ZMD31015

RBic$_{dLite}$™ Low-Cost Sensor Signal Conditioner with Diagnostics

SSC Evaluation Kit Documentation

ZMD31015 RBic$_{dLite}$™ Sensor Signal Conditioner

SSC Modular Evaluation Kit Documentation

Restrictions:

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

The ZMD AG RBic$_{Lite}$ ™ SSC Evaluation Kit hardware and software must not be used for module production and production test setups. ZMD AG shall not be liable for any damages arising out of defects resulting from (i) delivered hard and software (ii) non-observance of instructions contained in this manual, or (iii) misuse, abuse, use under abnormal conditions or alteration by anyone other than ZMD AG. To the extent permitted by law, ZMD AG hereby expressly disclaims and User expressly waives any and all warranties, whether express, implied or statutory, including, without limitation, implied warranties of merchantability and of fitness for a particular purpose, statutory warranty of non-infringement and any other warranty that may arise by reason of usage of trade, custom or course of dealing.

Contents

1 Kit Contents

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

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

c) SSC ZMD31010 Evaluation Board (for both the ZMD31010 and the ZMD31015)

d) ZMD31XXX Sensor Replacement Board (SRB)

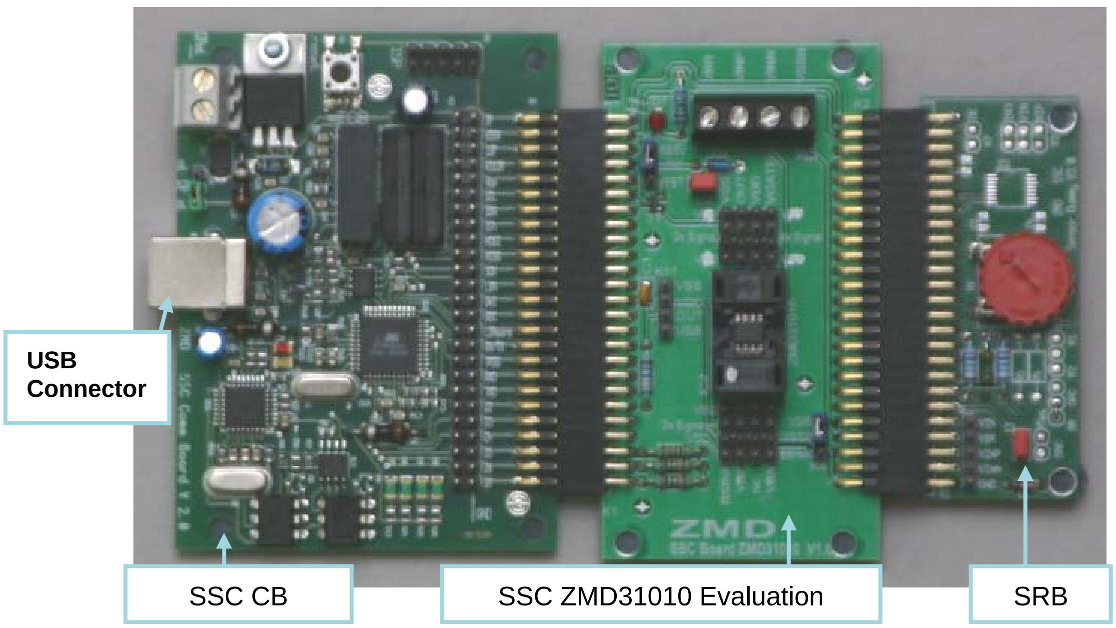


Figure 1.1 – ZMD31010 SSC Evaluation Kit (for both the ZMD31010 and the ZMD31015)

The RBic$_{dLite}$™ SSC Evaluation Kit contains the software and hardware needed for communication and calibration of an RBic$_{Lite}$™ sensor signal conditioning IC. A PC can communicate with the SSC Evaluation Board via a SSC Communication Board through a USB connection. The software should function on any Windows® 98/ME/XP/NT system after the installation of a USB driver.

2 USB Driver Installation

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 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 will 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.

Installation for Windows® XP Pro or XP Home Operating Systems

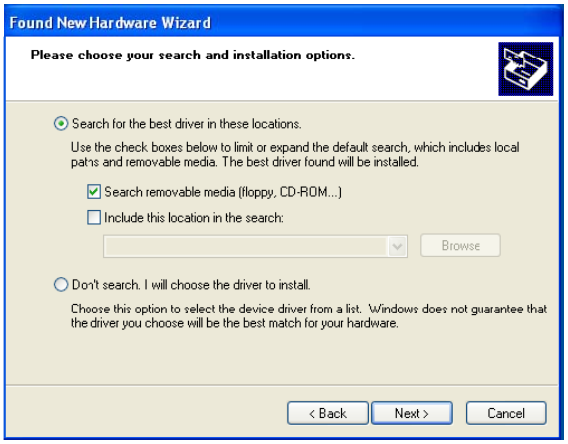
Installing the Basic USB Driver

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

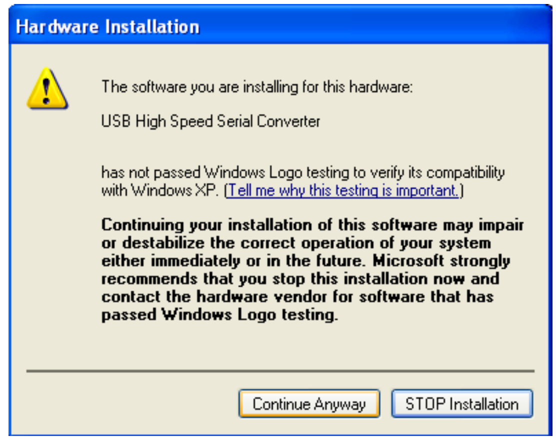
Use the USB cable to connect the SSC Evaluation Board to an available USB port on your PC. The “Found New Hardware” wizard launches and brings up the following dialog box. Complete the following steps.

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

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



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



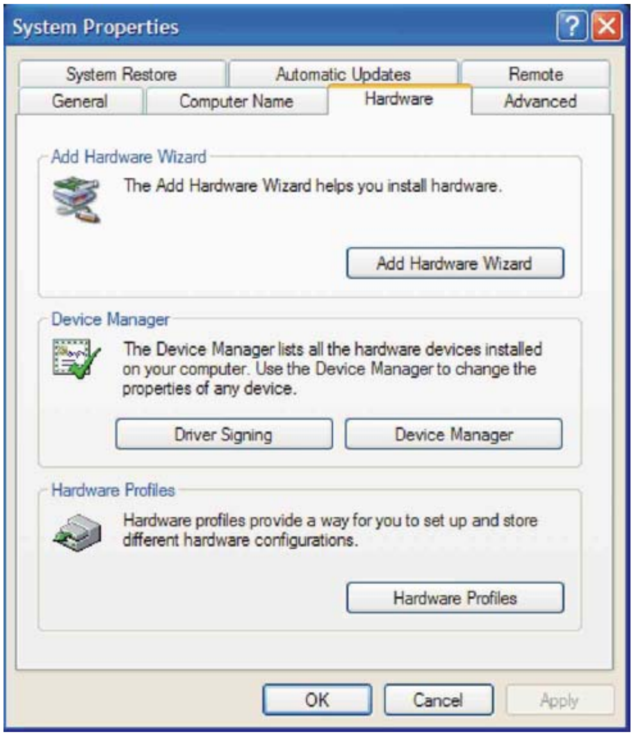
Step 4: When the warning about failing logo testing appears, click “Continue Anyway” because this concern is not applicable.

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.

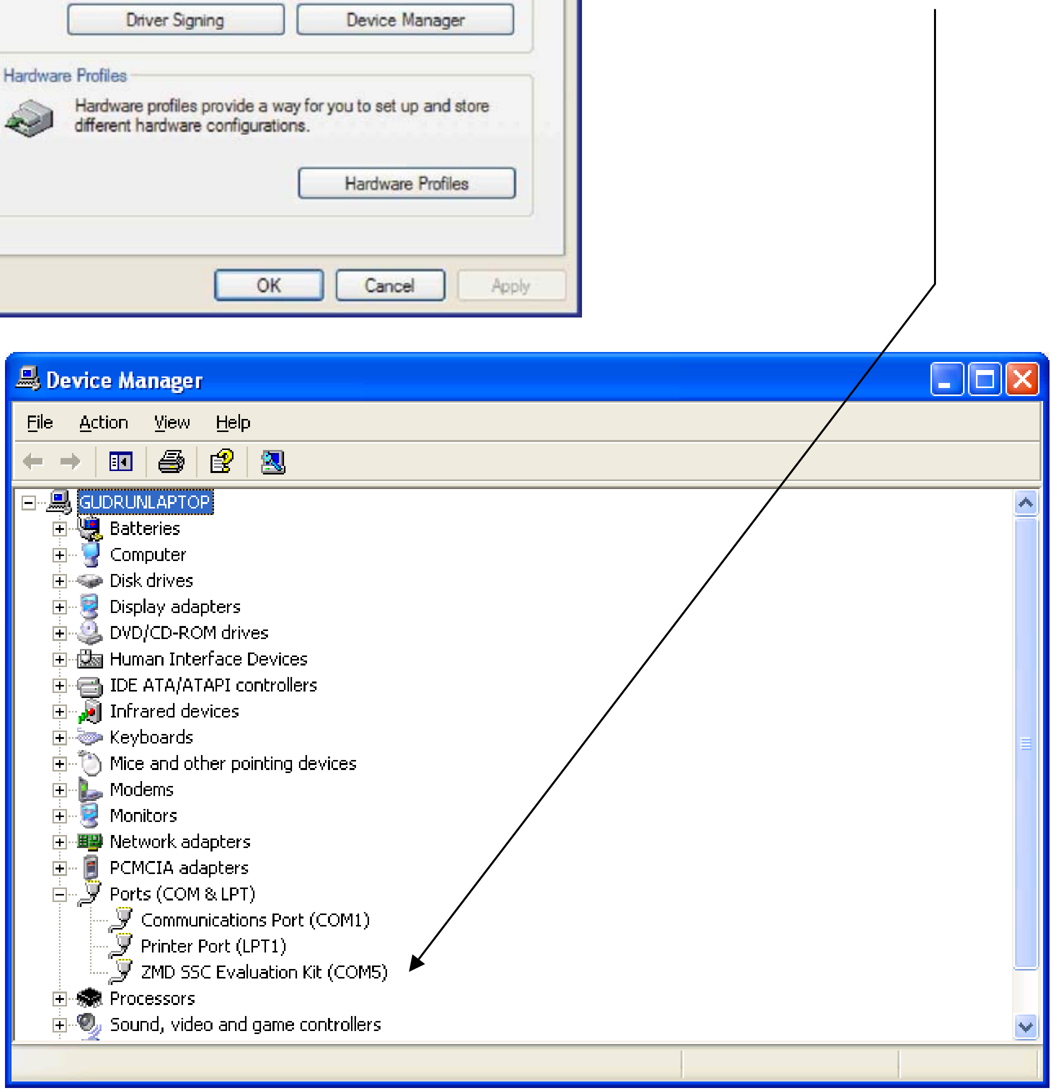


Checking USB Port Operation

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.



3 ZMD31010 SSC Evaluation Board

Overview

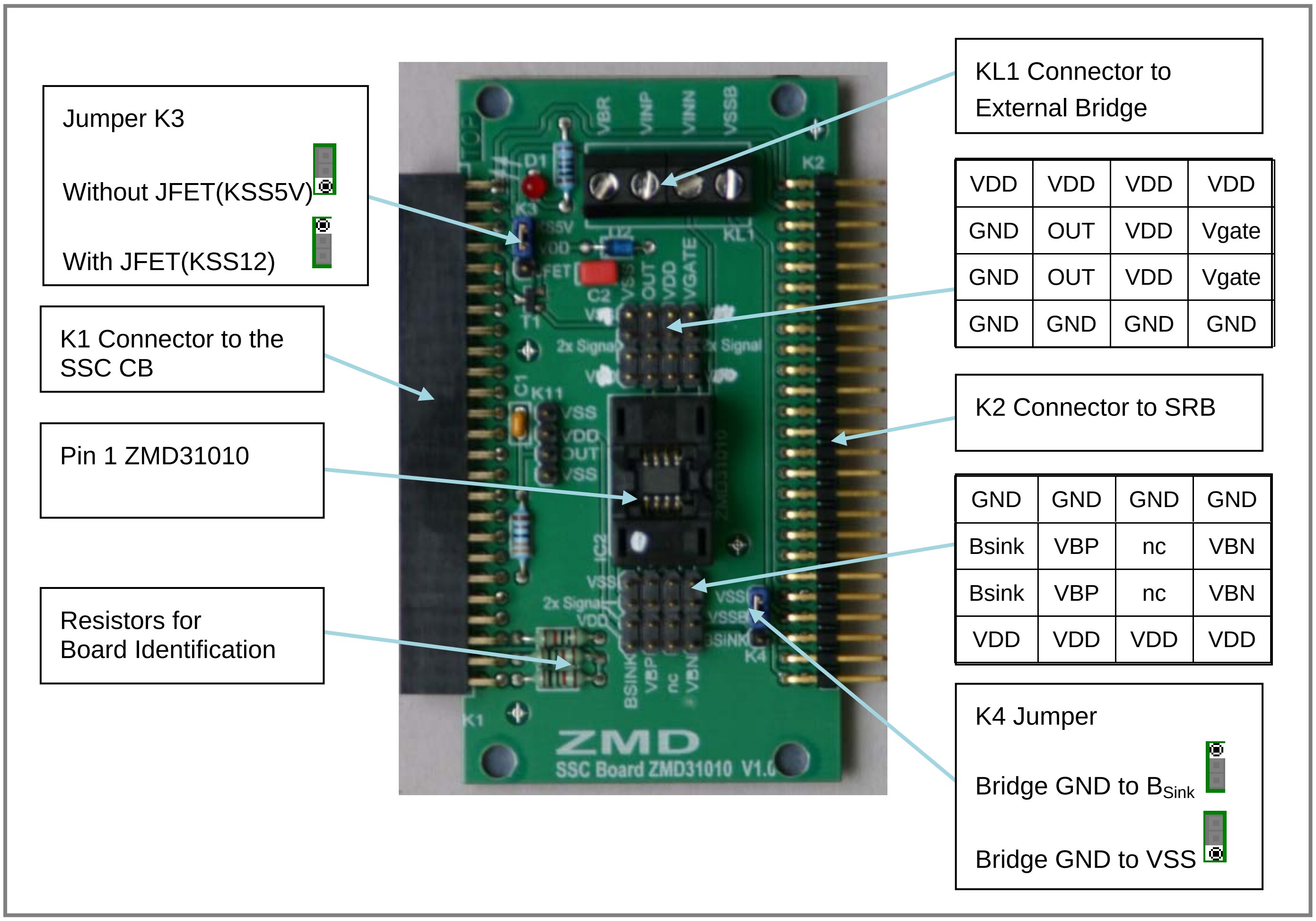


Figure 3.1– SSC Evaluation Board Overview

The main purpose of the SSC Evaluation System is to perform communication between the PC and the RBic$_{Lite}$™ IC. The PC sends commands and data via the USB/CB (virtual COM port). The µController on the SSC Communication Board interprets these commands and relays them to the RBic$_{dLite}$™ chip in the ZACwire™ format (K1 Pin 39). The µController will also forward any data bytes from the RBic$_{Lite}$™ chip back to the PC via the USB connection. These bytes can be bridge and temperature readings to be displayed by the PC software or raw ADC readings used during calibration or EEPROM content bytes.

Installing the Communication and Calibration Software

Install the RBic$_{dLite}$™ SSC Evaluation Kit CD-ROM in 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.

Connections to RBic$_{Lite}$™

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

Using the KS12V signal for power supply, the ZACwire™ signal (OWI) and the ground (GND) connection on connector K4 on the SSC CB, the board can be used for in-circuit programming of the RBic$_{Lite}$™ IC in the user's calibration fixture. Important: In this case (without the Evaluation Board) a pull-up resistor of 3.3 kΩ must be added to the Communication Board (CB) between OWI and Tr D2 or between OWI and KS5V (if connected).

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

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.

Reset Switch

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

4 RBic$_{dLite}$™ Tester Software

Overview

The ZMDI software provided with this SSC Evaluation Kit is intended for demonstration purposes and calibration of single units. ZMDI can provide the user with algorithms and assistance in developing their full production calibration software.

Board Type/Find Port/Initialize Button

Select “SSC_Eval” on the “Board Type” pull-down menu. Enter the correct virtual COM port to use for the PC ⇔ SSC Evaluation Board communication via USB. If the correct setting is unknown, click the “find port” button and accept/continue searching until the COM port setting is correct. Click on “Initialize” to set up the SSC hardware to function with the RBic$_{dLite}$™.

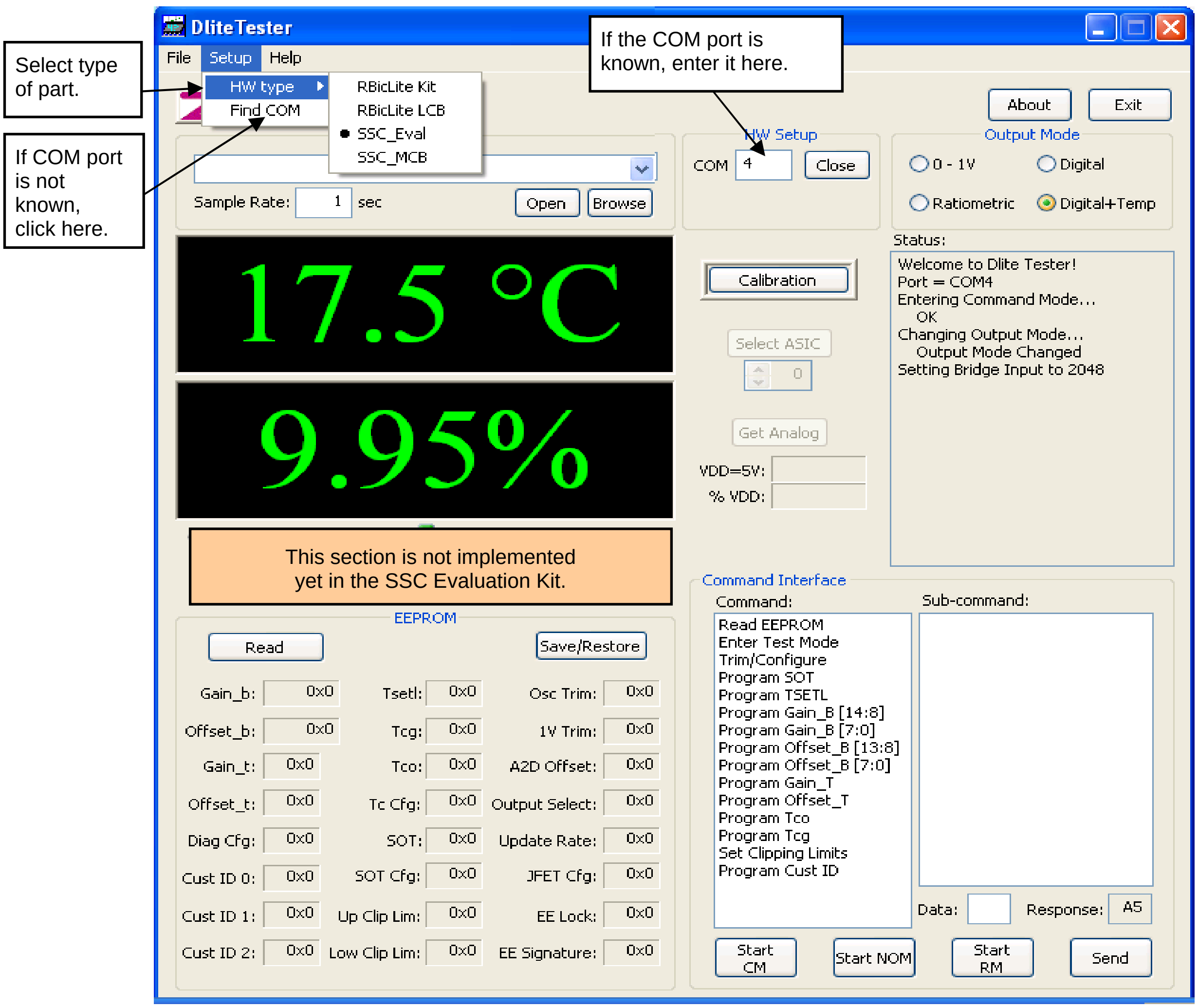


Figure 4.1 – Bridge & Temperature Display & Data Logging

Bridge and Temperature Display

The software displays two large readout windows for temperature and bridge values. The temperature reading is the RBic$_{dLite}$™ temperature in ^{o}C. The bridge reading is in %. Calibration determines the relationship of the % reading to the value the bridge is measuring. The RBic$_{dLite}$™ 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 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$_{dLite}$™ should give a 50% reading.

These readout windows only display temperature and bridge readings if the RBic$_{dLite}$™ is programmed in digital output configuration. There are two digital output configurations:

- Transmission of bridge readings and temperature
- Transmission of only bridge readings (no temperature)

Temperature is not displayed unless the RBic$_{dLite}$™ is configured to transmit both bridge and temperature in Digital Mode.

Data Logging Section

Bridge and temperature readings can be logged to a PC file. This feature is in the “Data Logging” section. 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$_{dLite}$™.

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

EEPROM Section

When “Read” is clicked, the “EEPROM” section displays all of the fields currently stored in the RBic$_{dLite}$™ EEPROM (non-volatile memory).

Command Interface Section

Use the “Command Interface” section to issue commands to the RBic$_{dLite}$™ including any valid RBic$_{dLite}$™ command. Click “START CM” (Start Command Mode) before sending any commands to the RBic$_{dLite}$™. This puts the RBic$_{dLite}$™ into Command Mode, and the output values in the black display fields do not update.

Response Field

If the RBic$_{dLite}$™ successfully enters Command Mode, it sends a 0xA5 response, which is displayed as A5 in the “Response” field.

Command/Subcommand/Data Fields

To send a command to the RBic$_{dLite}$™, click on its text description in the “Command” section. If the command has a sub-command component, then also click the selected sub-command in the “Sub-Command” section. Some commands also require one or more hex digits of data. Enter these in the “Data” field.

Send Button

After the desired command and any applicable sub-command are selected and any applicable data has been entered, click “Send.”

Start NOM Button

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

Start RM Button

When in Raw Mode, the block display fields show the raw values (uncorrected ADC results) for bridge and temperature input signals if the bridge gain (Gain_B) is programmed to unity (0x800) and the temperature gain (Gain_T) is programmed to unity (0x80). The "Start RM" button is provided only as an option for control and analysis; it is not typically needed during a standard calibration run.

The Raw Mode can only be entered after entering the Command Mode.

The calibration section of the software will automatically put the RBic$_{dLite}$™ in Raw Mode and collect all the raw data needed for a given calibration point.

Get Analog Function

This function uses one of the 10-bit ADC channels of the SSC CB. The input to this ADC is connected to the SIG™ pin of the RBic$_{dLite}$™. When "Get Analog" is clicked, the software issues a request for analog conversion to the board. When the board responds, the result is displayed as a voltage. The accuracy is limited by the ADC resolution. The value is shown as a % of VDD.

This feature is only useful if the RBic$_{dLite}$™ is programmed in analog output configuration.

Avg samples (Average Samples)

This feature allows averaging the measured values by choosing the number of samples to average before displaying the result. The range is up to 255 (FFH) and must be entered as a hexadecimal value.

Output Mode Section

In the "Output Mode" section, select the output mode before starting calibration. This selection determines the value range of the output signals as shown in the following table. Additional selections are possible in the Calibration/Set ASIC Configuration window (click "Calibration" to initialize).

Input Values Chamber Readings	**Output Values Depending on Output Selection**		
Measurement Example	**Digital With/Without Temperature**	**Ratiometric Analog VDD=5V**	**0-1V**
%	%(Digital)	V	V
10%	10% (204)	0.5	0.1
50%	50% (1024)	2.5	0.5
90%	90% (1834)	4.5	0.9

Table 4.1 – Output Mode Options

Adjustment of the Analog Pre-Amp Gain and the Analog ADC Offset Modes

The offset parameter is calculated automatically during the calibration procedure, and the result is stored in the EEPROM.

There are 4 programmable offset modes for the RBic$_{dLite}$™.

a.) [-1/2,1/2)
b.) [-1/4,3/4]
c.) [-1/8,7/8]
d.) [-1/16,15/16]

During the calibration process ("Add New Point"), the software will "acquire" data four different times, acquiring data for all 4 different offset modes. The best offset mode to use is calculated automatically by the software, and the result is stored in the EEPROM.

If the user has a good understanding of the bridge and its performance, the user can choose to disable data acquisition in certain offset modes. This will expedite the calibration process because then data acquisition will not be needed in all 4 modes.

These analog offset modes help compensate for bridges that have a large inherent offset (default pre-gain = 24).

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).

The gain term stored in EEPROM used to compensate for span is a digital gain term (a digital number multiplied by the result of the ADC to compensate sensor span). Prior to ADC conversion, however, there is an amplifier (pre-amp). This amplifier amplifies the bridge signal to produce the differential signal converted by the ADC conversion. This amplifier can be programmed to one of four different settings.

The programmable pre-amp gain can have the following values:

a.) A=6

b.) A=24 (default setting)

c.) A=48

d.) A=96

Any bridge input signal greater than 40mV/V in differential 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 6.

For very small differential input signals, the higher analog gain (48 or 96) can improve the output resolution given in section 6.4 in the datasheet, but the sensor offset has 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. With the higher analog gain (96) the total offset plus span cannot exceed 6mV/V differential. Otherwise the input to the ADC will be saturated.

Calibration Button

To initiate a calibration run, click the "Calibration" button. This results in the calibration screen and dialog box shown below.

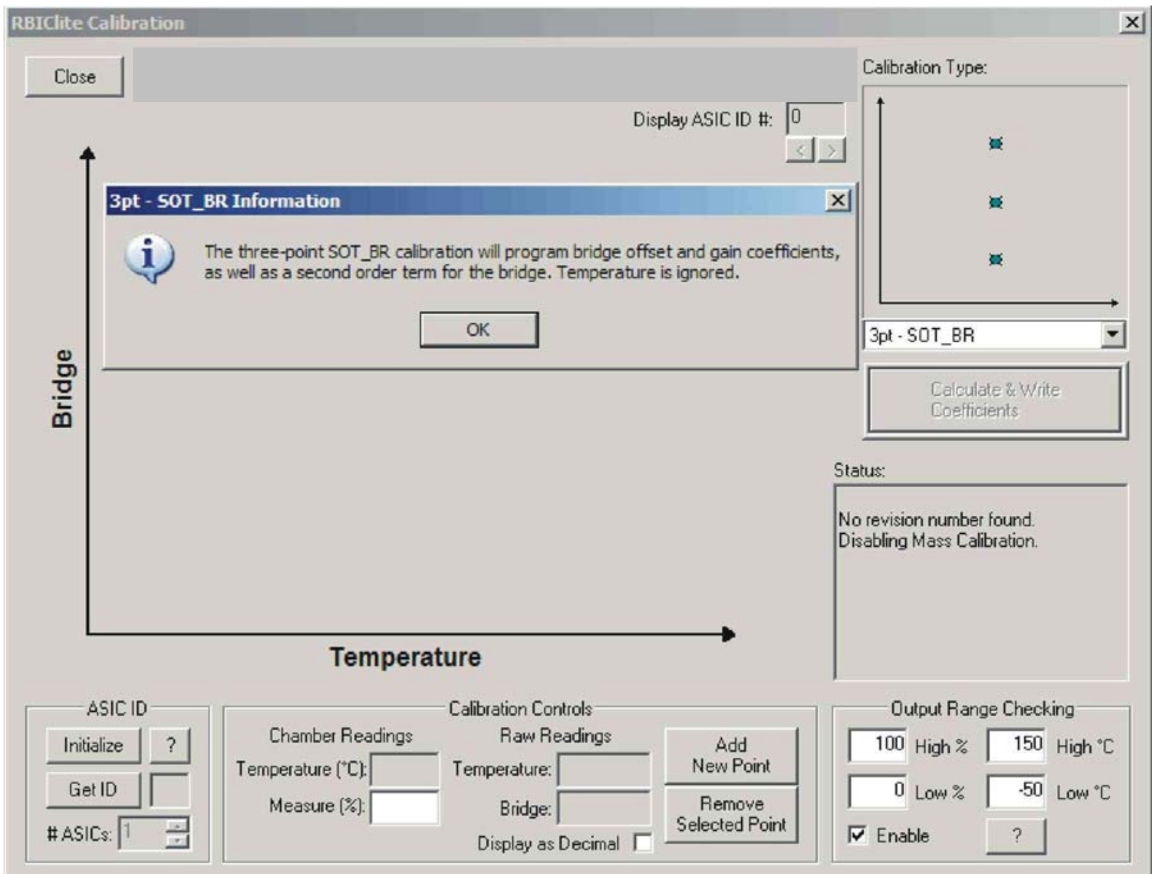


Figure 4.2 – Calibration Window

Calibration Sequence

Although the RBic$_{dLite}$™ 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$_{dLite}$™ 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$_{dLite}$™.

The software ZMDI provides with this SSC Evaluation Kit is intended for demonstration purposes and calibration of single units. ZMDI can provide customers with algorithms and assistance in developing their full production calibration software.

There are three main steps to calibration:

1. Assigning a unique identification to the RBic$_{dLite}$™. This identification is programmed in EEPROM and can be used as an index into 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$_{dLite}$™ 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$_{dLite}$™.

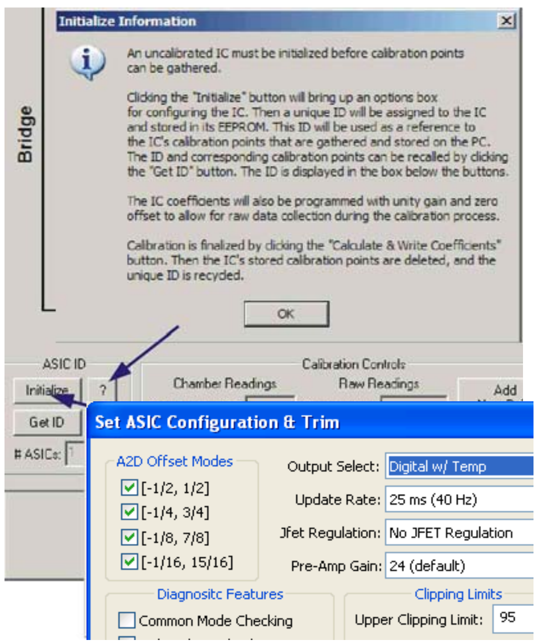


Figure 4.3 – ASIC ID Section for Initialization, Identification and Adjustment

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

In the “ASIC ID” section in the bottom left corner of the calibration screen, click on “Initialize.” A dialog box (see Figure 4.4) results for selecting the part configuration.

- Complete the fields for Output Select, Update Rate, JFET Regulation, Pre-Amp Gain, Gain Polarity and Flip Bridge Input.
- Select the diagnostic features to be enabled.
- Select External Temp if using the external temperature measurement.
- Enter the Upper and Lower Clipping Limits in hex code or % (in this case, also click “As %.”).
- Click OK.

The part is assigned a unique ID, which is used as an index in the database. This unique ID is also programmed into registers in the EEPROM.

Do not disable an ADC offset mode unless you are certain the mode will not be needed for the bridge being calibrated. If uncertain, leave all four modes checked. Disabling offset modes only saves time during calibration. For initial evaluations of the RBic$_{dLite}$, it is best to leave all four modes checked and let the calibration software decide which modes to use (see “Adjustment of the Analog Pre-Amp Gain and the Analog ADC Offset Modes” on page 13).

A Pre-Amp gain of 24 is the default and sufficient for most bridges. Bridges that produce a large signal (>40mV/V differential (max-min)) must use the lower gain setting of 6. For bridges that have a small output signal (<2mV/V), using a higher gain setting of 48 or 96 will increase output resolution (see “Adjustment of the Analog Pre-Amp Gain and the Analog ADC Offset Modes” on page 13).

The “?” next to “Initialize” is a help button that explains ASIC identification.

Initialize” is a help button that explains ASIC identification.

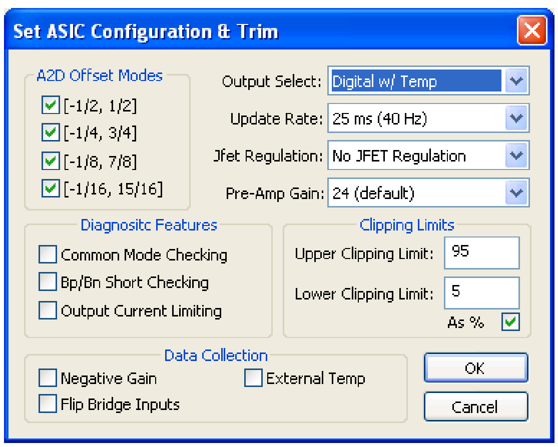


Figure 4.4 – ASIC ID Section for Initialization, Identification and Adjustment

Step 2 – Data Collection

Calibration Type Section with the Small Bridge-Temperature-Graph

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 5-point calibration. The next step is selecting the type of calibration.

Under “Calibration Type” in the upper right section of the calibration screen (Figure 4.2), there is a smaller graph (X-axis = Temperature, Y-axis = Bridge (pressure for this example)). This graph outlines the recommended spread of points (pressure for this example and temperature) to be used for calibration.

→ **Choose the desired calibration type from the drop-down menu below the smaller graph.**

The “?” next to the drop-down menu is a help button which explains the selected calibration type.

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

Calibration Controls Section

→ **Enter the temperature of the chamber, as well as the desired read out (in %) of the RBic$_{dLite}$™ at this pressure**.

→ **Click on "Add New Point."** The raw data (pressure and temperature) is obtained from the part, and the point is displayed on the large graph. It is graphed on the X-axis according to the raw temperature reading from the part, and on the Y-axis according to the % value entered in the previous step.

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

Hints:

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

Step 3 Calculate & Write Coefficients

After enough data points have been collected to calculate the calibration coefficients, the **"Calculate and Write Coefficients"** button becomes active. Click this 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\dLite Tester\caldata.txt).

Save/Restore Button

To save or restore EEPROM settings to and from a file, click the "Save/Restore" button. All settings are saved in a tab-separated file *SavedSettings.txt* located in *C:\program files\ZMD America\RBICdlite Tester*.

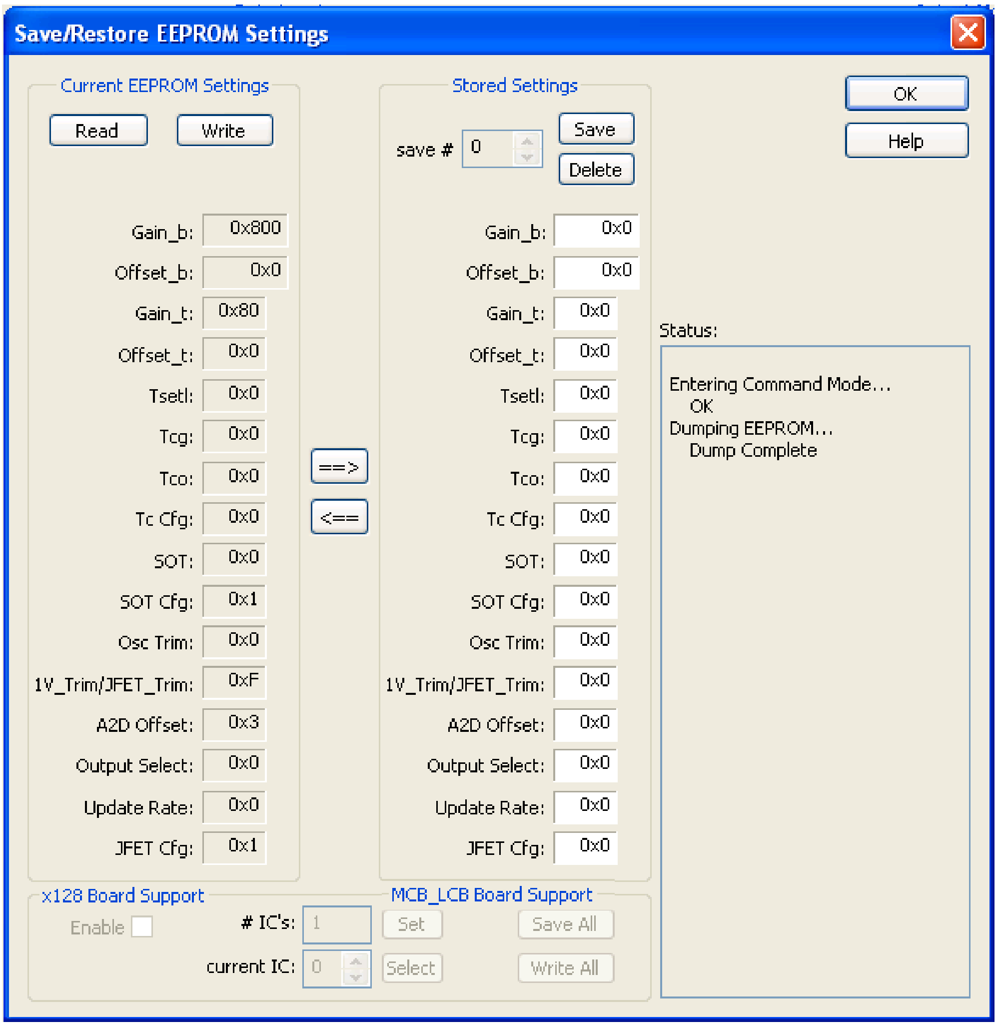


Figure 4.4 – Dialog Window Save/Restore EEPROM Settings

When the Save/Restore dialog window opens, the EEPROM contents of the currently selected IC are read and displayed in the text boxes under "Current EEPROM Settings."

==> Button

Clicking the "==>" button transfers the values under "Current EEPROM Settings" to the dialog boxes under "Stored Settings" and writes these values to the *SavedSettings.txt* file under the index selected in the "save #" dialog box.

<== Button

Clicking the "<==" button transfers the values currently displayed under "Stored Settings" to "Current EEPROM Settings" and writes these values to the EEPROM of the currently selected IC. To manually change the EEPROM settings in the currently selected IC, change the values under "Stored Settings" and click the "<==" button. Note: These changes are not stored to the *SavedSettings.txt* file until the Save button is clicked.

Current EEPROM Settings Section

Read Button

To read and display the EEPROM settings stored in the currently selected IC, click the Read button. This is done automatically upon opening the Save/Restore dialog window; however the Read button can be used to verify a valid write operation. In addition, this button must be used to perform a single chip read in x64 Mode.

Write Button

This button writes all the values under "Current EEPROM Settings" to the EEPROM of the currently selected IC. This is done automatically when the restore (<==) button is clicked; however the "Write" button is available in case of a write failure.

Stored Settings Section

EEPROM Fields

The values in the EEPROM dialog boxes under "Stored Settings" can be changed by saving from EEPROM (==> button), restoring from the *SavedSettings.txt* file (automatically retrieved when the Save # index is changed), or by changing values manually. If values are changed manually, the changes are not saved in the *SavedSettings.txt* file until the Save button is pressed.

Save # Field

The "Save #" value represents the index in the *SavedSettings.txt* file on disk which is referenced when saving or retrieving EEPROM values. The first column of data in *SavedSettings.txt* lists the indices. The last available index will always contain all zeros in the EEPROM fields.

Save Button

The "Save" button writes the values in the dialog boxes under "Stored Settings" to the *SavedSettings.txt* file on disk. This is done automatically on a transfer (==> button); however the Save button must be used to save any manual changes in the dialog box values to the *SavedSettings.txt* file.

Delete Button

The "Delete" button deletes the current index and shifts all indices after the deleted index down by one position.

MCB_LCB Board Support Section

This section is not available when using the single IC SSC Evaluation Board; it only activates if the RBic$_{Lite}^{TM}$ Mass Calibration Board (LCB) or the SSC Mass Calibration Board (MCB) have been detected. For the LCB, this section allows interfacing with up to 128 ICs at a time; for the MCB, the maximum is 192 ICs.

ICs Field and Set Button

This section is not applicable when using the single IC SSC Evaluation Board; it only activates if the RBic$_{Lite}^{TM}$ Mass Calibration Board LCB or the SSC Mass Calibration Board MCB have been detected. In this case, type the number of ICs to be enabled in the # ICs dialog box and press the Set button. The software then validates that it can communicate with all the ICs.

Current IC Field and Select Button

This section is not applicable when using the single IC SSC Evaluation Board; it only activates if the RBic$_{Lite}$™ Mass Calibration Board (LCB) or the SSC Mass Calibration Board (MCB) have been detected. In this case, the enabled ICs can be scrolled through using the "Current IC" dialog box after the IC number has been set. After entering an IC number, press the "Select" button. All single chip operations can now be performed as described above (READ, WRITE, ==>, <==). Writing different values to each of the enabled ICs must be performed one chip at a time; there is no automated mass restore feature.

Save All Button

This section is not applicable when using the single IC SSC Evaluation Board; it only activates if the RBic$_{Lite}$™ Mass Calibration Board (LCB) or the SSC Mass Calibration Board (MCB) have been detected. In this case, the Save All button cycles through all of the enabled ICs (0 → (# ICs-1)), reads each IC's EEPROM, and writes its settings to the end of the *SavedSettings.txt* file. Note: It is not possible to automatically restore these values to multiple ICs.

Write All Button

This section is not applicable when using the single IC SSC Evaluation Board; it only activates if the RBic$_{Lite}$™ Mass Calibration Board (LCB) or the SSC Mass Calibration Board (MCB) have been detected. In this case, the Write All button writes the values currently displayed under "Current EEPROM Settings" to all enabled ICs. Upon completion, all enabled ICs will have identical EEPROM settings.

5 Dry Run Calibration

The following directions perform an example of a simple 2-point linear calibration using the Sensor Replacement Board (SRB)[1] and a DMM for measuring the sensor input values between pin 2 (VBP) and pin 4(VPN) of the ZMD31015.

Steps to the Dry Run Calibration

1.) Connect the three boards: the SSC Communication (SSC CB), SSC ZMD31010 Evaluation Board and the Sensor Replacement Board (SRB). Insert the RBic$_{dLite}$™ 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. Verify that the green PWR LED is lit on the SSC CB.
3.) Start the "RBICdLite Tester" software.
4.) Select "SSC_Eval'" under "Board Type." Select the proper COM port. Click on "Initialize."
5.) Click on "START CM." If the setup is correct, A5 is displayed in the "Response" field at the bottom right.
6.) Click on "Calibration." The calibration window appears (Figure 4.2).
7.) In the upper right section of the calibration window, under "Calibration Type," choose "2-Pt Gain_B & Offset_B" calibration from the drop-down menu. The smaller graph above the drop-down menu indicates the recommended pattern of two bridge readings at the same temperature.

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[1] For more information see *ZMD31xxxKit_SensorReplacementBoard_DS.pdf*

8.) Click on "Initialize" in the ASIC ID section (lower left corner). A dialog box results. Choose "Ratiometric Analog" as the output selection; "25ms" as the update rate; "No JFET Regulation"; and "normal bridge inputs" (not flipped) and pre-amp gain =24. A unique identifier is assigned to this RBic$_{dLite}$™ and is written to its EEPROM.

9.) The next step is to start data collection. Normally this would be done with a real bridge attached to the RBic$_{dLite}$™ 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 (about 0 mV).
   b. Enter 10% in the "Measure %" box in the "Calibration Controls" section.
   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 (about 110mV).
   e. Enter 90% in the "Measure %" box.
   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 and Write Coefficients," which should now be active.

11.) Connect the voltmeter to the analog output. The output voltage will change now from 0.5V to 4.5V with a clockwise turn of the potentiometer.

6 ZMD31015 Software with the ZMD SSC Terminal

Protocol

The microcontroller (type ATmega32) on the SSC Communication Board (SSC CB) enables communication with the SSC Evaluation Board/ RBic$_{dLite}$™ using the evaluation software running on the PC. The serial ZACwire™ 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.*

ZMD SSC Terminal

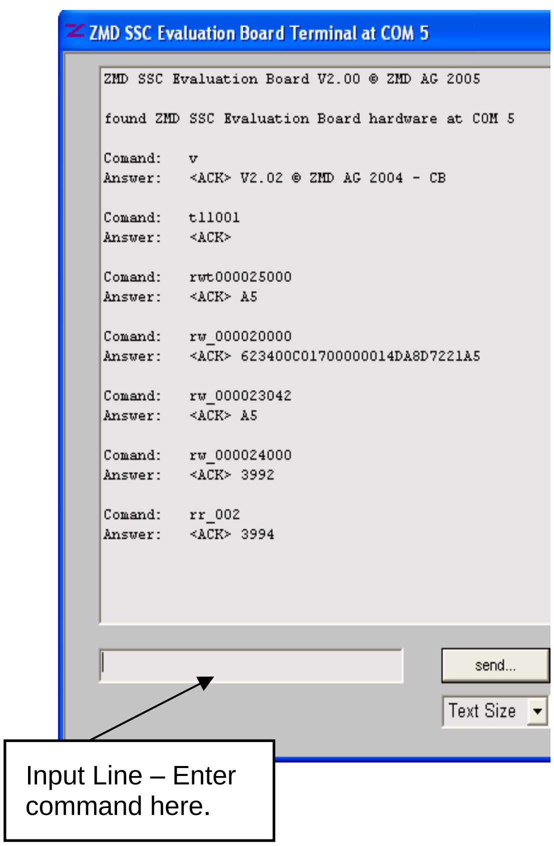
The ZMD SSC Terminal is the lowest level of communication for transferring commands from the PC to the microcontroller on the SSC CB. A fully summary and detailed command description of the applicable controller commands are given in "ZMD31xxxKIT_CommandSyntax_Rev_*.xls". For ZMD31015 communication mode, the "RBICLite" worksheet must be used for the dLite. All communication packets between the PC and the ZMD31015 begin with a leading "R."

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.

	Character Order					
	1	2	3	4,5	6,7,8	<d…d>
RBic$_{Lite}$	***R***	***R*** or ***W***	***T*** or _	***00***		
Comments		Read or Write	Trigger Power Cycle or Not	Always 00	Number of Bytes to Read and Write	Blank for Read; Data Bytes to Write
Example	***R***	***W***	***T***	***00***	***002***	***5000***

Hint: If "T" is sent for the 3rd position (instead of "_"), the ZMD31010 is powered off and then on. "T" should be used only if power cycling is necessary for operation. For the RBic$_{dLite}$ use always the minimum pulse 000.

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

T11000 Set trigger timing for 5V, 12V to minimum pulse.

Note: The trigger delay must be set and is faster than for the RBic$_{dLite}$!

rwt000025090 Start Command Mode with power on using defined delay between power-on and starting communication

rw_000020000 Read EEPROM (For the order of the 20 bytes, see section 3.5 in the ZMD31015 Datasheet.)

rw_000023042 Set update rate to 25ms (40Hz)

(See section 7 for command details.)

rw_000024000 Start Normal Operation Mode

rr_002 Read 2 bytes output (bridge high, bridge low)

Figure 6.1 – SSC Terminal

7 Command/Data Pair Encoding

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

The 2-byte command sent to the RBic$_{dLite}$™ consists of 1 byte of command information and 1 byte of data information. Regardless of whether the command requires data or not, 2 bytes MUST be sent. The following table lists all the command/data pairings. (X=don't care.)

Example: To set the update rate to 00 (1ms (1kHz); see Update_Rate in section 8), send 3040H.

Command	Data	Description
00H	XXH	Read EEPROM command via SIG™ pin.
20H	YXH	Enter Test Mode (subset of Command Mode for testing purposes only). The SIG™ pin will assume the value of different internal test points, depending on the most significant nibble of data sent. Y = 0H => Internal oscillator Y = 1H => 2.5V reference Y = 2H => PTAT Y = 3H => Pre-Amp Output+ Y = 4H => Scan Mode (SDO* routed to SIG ™ pin; part goes into Clock Override Mode and Scan Mode) Y = 5H => DAC Ramp Test Mode. Gain_B[13:3] contains the starting point, and the increment is (Offset_B/8). The increment will be added every 125µsec. Y = 6H => Negative charge pump oscillator out. Y = 7H => Part goes into Clock Override Mode. Y = 8-FH => Undefined.

Command	Data	Description		
30H	WDH	Trim/Configure: 3^{rd} nibble determines what is trimmed/configured. The 4^{th} nibble is data to be programmed.		
		3^{rd} Nibble	4^{th} Nibble Data	Description
	W =>	0H	XH	Trim oscillator. Least significant 3 bits of data used.
	What	1H	XH	Trim 1V reference. Least significant 4 bits of data used.
		2H	XH	Offset Mode. Least significant 2 bits of data used.
	D =>	3H	XH	Set output mode. Least significant 2 bits used.
	Data	4H	XH	Set update rate. Least significant 2 bits used.
		5H	XH	Configure JFET regulation
	H => Hex	6H	XH	Program the Tc_cfg register. Least significant 3 bits used. Most significant bit of data nibble should be 0.
		7H	XH	Program EEPROM bits [99:96] {SOT_cfg,Pamp_Gain}
		8H	XH	Clear all case: Used to clear all bits in EEPROM to 0.
		9H	XH	0101… case: Sets whole EEPROM to alternating pattern.
		AH	XH	1010…case: Sets opposite alternating pattern.
		BH	XH	Set all case: Sets all EEPROM bits to 1.
		CH	XH	EEPROM Endurance Mode. Initial setting of Offset_B[13:3] determines the # of cycles. Offset_T must be programmed to zero initially.
		DH	XH	Program EEPROM lock field. Least significant 3 bits used. 011 => locked
		EH	XH	Program diagnostic config field. 3 bits of data used.
		FH	XH	Reserved.
40H	00H	Start NOM => Ends Command Mode; transition to Normal Operation Mode.		
40H	10H	Start_RM = Start the Raw Mode (RM) In this mode, if Gain_B = 800H and Gain_T = 80H, then the digital output will simply be the raw values of the ADC for the Bridge reading, and the PTAT conversion.		
50H	90H	Start_CM => Start the Command Mode; used to enter Command Interpret Mode.		
60H	YYH	Program SOT (2^{nd} Order Term)		
70H	YYH	Program T_{SETL} (Set the MSB to 0.)		

Command	Data	Description
80H	YYH	Program Gain_B upper 7-bits (Set the MSB to 0.)
90H	YYH	Program Gain_B lower 8-bits
A0H	YYH	Program Offset_B upper 6-bits (Set the two MSBs to 0.)
B0H	YYH	Program Offset_B lower 8-bits
C0H	YYH	Program Gain_T
D0H	YYH	Program Offset_T
E0H	YYH	Program Tco
F0H	YYH	Program Tcg
08H	YYH	Program Upper Clipping Limit (Set the MSB to 0.)
18H	YYH	Program Lower Clipping Limit (Set the MSB to 0.)
28H	YYH	Program Cust_ID0
38H	YYH	Program Cust_ID1
48H	YYH	Program Cust_ID2

*SDO: Scan Data Out

8 EEPROM Bits

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

EEPROM Range	Description	Note
2:0	Osc_Trim	See the table in the "Trimming the Oscillator" section for complete data. 100 => Fastest 101 => 3 clicks faster than nominal 110 => 2 clicks faster than nominal 111 => 1 click faster than nominal 000 => Nominal 001 => 1 click slower than nominal 010 => 2 clicks slower than nominal 011 => Slowest
6:3	1V_Trim/JFET_Trim	See the table under "Voltage Reference Block," section **Fehler! Verweisquelle konnte nicht gefunden werden.**.
10:7	A2D_Offset	The upper two bits are flip polarity and invert bridge input (negative gain) respectively. If both are used in conjunction, negative offset modes can be achieved. 00 => normal polarity, positive gain 01 => normal polarity, negative gain 10 => flip polarity, positive gain 11 => flip polarity, negative gain The lower two bits form the ADC offset selection. Offset selection: 11 => [-1/2,1/2] mode bridge inputs 10 => [-1/4,3/4] mode bridge inputs 01 => [-1/8,7/8] mode bridge inputs 00 => [-1/16,15/16] mode bridge inputs

EEPROM Range	Description	Note
12:11	Output_Select	00 => Digital (3 bytes with parity) Bridge High {00,[5:0]} Bridge Low [7:0] Temp [7:0] 01 => 0-1V Analog 10 => Rail-to-Rail Ratiometric 11 => Digital (2 bytes with parity) (No Temp) Bridge High {00,[5:0]} Bridge Low [7:0]
14:13	Update_Rate	00 => 1 msec (1kHz) 01 => 5 msec (200Hz) 10 => 25 msec (40Hz) 11 => 125 msec (8 Hz)
16:15	JFET_cfg	00 => No JFET regulation (lower power) 01 => No JFET regulation (lower power) 10 => JFET regulation centered around 5.0V 11 => JFET regulation centered around 5.5V (i.e. over-voltage protection).
31:17	Gain_B	Bridge Gain (also see bits 10:7): Gain_B[14] => multiply x 8 Gain_B[13:0] => 14-bit unsigned number representing a number in the range [0,8)
45:32	Offset_B	Unsigned 14-bit offset for bridge correction
53:46	Gain_T	Temperature gain coefficient used to correct PTAT or ExtTemp reading
61:54	Offset_T	Temperature offset coefficient used to correct PTAT or ExtTemp reading
68:62	T_{SETL}	Stores Raw PTAT or ExtTemp reading at temperature in which low calibration points were taken

EEPROM Range	Description	Note
76:69	Tcg	Coefficient for temperature correction of bridge gain term: Tcg = 8-bit magnitude of Tcg term. Sign is determined by Tc_cfg (bits 87:85).
84:77	Tco	Coefficient for temperature correction of bridge offset term. Tco = 8-bit magnitude of Tco term. Sign and scaling are determined by Tc_cfg (bits 87:85)
87:85	Tc_cfg	This 3-bit term determines options for temperature compensation of the bridge. Tc_cfg[2] => If set, Tcg is negative Tc_cfg[1] => Scale magnitude of Tco term by 8, and if SOT applies to Tco, scale SOT by 8 Tc_cfg[0] => If set, Tco is negative
95:88	SOT	2nd Order Term. This term is a 7-bit magnitude with sign. SOT[7] = 1 ➔ negative SOT[7] = 0 ➔ positive SOT[6:0] = magnitude [0-127] This term can apply to a 2nd order Tcg, Tco or bridge correction. (See Tc_cfg above.)
99:96	{SOT_cfg, Pamp_Gain}	Bits [99:98] = SOT_cfg 00 = SOT applies to Bridge 01 = SOT applies to Tcg 10 = SOT applies to Tco 11 = Prohibited Bits [97:96] = Pre-Amp Gain 00 => 6 01 => 24 (default setting) 10 => 48 11 => 96

EEPROM Range	Description	Note
102:100	Diag_cfg	This 3-bit term applies to diagnostic features Diag_cfg[2] → enable output short circuit protection. Diag _cfg[1] → enable sensor short checking. Diag_cfg[0] → enables sensor connection checking.
105:103	Lock_ExtTemp	EEPROM lock 011 or 110 => locked All other => unlocked When EEPROM is locked, the internal charge pump is disabled and the EEPROM can never be programmed again. Bit 105 (the MSB of this field) is also used for selecting external temperature measurement. 0XX => Internal PTAT used for temp 1XX => External diode used for temp
112:106	Up_Clip_Lim	7-bit value used to select an upper clipping limit for the output. It affects both analog and digital output. The 14-bit upper clipping limit value is comprised of {11,Up_Clip_Lim[6:0],11111}. 127 different clipping levels are selectable between 75.19% and 100% of VDD.
119:113	Low_Clip_Lim	7-bit value used to select a lower clipping limit for the output. It affects both analog and digital output. The 14-bit lower clipping limit value is comprised of {00,Low_Clip_Lim[6:0],00000}. 127 different clipping levels are selectable between 0% and 24.8% of VDD.
127:120	Cust_ID0	Customer ID byte 0
135:128	Cust_ID1	Customer ID byte 1
143:136	Cust_ID2	Customer ID byte 2
151:144	Signature	8-bit EEPROM signature. Generated through a LFSR[2]. This signature is checked on power-on to ensure integrity of EEPROM contents.

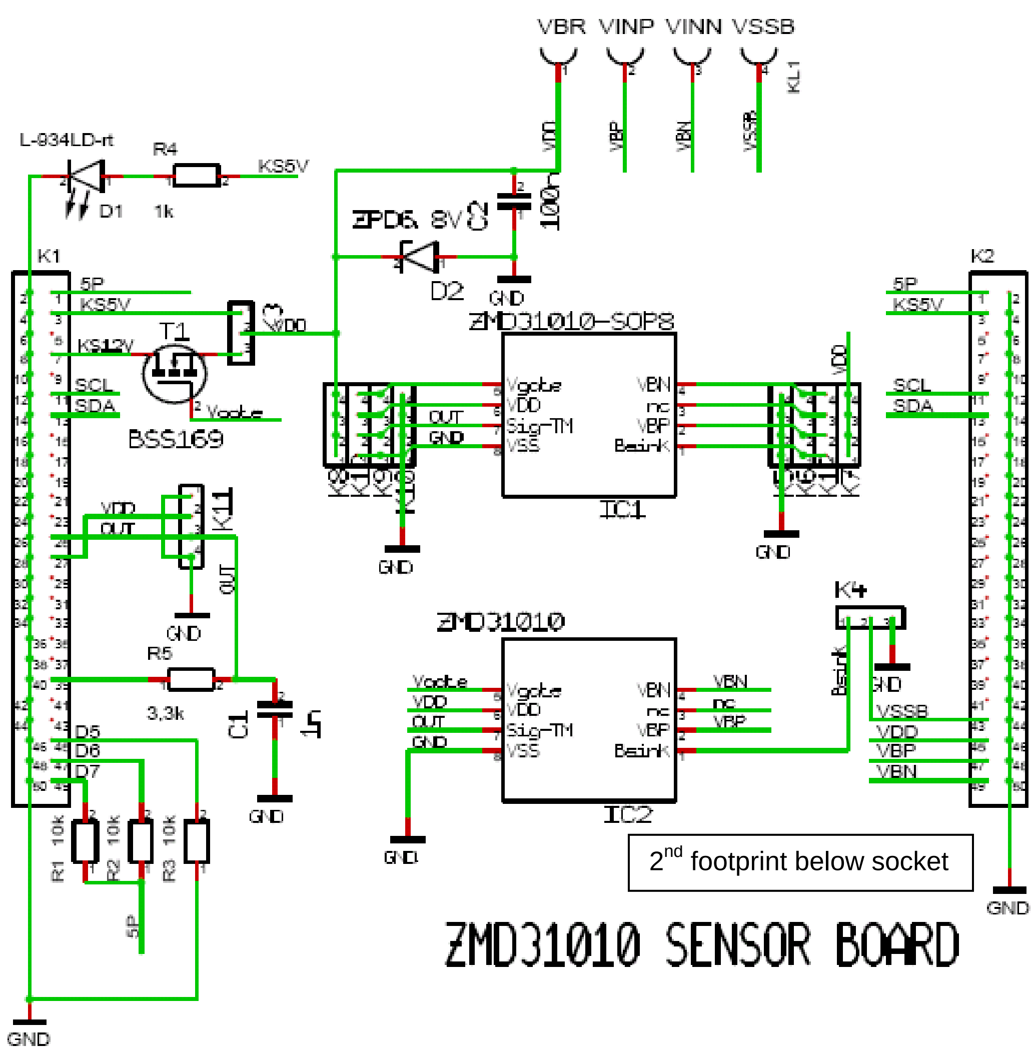
[2] Linear feedback shift register

9 Related Documents

- ZMD31xxxKIT_CommBoard_DS.pdf
- ZMD31xxxKIT_SensorReplacementBoard_DS.pdf
- ZMD31xxxCommandSyntax.xls
- ZMD31015 RBic$_{dLite}$™ *Datasheet*
- ZMD31015 RBic$_{dLite}$™ *SSC Kits Feature Sheet* (includes ordering codes and price information)
- ZMD31015 RBic$_{dLite}$™ *Die Dimensions and Pad Coordinates*
- ZMD31015 RBic$_{dLite}$™ *Technical Notes – Revision C1 Engineering Samples*
- ZMD31015 RBic$_{dLite}$™ *Errata – Rev C Engineering Samples*

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

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



Appendix B: List of Error Messages in the ZMD31015 Software

Error Message	***Possible Reason***
Main Window	
ERROR! No communication (NC1).	Lost communication. Could not enter Command Mode.
ERROR opening COM#{}! COM#{} might be busy.	Wrong COM port or COM port busy.
ERROR! Not enough PC memory (#M1).	Insufficient system memory.
WARNING! Selecting IC #{} failed (#S1).	IC #{} does not exist or lost communication.
ERROR! No communication (#NC2).	Lost communication.
ERROR! No communication (#NC3).	Lost communication.
WARNING: ADC adjusted. **<Alt>, <Shift>**and **>** to undo	**<Alt>, <Shift>**and **<** was pressed.
WARNING: ADC adjusted. **<Alt>, <Shift>**and **<** to undo	**<Alt>, <Shift>**and **>** was pressed.
ERROR! Not enough PC memory (#M2).	Insufficient system memory.
ERROR! Wrong COM port or wrong HW type or lost communication.	Wrong COM port or wrong HW type or lost communication.
Calibration Window	
WARNING: Calibration method does not support sensor input greater than 200% of full scale. (See details in “SOT Interpretation” section of datasheet.)	
WARNING! Digital gain too large. Clipping will occur.	Pre-amp gain too low.
WARNING! Second order correction out of range. Clipping will occur.	Sensor has larger non-linearity than can be corrected.
WARNING! TCO out of range. Clipping will occur.	Sensor has larger TCO than can be corrected.
WARNING! TCG out of range. Clipping will occur.	Sensor has larger TCG than can be corrected.
WARNING! Bridge Offset out of range. Clipping will occur. Enable a larger A2D offset and re-calibrate.	Sensor has larger offset than is supported. Try a different offset mode.
ERROR! RBic Lite does not support negative gain. Invert bridge-polarity and re-calibrate.	Bridge polarity is flipped.
WARNING! Raw values out of range! Check adjustment (Pre-Amp and A2D Offset)!	Pre-amp gain is too high.
ERROR! No communication – Write EEPROM.	Lost communication.
ERROR! No communication – Start CM.	Lost communication.
Selected IC #{} failed (#S2).	IC #{} does not exist or lost communication.
ERROR! Not enough PC memory (#M3).	Insufficient system memory.
ERROR! Initialize before calibrating.	Calibration must be initialized prior to adding any points.
ERROR: Enough calibration points have already been taken. To add another point, first remove a point.	Too many points have been entered for selected calibration type.

Error Message	*Possible Reason*
ERROR! Enter the bridge target value (%) before adding a new point!	A desired bridge value is required before adding a new point.
ERROR! Enter the chamber value (%) before adding a new point!	Calibration type requires a desired temperature to be entered before adding a new point.
Error calculating coefficients! (See CalibrationLog.txt for details.)	Invalid calibration points or insufficient system memory.
ERROR! Could not open "CalibrationLog.txt" file. Use Windows Explorer to open.	User's PC operating system does not allow opening existing CalibrationLog.txt file via the RBic software. Use Windows Explorer™ to manually open the file.
Selecting IC #{} failed (#S3).	IC #{} does not exist or lost communication.
ERROR! No communication (#NC4).	Lost communication.
ERROR! No communication (#NC5).	Lost communication.
ERROR! No communication (#NC6).	Lost communication.
ERROR! No data entry for this ID!	Temporary ID stored on chip does not match any values in database. Re-calibrate.
ERROR! No communication (#NC7).	Lost communication.
ERROR! No communication (#NC8).	Lost communication.
ERROR! No communication (#NC9).	Lost communication.
Save/Restore Window	
ERROR! No communication (#NC10).	Lost communication.
ERROR! No communication (#NC11).	Lost communication.
Selected IC #{} failed! (#S4)	IC #{} does not exist or lost communication.
ERROR! No communication (#NC12).	Lost communication.

Appendix C: Format of the caldata.txt file for ZMD31015

```
|------------A-------------|-B-C-D-E-F-G-H-I-J|
09/04/07 16:54:02 1188942842 9 2 0 1 1 0 0 2 8
 |K--L|---M---|-------N--------|
 25 25 24.9389 52.2651 -1 -1 -1
 75 25 24.9389 76.8429 -1 -1 -1
```

A	B	C	D	E	F	G	H	I	J
03/30/07 17:10:46 1175289046	9	2	0	1	1	0	0	2	8

K	L	M	N	N	N	N
20	25	24.9389	32.84291	-1	-1	-1
70	25	24.9389	56.84291	-1	-1	-1

The top line contains calibration specific information (1 part)

A: Time and date information for the calibration

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

C: Number of points currently in the calibration

D: Output_Select

E: Update_Rate

F: JFET_cfg (configuration)

G: Flip polarity (A2D_Offset upper two bits)

H: Invert bridge input (negative gain - A2D_Offset upper two bits

I : Pre-Amp Gain

J: A2D_Offset modes used (flags --bit3 is [-1/2,1/2], bit2 is [-1/4,3/4], etc)

The next lines contain calibration point specific data

K: Desired Bridge ('Actual')

L: Desired Temperature ('Actual')

M: Raw temperature reading

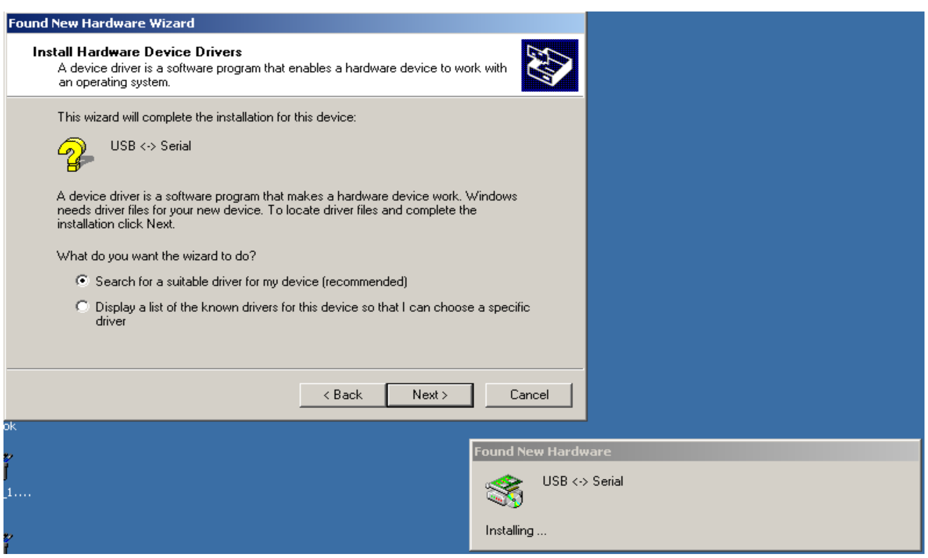
N: Raw Bridge Readings, 1 per A2D_Offset mode selected. (-1 means not in use)

Appendix D: Driver Installation on Windows 2000 Operating Systems

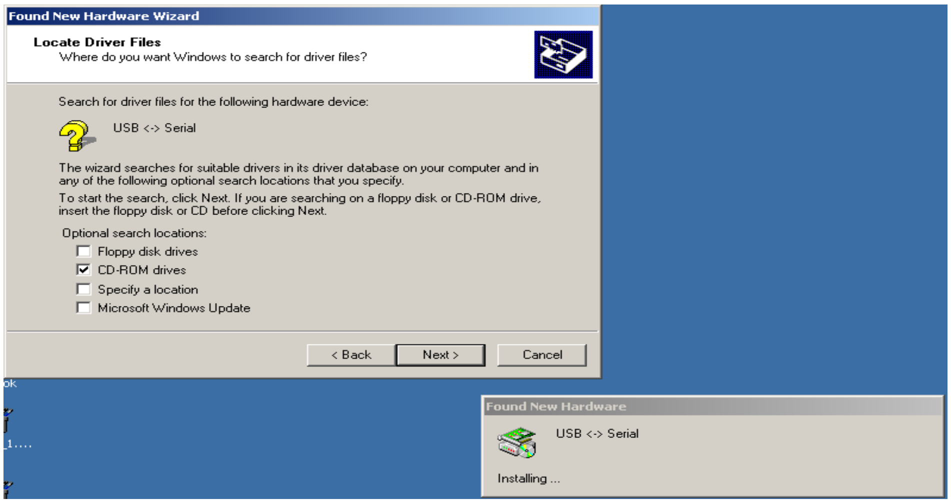
Follow these steps to install the basic USB driver on Windows 2000 operating systems:

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:

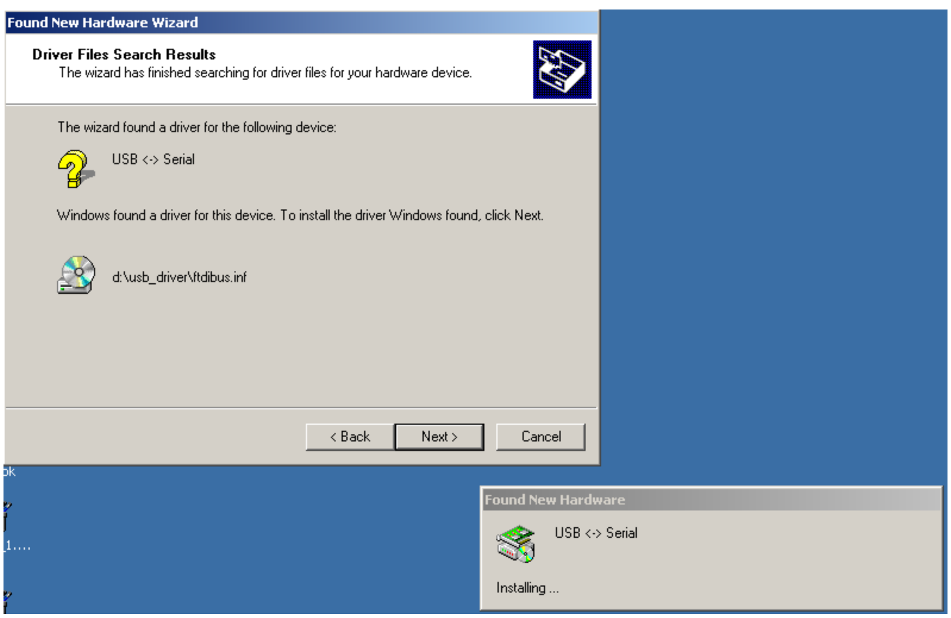
2. Click Next. The following dialog box appears. Select "Search for a suitable driver for my device (recommended)".



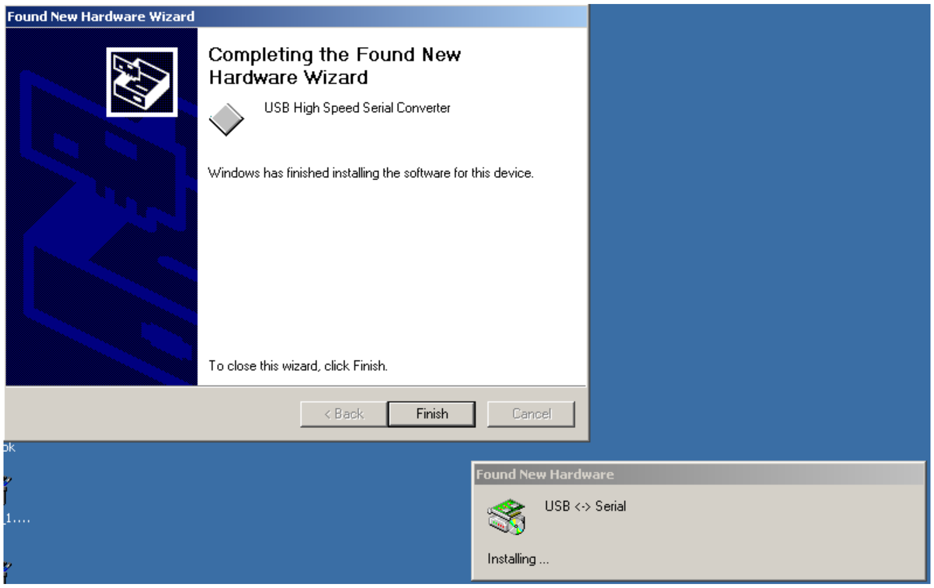
3. Click on Next. The following dialog appears. Select “CD-ROM drives.”



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



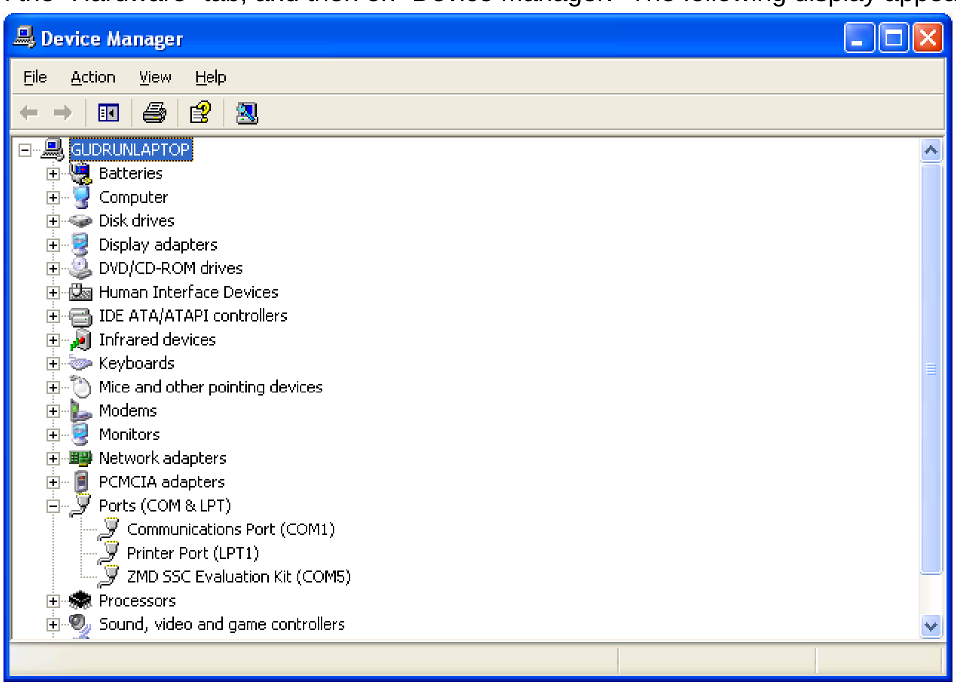
5. Click on Next. The following display confirms the installation of the basic USB driver.



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.

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.

ZMD31015

RBic$_{dLite}$™ Low-Cost Sensor Signal Conditioner with Diagnostics

SSC Evaluation Kit Documentation

Restrictions:

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

The ZMD AG RBic$_{dLite}$ ™ SSC Evaluation Kit hardware and software must not be used for module production and production test setups. ZMD AG shall not be liable for any damages arising out of defects resulting from (i) delivered hard and software (ii) non-observance of instructions contained in this manual, or (iii) misuse, abuse, use under abnormal conditions or alteration by anyone other than ZMD AG. To the extent permitted by law, ZMD AG hereby expressly disclaims and User expressly waives any and all warranties, whether express, implied or statutory, including, without limitation, implied warranties of merchantability and of fitness for a particular purpose, statutory warranty of non-infringement and any other warranty that may arise by reason of usage of trade, custom or course of dealing.

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