHZ 18PF 49US	Digikey	XC1707-ND

47	4	N/A	N/A	BUMPON HEMISPHERE .44X.20 BLACK	Digikey	SJ5003-0-ND

Table 5 - BOM

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