ZMD31014 RBic$_{iLite}$™ Sensor Signal Conditioner

SSC Modular Evaluation Kit Documentation

Restrictions:

The ZMD AG RBic$_{Lite}$™ SSC Evaluation Kit hardware and software are designed for RBic$_{Lite}$™ evaluation, laboratory setup and module development only.

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1 Kit Contents

a) SSC CD ROM including RBic$_{iLite}$™ Tester/Calibration Software

b) SSC Communication Board (SSC CB), including USB Cable

c) SSC ZMD31014 Evaluation Board

d) SSC Sensor Replacement Board (SRB)

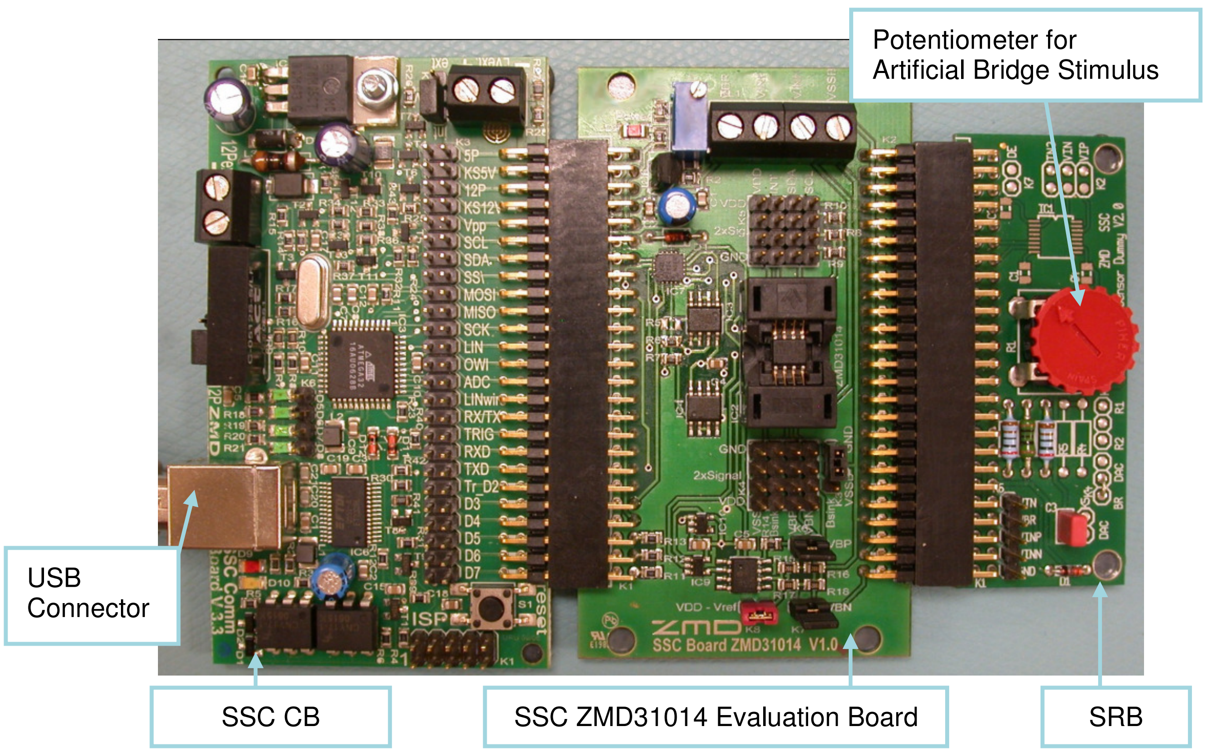

Figure 1.1 – ZMD31014 SSC Evaluation Kit

The RBic$_{iLite}$™ SSC Evaluation Kit contains the software and hardware needed for communication and calibration of an RBic$_{iLite}$™ sensor signal conditioning IC. A PC can communicate with an RBic$_{iLite}$™ socketed on the SSC Evaluation Board via an SSC Communication Board through a USB connection. The software should function on any Windows® 98/ME/XP/NT system after installation of a USB driver. Both the SSC Evaluation Board and the Sensor Replacement Board (SRB) can provide a replacement for a sensor. Only one of these can be used at a time for calibration as determined by the settings of jumpers K6 and K7 (see Figure 3.1). On the SRB, the sensor replacement is controlled by a potentiometer (see Figure 1.1). The SRB can be disconnected if the SSC Evaluation Board's sensor replacement (artificial bridge stimulus) will be used.

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2 USB Driver Installation

2.1 System Requirements

- 5x86-compatible PC
- 32 MB RAM
- Hard drive with 20MB free space
- USB port
- Microsoft® W98/ME/2000/XP

The USB version of the ZMD31014 RBic$_{iLite}$™ SSC Evaluation Kit requires installation of two drivers. All the required driver files are in the “USB_Driver” folder on the SSC Evaluation Kit CD-ROM.

These two drivers make the PC’s USB port appear as a virtual COM port (typically COM3 or COM4 on most computers). The software provided with the SSC Evaluation Kit accesses the SSC Evaluation Board as if it were a COM (RS232) port. These drivers will not affect the operation of any other USB peripherals.

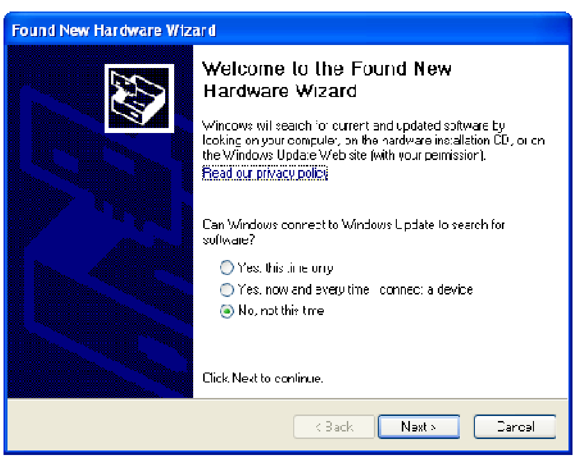
Driver installation is very similar for Windows® XP or Windows 2000 installations; however, there are slight differences in the appearance of the dialog boxes. Windows® XP installation procedures are given below. Similar steps for Windows® 2000 installation are given in Appendix A in this document.

2.2 Installation for Windows® XP Pro or XP Home Operating Systems

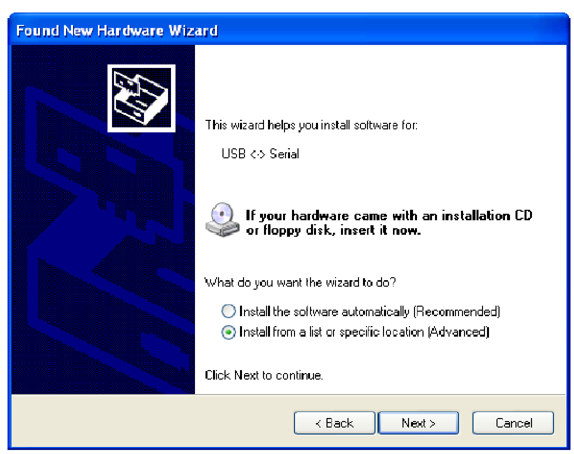
Installing the Basic USB Driver

Important: System administrator rights are required to install the USB driver on your PC.

Use the USB cable to connect the SSC Evaluation Board to an available USB port on your PC. The “Found New Hardware” wizard launches and brings up the following dialog box. Complete the following steps.



Step 1: Select “No, not this time,” and click “Next.”



Step 2: Select “Install from a list or specific location (Advanced).” Click “Next.”

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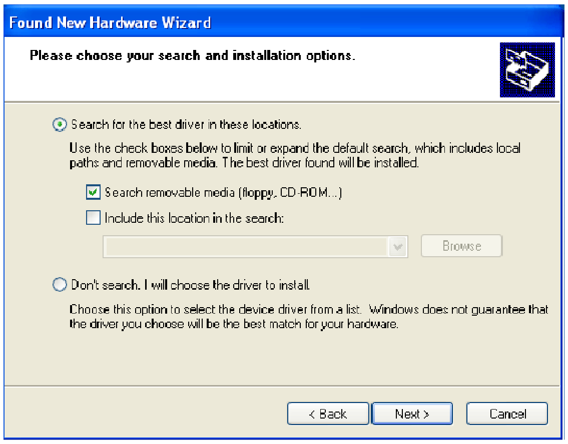
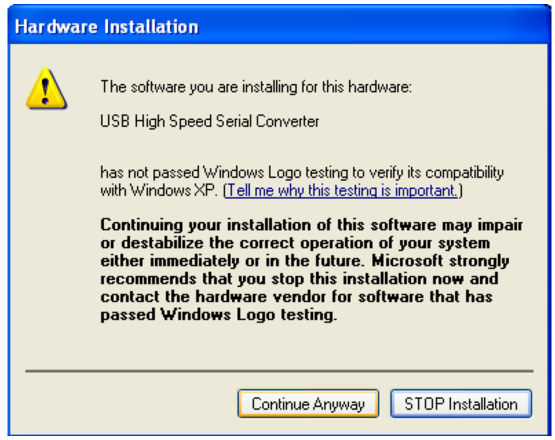


Step 3: Select “Search removable media (floppy, CD-ROM),” and click “Next.”



Step 4: When the warning about failing logo testing appears, click “Continue Anyway” because this concern is not applicable.

Step 5: Finish the driver installation by clicking “Finish.”

Installing the Virtual Com Port USB Driver

The second required USB driver causes the USB device to appear to the system as a virtual COM port.

Follow the same steps as outlined under *Installing the Basic USB Driver* above to complete this second driver installation.

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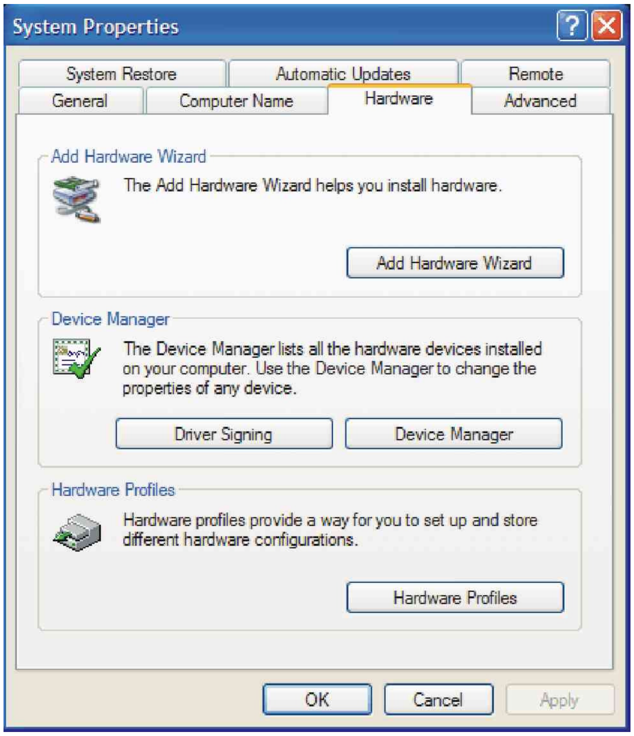
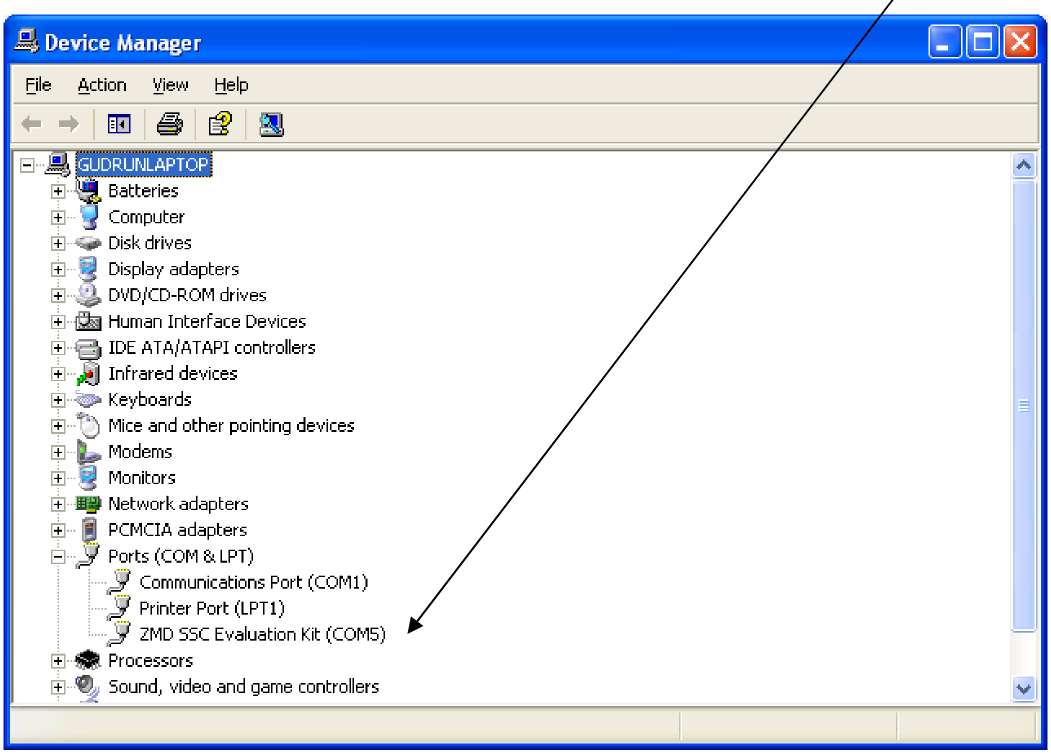


Checking USB Port Operation

Verify that the new hardware is operating properly before continuing. Access the control panel by clicking Start ➔ Settings ➔ Control Panel. Double click the "System" icon. The adjacent dialog box appears.

Click on the "Hardware" tab, and then on "Device Manager." This brings up the dialog box shown below.

If the USB is operating properly, "ZMD SSC Evaluation Kit (COMx)" appears under "Ports (COM & LPT)." Typically, the "x" is 3 or 4. Remember this virtual COM port number. It is the COM port to select when using the software provided with the SSC Evaluation Kit.



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3 ZMD31014 SSC Evaluation Board

3.1 Overview

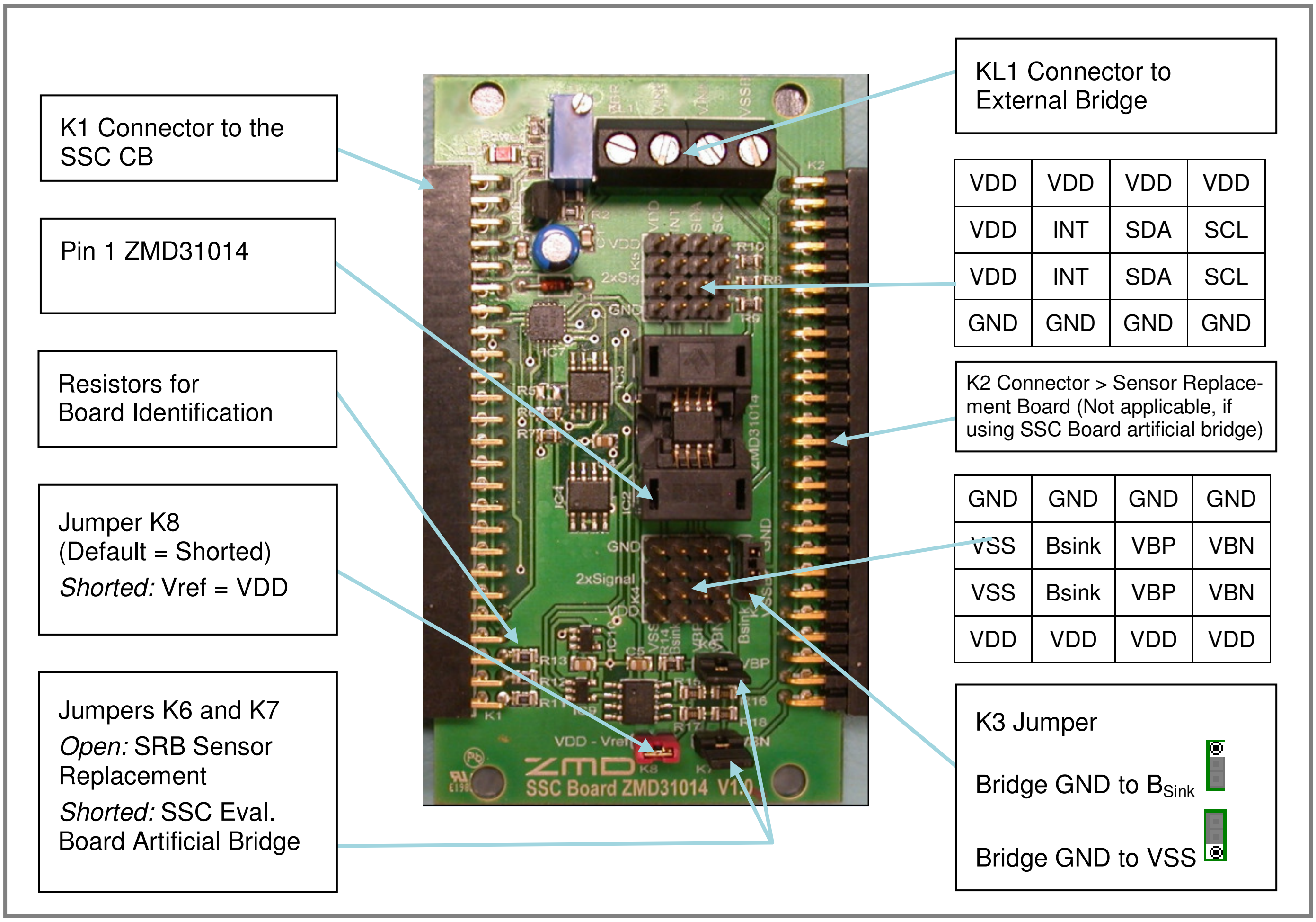

Figure 3.1 – SSC Evaluation Board Overview

The main purpose of the SSC Evaluation System is communication between the PC and the RBic$_{iLite}$™ IC. The PC sends commands and data via the USB / SSC CB (virtual COM port). The µController on the SSC CB interprets these commands and relays them to the RBic$_{iLite}$™ in the I^{2}C bus standard format (K1 Pin 9/SCL Pin 11/SCK). The µController will also forward any data bytes from the RBic$_{iLite}$™ chip back to the PC via the USB connection. These bytes can be bridge and temperature readings to be displayed by the PC software; raw ADC readings used during calibration; or EEPROM content bytes.

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3.2 Installing the Communication and Calibration Software

To install the RBic$_{iLite}$™ SSC Evaluation Kit CD-ROM on the PC hard drive, locate the *setup.exe* file in the root directory of the CD-ROM, and double click on it. The software completes the installation.

3.3 Connections to RBic$_{iLite}$™

The SSC Evaluation Board has an SOP-8 socket for inserting the RBic$_{iLite}$™.

Using the VDD, GND, SDA/MISO, SCL/SCLK and INT/SS/ connections on connector K5 on the SSC Evaluation Board, the board can be used for in-circuit programming of the RBic$_{iLite}$™ IC in the user's calibration fixture.

NOTE: Only one ASIC connection option can be used at a time.

3.4 Power Supply to the Board

The K1 connector to the SSC CB provides the power supply from the SSC CB's USB port to the SSC Evaluation Board. Using the power via the USB port, the maximum current that can be provided is 40mA. All functions of the board are operative down to 2.7V. The board has a red LED labeled D1, which lights if the board has power.

3.5 Reset Switch

Use the push button on the Communication Board to reset communications if needed.

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4 RBic$_{iLite}$™ Tester Software

4.1 Overview

The ZMD software provided with this SSC Evaluation Kit is intended for demonstration purposes and calibration of single units. ZMD can provide the user with algorithms and assistance in developing their full production calibration software. Five types of text files support the software user:

- When the software is activated, a *CommLog.txt* file is saved to the application folder (*C:\\program files\ZMD America\ZMD31014_iLite*). This file is a log of the communication to the IC during the software session and can be saved after closing the software by renaming the file. Otherwise, it would be overwritten the next time the software will be opened.
- In Command Mode (CM) the user can save/load the EEPROM contents from a text file to the EEPROM and vise versa.
- In Normal Operation Mode (NOM) the user can log bridge and temperature readings to the *DataLog.txt* file.
- The *caldata.txt* file is used by the software for calibration. Its structure is explained in Appendix C.
- The calibration is documented in the *CalibrationLog.txt* file, which is more convenient for users than the *caldata.txt* file.

4.2 "Find Com" Button

The RBic$_{iLite}$™ Tester software automatically detects which type of ZMD evaluation board is connected. To set up communication with the SSC CB, click on "Setup" and then "Find COM." Click "Yes" in the resulting dialog box if the COM port selected is acceptable. If not, click "No" until an acceptable COM port is found.

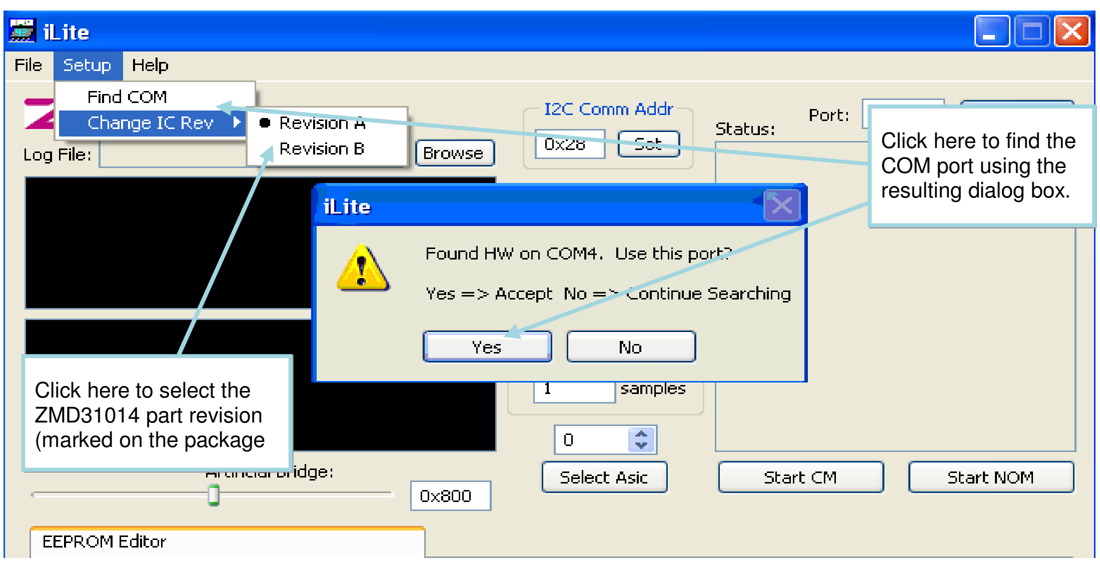

Figure 4.1 – Setting Up Communications

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4.3 "I2C Comm Addr" Field

Use the "I2C Comm Addr" field to enter the address that the SSC CB uses to communicate with the RBic$_{iLite}$™ installed in the socket on the Evaluation Board. Valid settings are 0x00 to 0x7FH. The default is 0x28H. See important notes in section 4.10 regarding settings when the communication address is locked.

4.4 Bridge and Temperature Display

The software displays two large readout windows for temperature and bridge values. The temperature reading is the RBic$_{iLite}$™ temperature in °C. The bridge reading is in %. Calibration determines the relationship of the % reading to the value the bridge is measuring.

The RBic$_{iLite}$™ is designed to be a generic resistive bridge conditioner, but for the following calibration example, assume it is connected to a pressure bridge. If the unit is calibrated to read pressure with 50kPa reading as 100% and 10kPa reading as 0%, then the span of pressure readings would be 40kPa. Half of that span (20kPa) plus the set zero point (10kPa) should be the 50% point. After calibration, if the chamber is set to 30kPa, the RBic$_{iLite}$™ should give a 50% reading.

There is a continuous transmission of bridge readings and temperature readings.

If the RBic$_{iLite}$™ has not been temperature calibrated, the displayed temperature is invalid.

The different colors of the display field indicate the IC mode:

Color	Green	Blue	Red	Yellow
IC Mode/State	Valid value (NOM)	Valid (CM)	Diagnostic	Invalid value (NOM)[1]

4.5 "Log File" Field

Bridge and temperature readings can be logged to a PC file. Use the "Browse" button to select the filename and directory where the file will be stored. Then click "Open." The "Sample Rate" field sets how often the data is collected. If the sample rate is 0 sec, then an entry is written for each transmission from the RBic$_{iLite}$™.

The resulting text file is a space-delimited ASCII file and can be imported into Microsoft Excel®.

4.6 "Start CM" Button

To communicate to the RBic$_{iLite}$™, start the Command Mode (full command set, measurement cycle stopped) by clicking "START CM" (Start Command Mode).

4.7 "Start NOM" Button

To exit Command Mode and return the RBic$_{iLite}$™ to Normal Operation Mode (reading, conditioning and transmitting bridge data), click "START NOM" (Start Normal Operation Mode).

Note: For the ZMD31014, the NOM is recommended for the raw value collection during the calibration.

[1] For more details refer to section 3 of the *ZMD31014_iLite_Datasheet.pdf*.

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4.8 "Normal Mode" Section

"Run Continuous" Button

To start a continuous readout of bridge and temperature data, click the "Run Continuous" button.

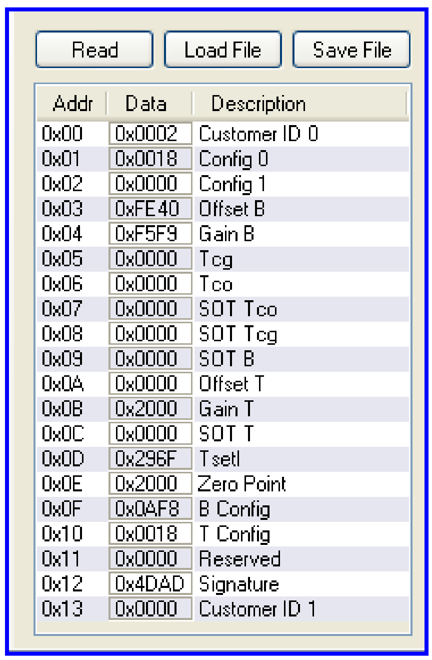
"Sample Rate" Field

This field sets the period (ms) for the sample rate of the continuous read out. Valid settings are 10ms or longer.

"Average Samples" Field

This feature allows averaging the measured values by choosing the number of samples to average before displaying the result.

4.9 "EEPROM Editor" Section



Addr	Data	Description
0x00	0x0002	Customer ID 0
0x01	0x0018	Config 0
0x02	0x0000	Config 1
0x03	0xFE40	Offset B
0x04	0xF5F9	Gain B
0x05	0x0000	Tcg
0x06	0x0000	Tco
0x07	0x0000	SOT Tco
0x08	0x0000	SOT Tcg
0x09	0x0000	SOT B
0x0A	0x0000	Offset T
0x0B	0x2000	Gain T
0x0C	0x0000	SOT T
0x0D	0x296F	Tsetl
0x0E	0x2000	Zero Point
0x0F	0x0AF8	B Config
0x10	0x0018	T Config
0x11	0x0000	Reserved
0x12	0x4DAD	Signature
0x13	0x0000	Customer ID 1

Figure 4.2 – EEPROM Editor

"Read" Button

To read EEPROM settings, enter the Command Mode and click the "Read" button. The "EEPROM" section displays all of the fields currently stored in the RBic$_{iLite}$™ EEPROM (non-volatile memory). Double clicking on the contents allows editing the EEPROM content. The EEPROM signature will be changed after the Command Mode is exited (Start_NOM).

"Load File" Button

EEPROM contents that have been previously saved in a text file can be written to the current EEPROM by clicking the "Load File" button. The default folder for the saved text file is *C:\program files\ZMD America\ZMD31014_iLite.* The standard Windows™ dialog box for file saving results.

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"Save File" Button

The EEPROM contents can be saved in a text file in the *C:\program files\ZMD America\ZMD31014_iLite* directory by clicking the "Save File" button. The standard Windows™ dialog box for file saving results.

4.10 "Communication and Operation Config" Section

This section is used to expedite programming configuration and communication settings in the EEPROM of the ZMD31014 RBic$_{iLite}$™ under test.

"Comm Type" Menu

Three communication options are available on the "Comm Type" drop-down menu:

- **I2C**
- **SPI (pos edge)**: SPI / MISO changes on positive edge clock frequency
- **SPI (neg edge)**: SPI / MISO changes on negative edge clock frequency

"Clock Freq" Menu

Select 1MHz or 4MHz for the clock frequency for the ZMD31014 RBic$_{iLite}$ using the "Clock Freq" drop-down menu. The lower clock frequency (1MHz) is the recommend selection for lower power and better noise performance. If faster response time is required, the 4MHz clock frequency setting is needed.

"I2C Addr" Field

When the ZMD31014 RBic$_{iLite}$ is in I^{2}C communication mode, the default slave address is 0x28H. If a different slave address is required, program the part for the new address by entering the hex value of the new address in the "I2C Addr" field and then click "Write Addr." The valid address range is 0x00 to 0x7FH.

Note: If the "Lock I2C Address" is on (see below), "I2C Addr" must match the "I2C Comm Addr" setting (see section 4.3).

"Lock I2C Address" Checkbox

Lock the slave address selection by clicking "Lock I2C Address" checkbox. Without this lock, the IC will respond to all I2C addresses.

"Sleep Mode" Checkbox

To select the Sleep Mode, click on the "Sleep Mode" checkbox; otherwise, the Update Rate Mode is selected as the default mode. The Sleep Mode enables the most power saving mode of the ZMD31014 RBic$_{iLite}$.

"Update_Rate" Menu

When operating in Update Mode, the update rate determines power consumption and response time. Select the update rate by clicking on one of the four update rates on the "Update_Rate" drop-down menu.

"Sensor Short Check" Checkbox

To enable the sensor short diagnostic, click on the "Sensor Short Check" checkbox.

"Sensor Connection Check" Checkbox

To enable the sensor open diagnostic, click on the "Sensor Connection Check" checkbox.

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4.11 Math Config Section

"SOT_Curve" Menu [1]

Some sensors perform better when compensated with a second order term (SOT) based on a zero-point symmetrical output function (S-shaped) instead of the parabolic curve function used to compensate more common sensors. The curve type is controlled by SOT_Curve (bit 9 in EEPROM word 0x01). Select the curve type from the "SOT_Curve" drop-down menu. When the S-shaped curve is selected, the zero point is in the middle of the output and a negative and positive output signal can be compensated using only the 2nd order term.

"Negative Coeffs" Subsection

The Tco, Tcg, SOT_Bridge, SOT_Tco, SOT_Tcg and SOT_T checkboxes in the "Negative Coeffs" section indicate the sign of the calculated calibration coefficients after calibration.

4.12 "Front End Config" Section

In the "Front End Config" section, select the configuration for the AFE (Analog Front End**)** as determined from the bridge sensor performance before starting calibration. The configuration for the temperature depends on the choice of an internal or external temperature sensor. For the internal sensor, a default calibration word is configured. Additional selections are available in the "Calibration/Set ASIC Configuration" window (click "Calibration" to initialize).

Note: The Excel™ file *ZMD31014 AFE Configuration.xls* can be used to determine the correct adjustment of the analog PreAmp gain and the analog A2D offset modes based on the known sensor characteristics. The Excel™sheet *ZMD31014_iLite_ext_Temperaturemeasurement.xls* can be used to determine the configuration for external temperature sensors.

"A2D_Offset" Menu

To help compensate for bridges that have a large inherent offset, the ZMD31014 RBic$_{iLite}$ has seven programmable analog offset modes for bridge and temperature measurements:

[-15/16,1/16]
[-7/8,1/8]
[-3/4,1/4]
[-1/2,1/2]
[-1/4,3/4]
[-1/8,7/8]
[-1/16,15/16]

Use the "A2D_Offset" drop-down menus for "Bridge" and "Temperature" to select the A2D offset mode settings, which are stored in EEPROM.

The [-1/2, 1/2] mode is best for a balanced bridge [-50mV, 50mV] @ VDD=5V (Pre-Amp=24).The [-1/16, 15/16] mode is best for positive-skewed bridges [-10mV, 90mV] @VDD=5V (Pre-Amp=24).

Note for External Temperature Sensors: The A2D_Offset is always [-1/16, 15/16] for external temperature sensors.

[1] For the ZMD31014 RBic$_{iLite}$ revision A, only the parabolic curve is usable.

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Note: As a single ended input, the temperature input signal must fit in the voltage range 1V to (VDD/2-1.2V).

"PreAmp_Gain" Menu

The ZMD31014 RBic$_{iLite}$ PreAmp amplifies the bridge signal to produce the differential signal that will be converted by the ADC. The PreAmp has eight possible analog gain settings: 1.5, 3, 6, 12, 24 (default), 48, 96, and 192[1]. Use the "PreAmp_Gain" drop-down menus for "Bridge" and "Temperature" to select the PreAmp gain settings, which are stored in EEPROM. (Note: This term is different from the digital gain terms Gain_B and Gain_T, which are multiplied by the result of the ADC to compensate sensor span for bridge and temperature measurements.)

Any bridge input signal greater than 40mV/V in differential mode will saturate the pre-amp if the gain is set to 24 (default). In this case, the pre-amp gain must be set to the lower value 12.

For very small differential input signals, the higher analog gain (e.g., 40) can improve the output resolution (see section 1.4 in the datasheet), but the sensor offset must always be considered as well as sensor span. Both the offset and span of the sensor are amplified by the pre-amp. With a high analog gain (48), the total offset plus span cannot exceed 20mV/V differential. Otherwise the input to the ADC will be saturated.

Note for External Temperature Sensors: The PreAmp_Gain is usually set to 3 or 5, which always guarantees the specified resolution.

Note: As a single ended input, the temperature input signal must fit in the voltage range 1V to (VDD/2-1.2V).

"Negative" Checkbox

To select negative bridge gain polarity, click on the "Negative" checkbox.

"LongInt" Checkbox

To select the longer conversion time for low noise, click on the "LongInt" checkbox. (For more details see the *ZMD31014 RBic$_{iLite}$™Datasheet.)*

"BSink" Checkbox

To enable the BSink power-saving option, click on the "BSink" checkbox.

"Gain8X" Checkbox

To multiply the Gain_B value (EEPROM word 0x04) by a factor of 8, click on the "Gain8X" checkbox.

[1] For the previous silicon revision (A), the PreAmp gain settings were 1, 3, 5, 15, 24 (default), 40, 72, and 120.

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4.13 "Calibration" Button

To initiate a calibration run, click the "Calibration" button. This results in the calibration screen and dialog box shown below. See section 5 for a full description of calibration and settings used on the "Calibration" window.

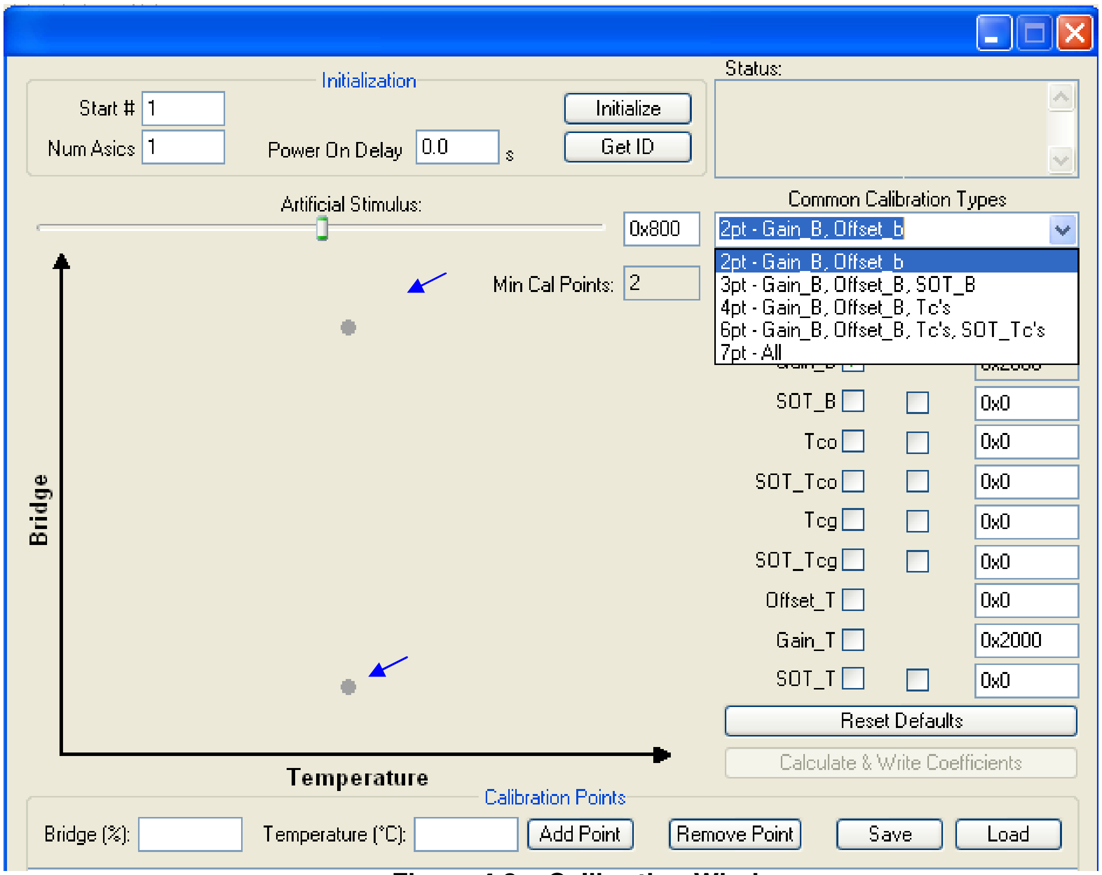

Figure 4.3 – Calibration Window

"Get ID" Button

The "Get ID" feature is not available yet for the RBic$_{iLite}$™.

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5 Calibration

5.1 Calibration Sequence

Although the RBic$_{iLite}$™ can function with many different types of resistive bridges, assume it is connected to a pressure bridge for the following calibration example. In this case, calibration essentially involves collecting raw bridge and temperature data from the RBic$_{iLite}$™ for different known pressures and temperatures. This raw data can then be processed by the calibration master (the PC), and the calculated coefficients can then be written to the EEPROM of the RBic$_{iLite}$™.

The software ZMD provides with the SSC Evaluation Kit is intended for demonstration purposes and calibration of single units. ZMD can provide customers with algorithms and assistance in developing their full production calibration software. For the following steps, refer to the calibration window shown in Figure 4.3.

There are three main steps to calibration:

1. Assigning a unique identification to the RBic$_{iLite}$™. This identification is programmed in EEPROM Cust_ID0 and Cust_ID1 registers and can be used as an index in the database stored on the calibration PC. This database will contain all the raw values of bridge readings and temperature readings for that part, as well as the known pressure and temperature to which the bridge was exposed.
2. Collecting data. Data collection involves getting raw data from the bridge at different known pressures and temperatures. This data is then stored on the calibration PC using the unique identification of the RBic$_{iLite}$™ as the index into the database.
3. Calculating and writing coefficients to EEPROM. After enough data points have been collected to calculate all the desired coefficients, the coefficients can be calculated by the calibrating PC and written to the EEPROM of the RBic$_{iLite}$™.

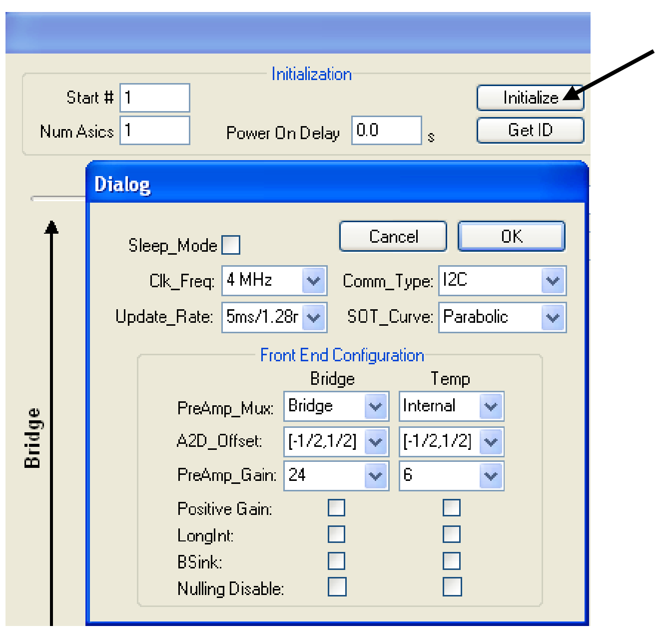

Figure 5.1 – Initialization Configuration Dialog Box

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Step 1 – Assigning a Unique Identification (ASIC ID Section)

In the top middle of the calibration screen (see Figure 4.3), click on “Initialize.” In the resulting dialog box (see Figure 5.1), verify or correct the configuration for the ZMD31014 RBic$_{iLite}$ under test and then click OK to initialize the part. The part is assigned a unique ID, which is used as an index in the database. This unique ID is also programmed into the EEPROM Cust_ID0 and Cust_ID1 registers. The software automatically loads and writes unity values for Gain_B and Gain_T to the EEPROM and set the Offset_B to an ADC_Offset related value. All other coefficients are set to zero. The raw data are collected with these settings in NOM.

Note: The default values shown in this dialog window are the previous settings and can differ from the actual EEPROM contents, which will be overwritten by clicking the OK button.

Step 2 – Data Collection

“Common Calibration Type” Menu

Next, select the type of calibration required from the “Common Calibration Type” pull-down menu in the top right of the calibration screen (see Figure 4.3). The number of unique points (for this example, pressure and temperature points) at which calibration must be performed depends on the user’s requirements. The minimum is a 2-point calibration, and the maximum is a 7-point calibration.

Depending on the number of calibration temperature points, a linear or second order temperature correction is performed with 2 or 3 (respectively) temperature coefficients (Offset_T&Gain_T or Offset_T&Gain_T&SOT_T).

In the left section of the calibration screen (see Figure 4.3), there is a graph (X-axis = Temperature, Y-axis = Bridge). This graph outlines the recommended spread of points (pressure for this example and temperature) to be used for calibration.

Based on statistical sensor measurements, a customer can decide to reduce the calibration costs by setting user-selected default values for various calibration coefficients instead of using the calibration measurements. In this case, enter the default values to be used for the selected calibration method in the coefficient entry fields at the right of the calibration screen (see Figure 4.3). These fields will not be calculated by the chosen calibration method. The calculation is disabled if there are entries for all defaults.

“Reset Defaults” Button

If needed, clicking the “Reset Defaults” button sets the default coefficients to 0x00 except Gain_B/Gain_T, which are set to unity (0x2000) and Offset_B, which is set to a value related to the ADC offset (A2D_Offset setting). See Table 5.1.

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Table 5.1 – Offset_B Default Values Determined by A2D_Offset Settings

A2D Input Range [VREF]	A2D_Offset	Offset_B(hex)
-15/16 to 1/16	15/16	0x1C00
-7/8 to 1/8	7/8	0x1800
-3/4 to 1/4	3/4	0x1000
-1/2 to 1/2	1/2	0x0000
-1/4 to 3/4	1/4	0xF000
-1/8 to 7/8	1/8	0xE800
-1/16 to 15/16	1/16	0xE400

"Bridge (%)" and "Temperature (°C)" Fields

Place the bridge/RBic$_{iLite}$™ pair to be calibrated in a controlled environment (for this example, a pressure and temperature chamber), and stabilize the environment at the first desired calibration point.

→ **Enter the target bridge readout in % (in this case, pressure) in the "Bridge (%)" field under "Actual."** (See Figure 5.1.)

→ **Enter the target temperature in °C in the "Temperature (°C)" field under "Actual."**

→ **Click on "Add New Point."** The raw data (pressure and temperature) are obtained from the part, and the point is displayed on the large graph. The point is graphed as the values entered in the previous two steps: the X-axis is the target temperature reading and the Y-axis is the target % value.

→ **Change the pressure/temperature of the bridge/ RBic$_{iLite}$™ pair being calibrated and repeat. Take as many more points as needed.**

Hints:

For good calibration results, choose the temperature and bridge readout (%) values as close as possible to the desired working range.

Step 3 – Calculating and Writing the Coefficients

"Calculate & Write Coefficients" Button

After enough data points have been collected to calculate the calibration coefficients, click the "Calculate & Write Coefficients" button. The software calculates all the coefficients, writes them to EEPROM, and frees up that index for future use. The bridge/IC pair is now calibrated. Before the software starts to calculate and write the coefficients, all raw readings are stored in a text file (C:\Program Files\ZMD America\RBICiLite Tester\caldata.txt).

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5.2 Dry Run Calibration

Steps for a Dry Run Calibration using the Artificial Bridge on the Evaluation Board:

The following steps demonstrate a simple 2-point linear calibration using the artificial bridge on the Evaluation Board.

Important: The jumpers must be connected on K6 (VBP) and K7 (VNP).

1.) Connect the SSC Communication (SSC CB) and the SSC ZMD31014 Evaluation Board. Insert the RBic$_{iLite}$™ in the SOP-8 socket on the SSC Evaluation Board. The correct orientation for pin 1 is shown in Figure 3.1.

2.) Connect a USB cable from the USB connector on the SSC CB to an available USB port on the PC. Verify that the green PWR LED is lit on the SSC CB.

3.) Start the RBIC$_{iLite}$™ Tester software.

4.) Click “Find Port” to find the proper COM port.

5.) Click on “START CM.” If the setup is correct, the buttons in the lower part of the main window will be activated.

6.) Click on “Calibration.” The calibration window appears (Figure 4.3).

7.) In the upper right section of the calibration window, under the “Common Calibration Types” drop-down menu, choose “2-Pt Gain_B, Offset_B” calibration. The graph indicates the recommended pattern of two bridge readings at the same temperature.

8.) Click on the “Initialize” button, and click “OK” to keep the default settings for the dialog box (Figure 5.2). A unique identifier is assigned to this RBic$_{iLite}$™ and is written to its EEPROM

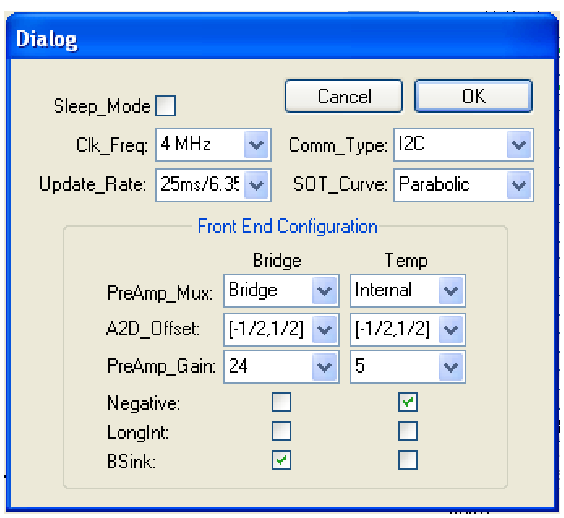

Figure 5.2 – Initialization Dialog Window with Default Values (Calibration with Artificial Bridge)

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9.) The next step is to start data collection. Normally this would be done with a real bridge attached to the RBic$_{iLite}$™ on a remote board in a controlled chamber. Instead, this dry run calibration uses the artificial bridge inputs controlled by the on-board DAC. The DAC is controlled by the “Artificial Stimulus” slider bar or its adjacent entry field at the top of the calibration window (see Figure 4.3).
   a. Set the DAC control to 0x300 (hex).
   b. Enter 10 in the “Bridge (%)” field under “Actual.”
   c. Click on “Add New Point.” The software obtains a raw reading from the part and graphs the new data point.
   d. Change the DAC setting to 0xD00.
   e. Enter 90 in the “Bridge (%)” field under “Actual.”
   f. Click on “Add New Point” again. The software obtains a new raw reading from the part and graphs the new data point.

10.) Because this is a 2-point calibration, the software has all the necessary data for calculating and writing the coefficients. Click on “Calculate & Write Coefficients,” which should now be active.

11.) Close the calibration window. The temperature reading is not valid because not enough data points were collected for temperature calibration.

12.) Start the Normal Operation Mode (NOM) by clicking on “START NOM” and read the measurement results continuously (click Run Continuous).The DAC is now controlled by the “Artificial” slider below the data read-outs and its adjacent entry field. Adjust the DAC, and check that the displayed values make sense. For example, 0x800 should read 50% and 0xA80 should read 70%.

Steps for a Dry Run Calibration using the Sensor Replacement Board:

The following steps demonstrate a simple 2-point linear calibration using the artificial bridge on the Sensor Replacement Board (SRB).

Important: The jumpers must be removed from connectors K6 (VBP) and K7 (VNP).

1.) Connect the SSC Communication (SSC CB), the SSC ZMD31014 Evaluation Board and SSC SRB. Insert the RBic$_{iLite}$™ in the SOP-8 socket on the SSC Evaluation Board. The correct orientation for pin 1 is shown in Figure 3.1.

2.) Connect a USB cable from the USB connector on the SSC CB to an available USB port on the PC. Verify that the green PWR LED is lit on the SSC CB.

3.) Start the RBIC$_{iLite}$™ Tester software.

4.) Click “Find Port” to find the proper COM port.

5.) Click on “START CM.” If the setup is correct, the buttons in the lower part of the main window will be activated.

6.) Click on “Calibration.” The calibration window appears (Figure 4.3).

7.) In the upper right section of the calibration window, under the “Common Calibration Types” drop-down menu, choose “2-Pt Gain_B, Offset_B” calibration. The graph indicates the recommended pattern of two bridge readings at the same temperature.

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8.) Click on the “Initialize” button, and change the default settings to the settings shown Figure 5-3 and click “OK”. A unique identifier is assigned to this RBic$_{iLite}$™ and is written to its EEPROM.

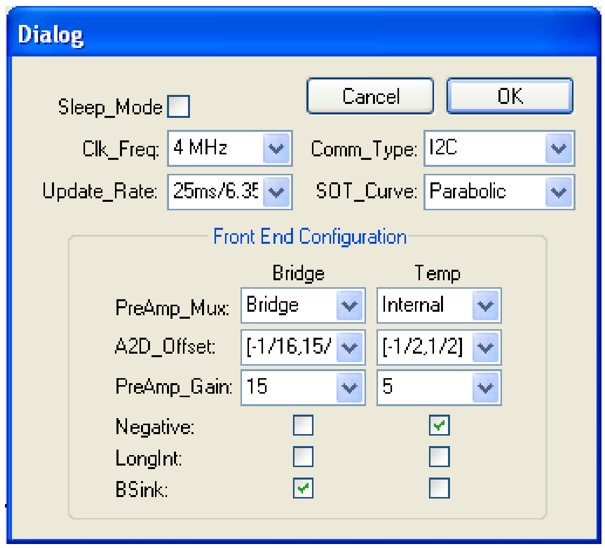

Figure 5-3– Initialization Dialog Window with changed Values (Calibration with SRB)

9.) The next step is to start data collection. Normally this would be done with a real bridge attached to the RBic$_{iLite}$™ on a remote board in a controlled chamber. Instead, this dry run calibration uses the Sensor Replacement Board (SRB) as bridge inputs.

a. Turn the red potentiometer on the SRB all the way to the left.

b. Enter 10% in the “Bridge (%)” field under “Actual.”

c. Click on “Add New Point.” The software obtains a raw reading from the part and graphs the new data point.

d. Turn the red potentiometer on the SRB all the way to the right.

e. Enter 90% in the “Bridge (%)” field under “Actual.”

f. Click on “Add New Point” again. The software obtains a new raw reading from the part and graphs the new data point.

10.) Because this is a 2-point calibration, the software has all the necessary data for calculating and writing the coefficients. Click on “Calculate & Write Coefficients,” which should now be active.

11.) Close the calibration window. The temperature reading is not valid because not enough data points were collected for temperature calibration.

12.) Start the Normal Operation Mode (NOM) by clicking on “START NOM” and read the measurement results continuously (click Run Continuous) to verify the output change according to the potentiometer position.

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6 ZMD31014 Software with the ZMD SSC Terminal

6.1 Protocol

The microcontroller (type ATmega32) on the SSC Communication Board (SSC CB) enables communication with the SSC Evaluation Board/ RBic$_{iLite}$™ using the evaluation software running on the PC. The standard I^{2}C protocol is implemented in the microcontroller's software. The USB_UART IC on the SSC CB transfers the signals from the microcontroller to the USB port of the PC.

For more details see the *ZMD31xxxCommBoard_DS_Rev_*.pdf.*

6.2 ZMD SSC Terminal

The ZMD SSC Terminal is the lowest level of communication for transferring commands from the PC to the microcontroller on the SSC CB. A fully summary and detailed command description of the applicable controller commands are given in *ZMD31xxxKIT_CommandSyntax_Rev_*.xls.*

Install the *SSC Terminal V201.exe* from the SSC CD-ROM, which will create a *ZMD SSC Terminal* icon on the PC desktop. Click on this icon to active the terminal program. For the ZMD31014 communication mode, use the setting explained for I^{2}C (bi-directional) or SPI (only reading).

For more details see the *ZMD31014_RBic_iLite_Tech_Notes_Calib_DLL+Terminal_Comm.pdf*.

	Character Order					
	1	**2**	**3**	**4,5**	**6,7,8**	**<d…d>**
RBic$_{iLite}$	***I***	***R*** or ***W***	***T*** or _			
Comments		Read or Write	Trigger Power Cycle or Not	Slave address) (28h default)	Number of Bytes to Read and Write	Blank for Read; Data Bytes to Write
Examples	***I***	***W***	***T***	***28***	***003***	***500000***
	I	***R***	_	***28***	***002***	

Hint: If "T" is sent for the 3rd position (instead of "_"), the ZMD31014 is powered off and then on. "T" should be used only if power cycling is necessary for operation.

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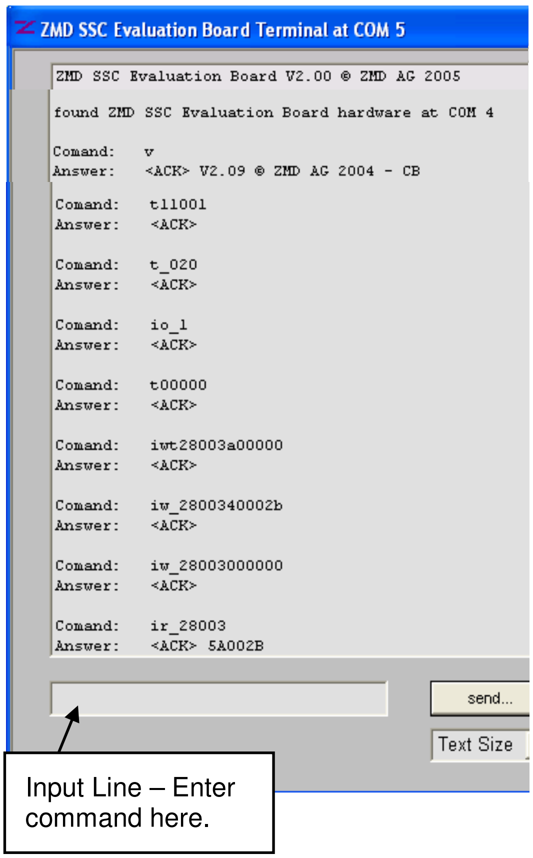
Figure 6.1 below shows a communication example. Write the command in the input line and press ENTER on the keyboard or click on "Send."



v	Readout of SSC CB's firmware version.
t11001	Switch on both supplies with 10ms delay between power on and first command.
t_020:	Set timing for switch supply off to 20ms off before trigger restart SSC.
io_1:	Set communication speed to 100kHz.
t00000:	Switch off all active channels, adjusted trigger timing is preserved.
iwt28003a00000	Start Command Mode with power on using defined delay between power-on and start of communication.
iw_2800340001b	Write to EEPROM adr.00 data 0x002b (IC default slave adr. 0x28).
iw_280030000000000	I2C Send command 00 0000 to slave adr 28. Read EEPROM adr 00.
ir_28003	Read 2(3) bytes (first byte is 5A as ACK) from digital register.

Figure 6.1 SSC Terminal Program Sample

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7 Command/Data Pair Encoding

See the current version of the *ZMD31014_iLite_Datasheet* document for more details on commands.

In Command Mode, the master uses the I^2C protocol to send 4-byte commands to the RBic$_{iite}$™. This 32-bit I^2C packet command/data stream consists of a I^2C WRITE command byte, which is the 7-bit slave address followed by the write bit 0 (e.g., 0x50 = I^2C WRITE command byte for the default slave address 0x28 and write bit 0); then a command byte; and then16 data bits. See the *ZMD31014_iLite_Datasheet* document for a detailed illustration of the WRITE command packet. Table 7.1 gives the format and valid range for the three bytes that follow the initial I^2C WRITE command byte.

Note: Only the commands listed in Table 7.1 are valid for the RBic$_{iLite}$™ in Command Mode. Other encodings might cause unpredictable results. If data is not needed for the command, zeros must be supplied as data to complete the 32-bit packet.

Table 7.1 – Encoding for the 3 Bytes after the Initial I^2C WRITE Command Byte

Command Byte (Second Byte) 8 Command Bits (Hex)	**Third and Fourth Bytes** 16 Data Bits(Hex)	**Description**
0x00 to 0x13	0x0000	EEPROM Read of addresses 0x00 to 0x13. After this command has been sent and executed, a data fetch of three bytes must be performed. The first byte will be a response byte, which should be a 0x5A, and then the next two bytes will be the EEPROM data.
0x40 to 0x53	0xYYYY (Y= data)	Write to EEPROM addresses 0x00 to 0x13. If the command is an EEPROM write, then the 16 bits of data sent will be written to the address specified in the 6 LSBs of the command byte.
0x80	0x0000	Start_NOM => Ends Command Mode and transitions to Normal Operation Mode. When a Start_NOM command is executed, a flag is checked to see if EEPROM was programmed during Command Mode. If so, the device will regenerate the checksum and update the signature EEPROM word.
0xA0	0x0000	Start_CM => Start Command Mode; used to enter the command interpreting mode. Start_CM is only valid during the power-on command window.

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8 EEPROM Bits

See the current version of the *ZMD31014_iLite_Datasheet* document for more details on the EEPROM bits.

Table 8.1 – EEPROM Word/Bit Assignments Programmed via the I²C Interface (RevB)

EEPROM Word	Bit Range	IC Default	Description	Note
0x00	15:0		Cust_ID0	Customer ID byte 0 (combines with EEPROM Word 0x13 to form customer ID)
0x01			ZMD_Config_1	Bits in the ZMD_Config_1 EEPROM word control the following settings. *Important:* IC must be power-cycled after changes to this word.
	2:0		Reserved	Leave at factory settings
	3		ClkSpeed	Digital Core Clock Frequency 0 = 4MHz 1 = 1MHz
	4		Comm_Type	Serial Communication Type 0 = I²C 1 = SPI
	5		Sleep_Mode	Normal Operation Mode 0 = Update Mode 1 = Sleep Mode
	7:6		Update_Rate	1MHz Clock / 4MHz Clock 00 = 1.4ms / 00 = 0.4ms 01 = 4.9ms / 01 = 1.28ms 10 = 25.1ms / 10 = 6.33ms 11 = 124.4ms / 11 = 31.16ms
	8		Reserved	Leave at factory setting
	9		SOT_curve	Type of second-order curve correction on bridge. If set to 0, the bridge SOT will correct for a parabolic curve. If set to 1, the bridge SOT will correct for an S-shaped curve.
	11:10		TC_Sign	TC_Sign[0] = 1, Tco is a negative number. TC_Sign[1] = 1, Tcg is a negative number.
	15:12		SOT_Sign	SOT_Sign[0] =1, SOT_bridge is negative. SOT_Sign[1] =1, SOT_tco is negative. SOT_Sign[2] =1, SOT_tcg is negative. SOT_Sign[3] =1, SOT_T is negative.
0x02			ZMD_Config_2	Bits in the ZMD_Config_2 EEPROM word control the following settings. *Important:* IC must be power-cycled after changes to this word.

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EEPROM Word	Bit Range	IC Default	Description	Note
	0		SPI_Polarity	Configure clock polarity of SPI interface 0 = MISO changes on SCLK negative edge. 1 = MISO changes on SCLK positive edge.
	2:1		Diag_cfg	2-bit diagnostic configuration field. Diag_cfg[0] enables sensor connection check. Diag_cfg[1] enables sensor short checking.
	9:3	0101000	Slave_Addr	I²C slave address (default = 0x28). Valid range is 0x00 to 0x7F.
	12:10	011	Comm_lock	Communications address lock 011 => locked All other => unlocked When communication is locked, I²C communication will only respond to its programmed address. Otherwise if communication is unlocked, I²C will respond to any address.
	15:13		EEP_Lock	EEPROM lock 011 = locked All other = unlocked When EEPROM is locked, the internal charge pump is disabled and the EEPROM can never be programmed again. **NOTE:** Next command must be Start_NOM so that the signature is calculated and written to EEPROM before power down.[1]
0x03	15:0		Offset_B	Signed 16-bit offset for bridge correction.
0x04	14:0		Gain_B	15-bit magnitude of bridge gain. Always positive. Unity is 0x2000.
	15		Gain8x_B	Multiple Gain_B by 8 0 = Gain_B x 1 1 = Gain_B x 8
0x05	15:0		Tcg	Coefficient for temperature correction of bridge gain term. Tcg = 16-bit magnitude of Tcg term with sign determined by TC_Sign[1].

[1] If the part is power cycled instead, the lock will take effect, and the checksum will be permanently wrong. In this case, the part will always output a diagnostic state.

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EEPROM Word	Bit Range	IC Default	Description	Note
0x06	15:0		Tco	Coefficient for temperature correction of bridge offset term. Tco = 16-bit magnitude of Tco term with sign determined by TC_Sign[0].
0x07	15:0		SOT_tco	2nd order term applied to Tco. This term is a 16-bit magnitude with sign determined by SOT_Sign[1].
0x08	15:0		SOT_tcg	2nd order term applied to Tcg. This term is a 16-bit magnitude with sign determined by SOT_Sign[2].
0x09	15:0		SOT_bridge	2nd order term applied to the bridge measurement. This term is a 16-bit magnitude with sign determined by SOT_Sign[0]. SOT_curve selects parabolic or S-shaped fit.
0x0A	15:0		Offset_T	Temperature offset correction coefficient.
0x0B	14:0		Gain_T	Temperature gain correction coefficient.
	15		Gain8x_T	Multiple Gain_T by 8 0 = Gain_T x 1 1 = Gain_T x 8
0x0C	15:0		SOT_T	2nd order term applied to the temperature reading. This term is a 16-bit magnitude with sign determined by SOT_Sign[3]. Always a parabolic fit.
0x0D	15:0		T_{SETL}	Stores raw temperature reading at the temperature at which low calibration points were taken.
0x0E	15:0		Unused	Leave at factory settings
0x0F			B_Config Register	Front-end configuration word for measurement of BP/BN (Bridge).
	3:0		A2D_Offset [3:0]	A2D_Offset [3:0] — A2D_Offset Point Shift 1111 — [-15/16,1/16] 1110 — [-7/8,1/8] 1100 — [-3/4,1/4] 1000 — [-1/2,1/2] 0100 — [-1/4,3/4] 0010 — [-1/8,7/8] 0001 — [-1/16,15/16]

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EEPROM Word	Bit Range	IC Default	Description	Note
	6:4		PreAmp_Gain [2:0]	PreAmp_Gain [2:0] GAIN 000 1.5 100 3 001 6 101 12 010 24 110 48 011 96 111 192
	7		Gain_Polarity	Gain polarity: 0=negative gain, 1=positive gain
	8		LongInt	If 1, selects long integration period (11-coarse + 3 fine), which results in lower noise, slower conversion; otherwise, the conversion is done as (9 coarse + 5 fine).
	9		Bsink	If 1, Bsink pull-down will be enabled during the measurement.
	11:10		PreAmp_Mux [1:0]	PreAmp_Mux [1:0] Measurement 10 Bridge 11 Single-ended input
	12		Disable_Nulling	Disable Nulling 0 = Nulling On 1 = Nulling Off (Use this setting if PreAmp gain ≤6.)
	15:13		Reserved	Leave at factory settings

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EEPROM Word	Bit Range	IC Default	Description	Note
0x10			T_Config Register	Front-end configuration word for temperature measurement
	3:0		A2D_Offset [3:0]	A2D_Offset [3:0] A2D_Offset Point Shift 1111 [-15/16,1/16] 1110 [-7/8,1/8] 1100 [-3/4,1/4] 1000 [-1/2,1/2] 0100 [-1/4,3/4] 0010 [-1/8,7/8] 0001 [-1/16,15/16]
	6:4		PreAmp_ Gain[2:0]	PreAmp_Gain [2:0] GAIN 000 1.5 100 3 001 6 101 12 010 24 110 48 011 96 111 192
	7		Gain_Polarity	Gain polarity; 0 = negative, 1= positive gain.
	8		LongInt	If 1, selects long integration period (11-coarse + 3 fine), for lower noise, slower conversion; otherwise, the conversion is (9 coarse + 5 fine).
	9		Bsink	If 1, Bsink pull-down will be enabled during the measurement.
	11:10		PreAmp_Mux [1:0]	PreAmp_Mux [1:0] Measurement 00 Ext. Temperature 01 Internal Temperature
	12		Disable_Nulling	Disable Nulling 0 = Nulling On 1 = Nulling Off (Use this setting if PreAmp gain ≤6.)
	15:13		Reserved	Leave at factory settings
	15:0		Reserved	Leave at factory settings
0x12	15:0		Signature	Generated through a linear feedback shift register (LFSR). Signature checked on power-up to ensure EEPROM contents integrity.
0x13	15:0		Cust_ID1	Customer ID byte 1 (combines with Word 0x00 to form customer ID).

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9 Related Documents

- ZMD31xxxKIT_CommBoard_DS.pdf
- ZMD31xxxKIT_SensorReplacementBoard_DS.pdf
- ZMD31xxxCommandSyntax.xls
- ZMD31014 RBic$_{iLite}$™ *Datasheet*
- ZMD31014 RBic$_{iLite}$™ *SSC Kits Feature Sheet* (includes ordering codes and price information)
- ZMD31014 RBic$_{iLite}$™ *Die Dimensions and Pad Coordinates*

For the current revisions of this document and of the related documents, please go to www.zmd.biz or contact the ZMD sales team (see addresses on last page).

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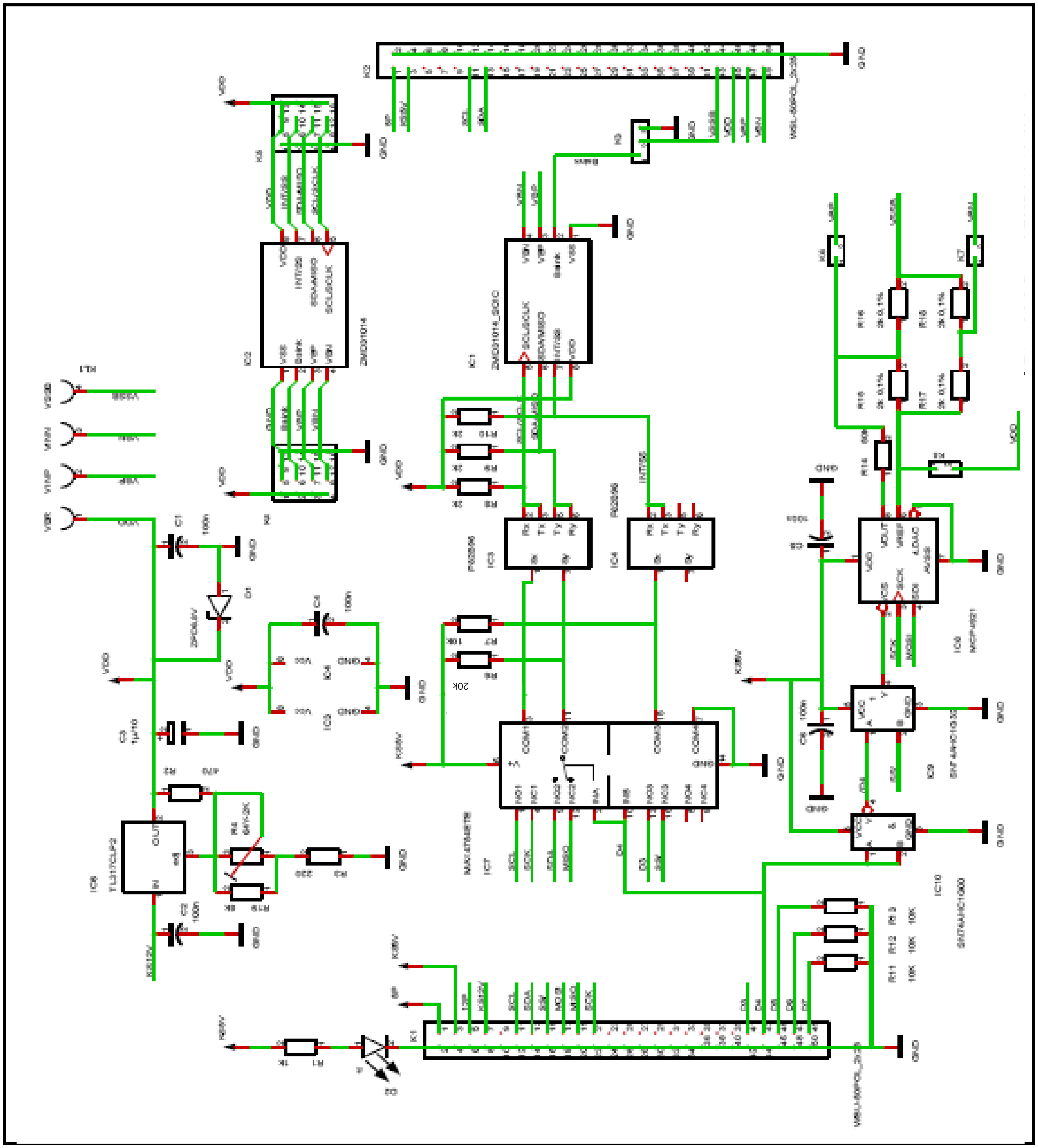
Appendix A: Schematic RBic$_{iLite}$™ SSC Evaluation Board



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Appendix B: List of Error Messages in the Software

(TBD)

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Appendix C: Format of the *caldata.txt* file

04/14/08 14:02:17 1208199737 3 2 3048 1176 0 72

35.7147 10 10.1563 25

64.3791 90 10.1563 25

Date	Time	Machine_TIME	ID	NUM_POINTS	B_CFG	T_CFG	OFFSET_B	CFG1
04/14/08	14:02:17	1208199737	3	2	3048	1176	0	128

RAW_B	BR	RAW_T	TEMP
35.7147	10	10.1563	25
64.3791	90	10.1563	25

The top line contains calibration specific information (1 part):

Date, time, and machine time of calibration

ID:Calibration ID number --this is what is programmed into the part for retrieval

SOT_TYPE: 0 → Parabolic, 1 → S-Shape

NUM_POINTS: Number of points currently in the calibration

B_CFG: Bridge configuration register EEPROM word 0x0F

T_CFG: Temperature configuration register EEPROM word 0x10

OFFSET_B ADC Shift related OFFSET_B (see Table 5.1)

CFG1: Configuration word Config1 (EEPROM word 0x01)

The next lines contain calibration point specific data:

RAW_B: Raw Bridge Readings

BR: Desired Bridge ("Actual")

RAW_T: Raw temperature reading

TEMP: Desired Temperature ("Actual")

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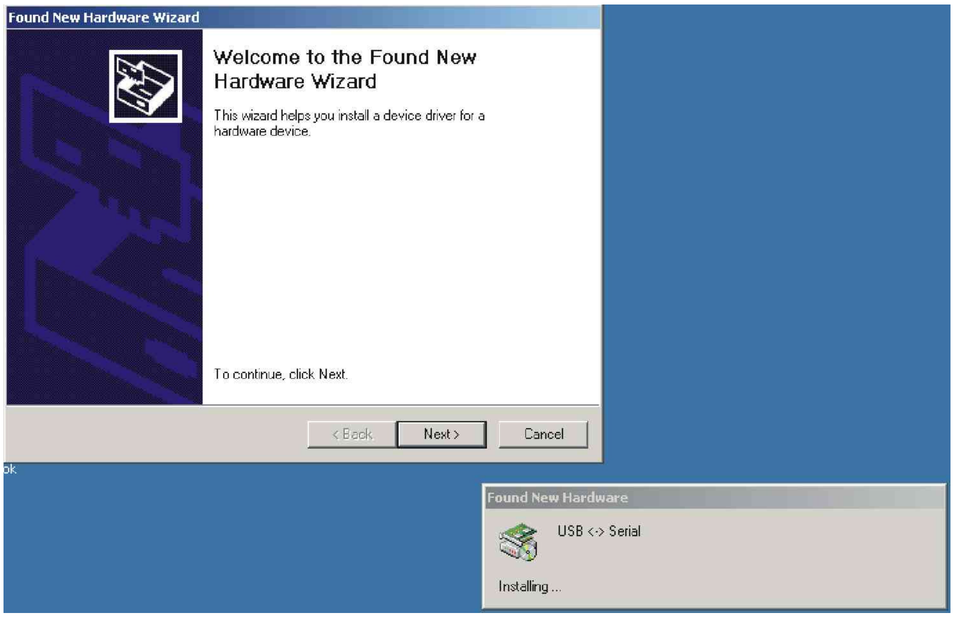
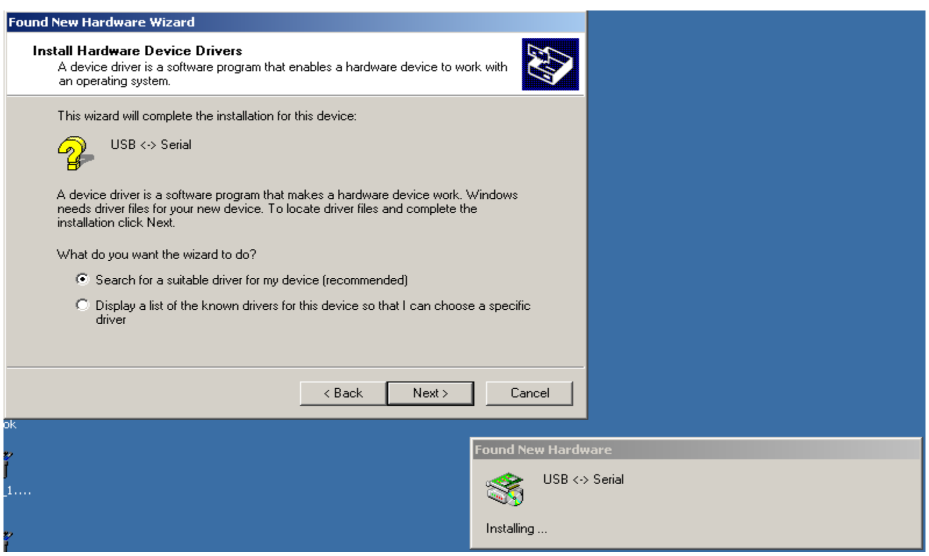
Appendix D: Driver Installation on Windows 2000 Operating Systems

Follow these steps to install the basic USB driver on Windows 2000 operating systems:

1. Connect the SSC Evaluation Board to a USB port with a USB cable. The "Found New Hardware" wizard automatically launches, and the following dialog box appears:



2. Click Next. The following dialog box appears. Select "Search for a suitable driver for my device (recommended)".



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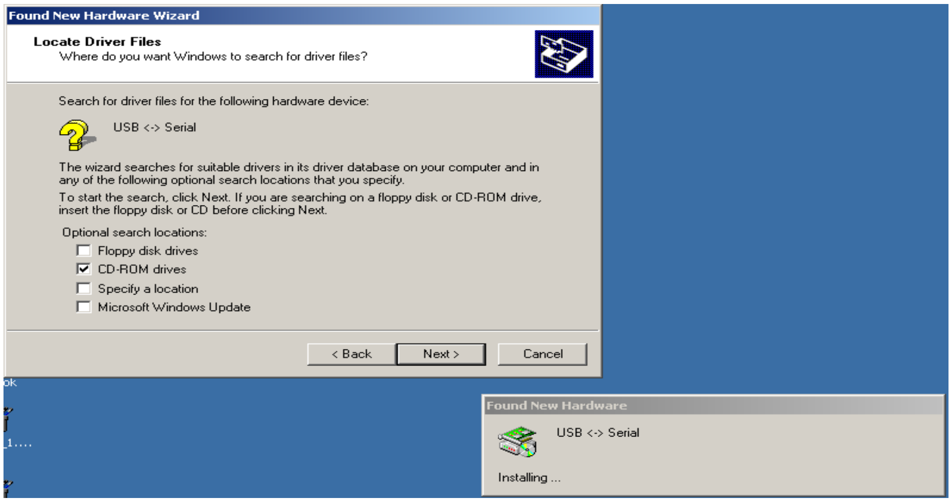
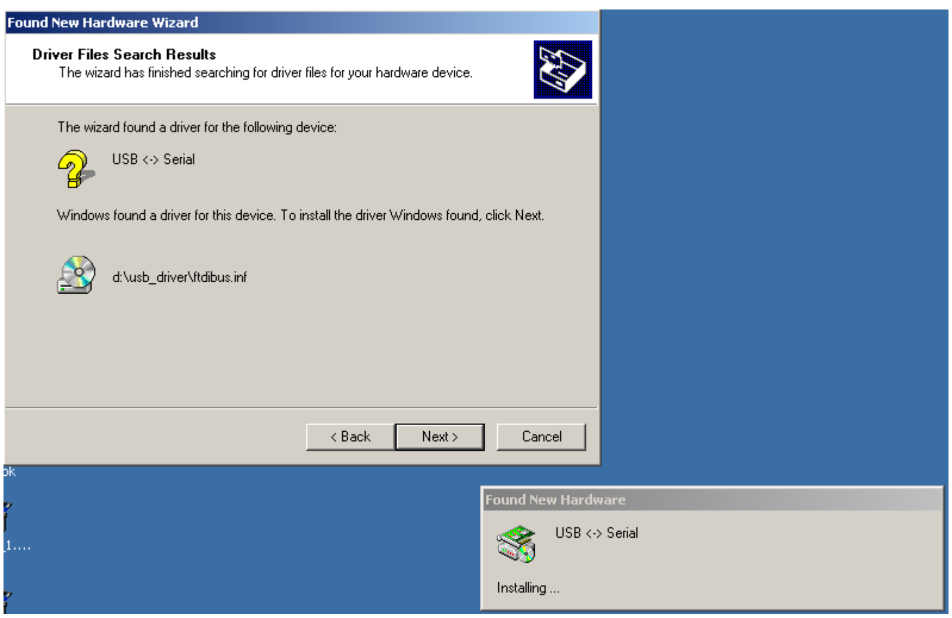
3. Click on Next. The following dialog appears. Select “CD-ROM drives.”



4. Click on Next. The following display appears confirming that the driver was found on the CD-ROM drive.



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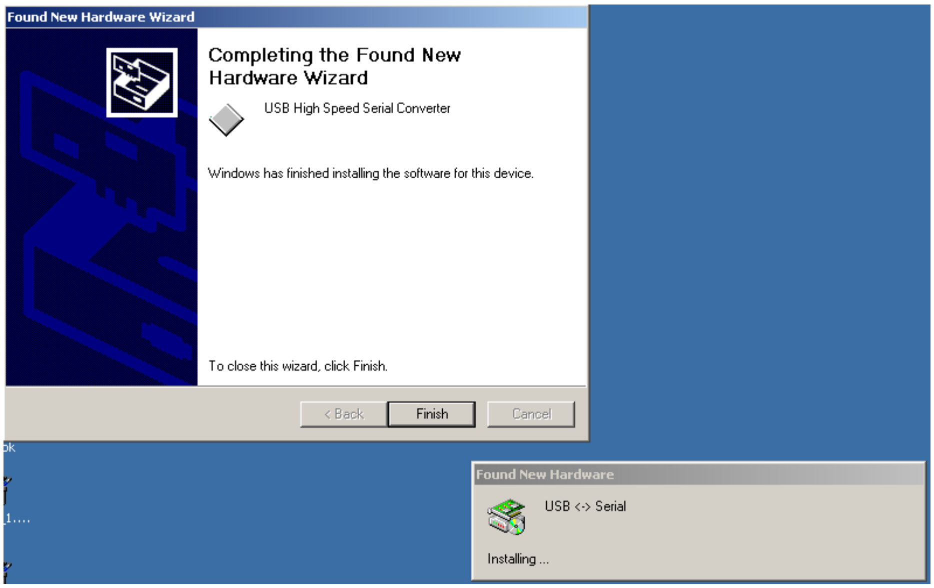
5. Click on Next. The following display confirms the installation of the basic USB driver.



6. Click on Finish. The second USB driver installation automatically starts. This second required USB driver causes the USB device to appear to the system as a virtual COM port. Follow the same steps as outlined under *Installing the Basic USB Driver* above to complete this second driver installation.

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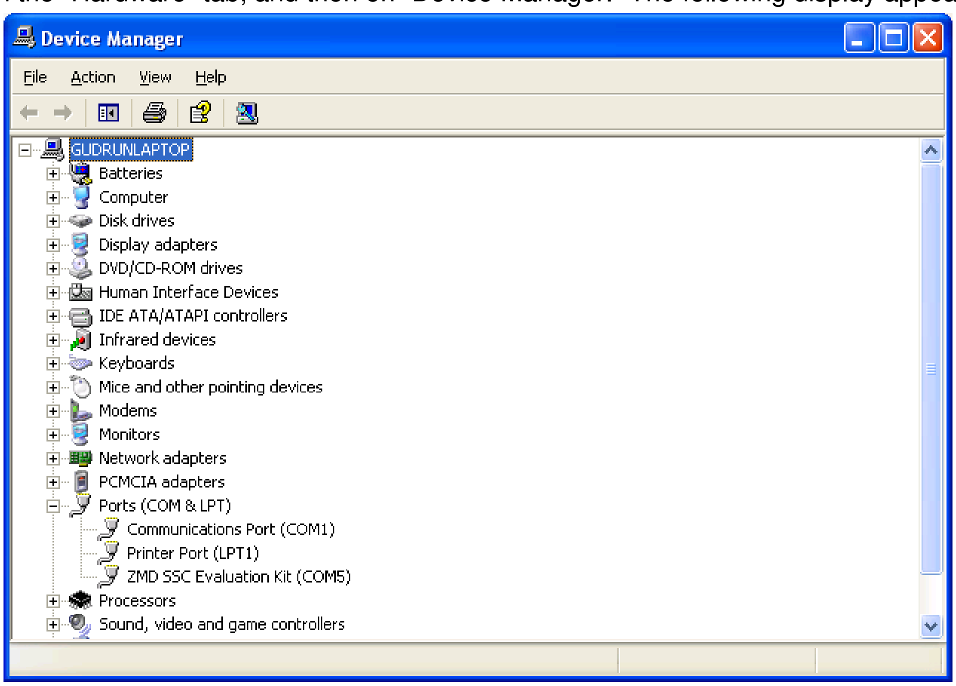
7. Verify that the new hardware is operating properly before continuing. Access the control panel by clicking Start ➔ Settings ➔ Control Panel. Double click the "System" icon. The following dialog box appears.

8. Click on the "Hardware" tab, and then on "Device Manager." The following display appears.



If the USB is operating properly, "ZMD SSC Evaluation Kit (COMx)" appears under "Ports (COM & LPT)." Typically, the "x" is 3 or 4. Remember this virtual COM port number. It is the COM port to select when using the software provided with the SSC Evaluation Kit.

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