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1. Introduction

To guarantee the performance specified in the *ZSSC4175D-01 Datasheet*, every ZSSC4175D-01 needs calibration. In the IDT production line, reference data is acquired for each chip and written into the User0 and User1 pages in the nonvolatile memory (NVM) of the ZSSC4175D-01. To apply the calibration, this reference data must be read in the sensor module production line, a calibration calculation must be executed (provided as a precompiled software library, DLL), and the calculated coefficients must be written into the chip NVM (together with the configuration).

This Application Note describes how to use the IDT SSC4160D Application Graphical User Interface (GUI) to calibrate the ZSSC4175D-01. GUI revision \geq V3.3.0 including DLL revision \geq V3.4.0.0 must be used for this procedure.

Download the zip folder for the GUI and the DLL from the following www.IDT.com location and extract the contents:

<https://www.idt.com/document/swr/zssc41xx-evaluation-software-v3300>

Click on the extracted file *ZSSC41xx-{revision number}-install.exe* to install the GUI on the user's computer.

After installation, the DLL zip file appears in the installation folder. This zip provides all the files needed to use the DLL.

2. Connecting to the ZSSC4175D-01 Sensor Module

2.1 Configuration Loading

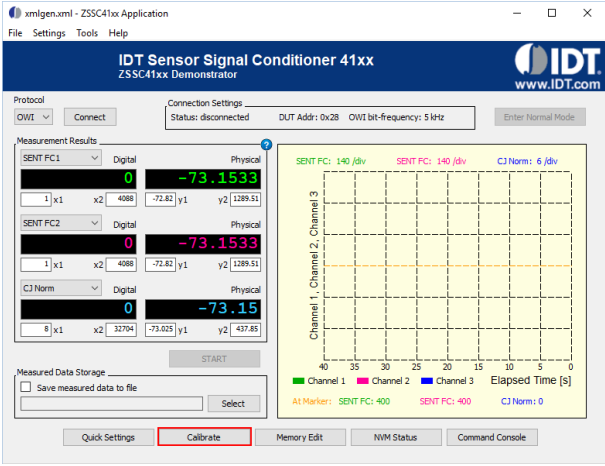
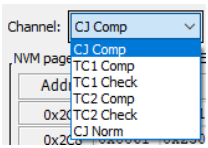
GUI Usage	Production Line Usage
<p>Open the GUI and load the GUI project file.</p> <p>Note: The file version must be \geq ZSSC4175_0500_01_v1.3_GUI.xml.</p>	<p>Load the default config section from the following file into the production line data buffer: ZSSC4175_0500_01_v1.3_CRS.xml file. The CRS-XML format is optimized for usage in the production line.</p> <p>Alternative: Use the memory dump export tool from the GUI (Menu \rightarrow Tools \rightarrow Cfg-Filedump).</p>

2.2 Connect to the DUT

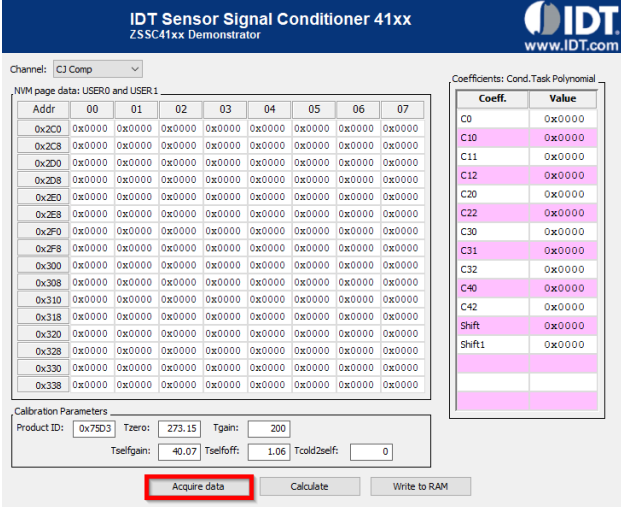
GUI Usage	Production Line Usage
<p>Click the “Connect” button.</p>	<p>The following description uses IDT’s SSC Communication Board (SSC CB) and its command syntax.</p> <p>Download the latest SSC CB Firmware zip file from www.idt.com/ssc-cb and extract the contents. The zip contains the SSC-CB firmware and the syntax documentation sheet. Install the firmware on the SSC CB.</p> <p>Note that the following versions are required for the SSC CB:</p> <ul style="list-style-type: none"> SSC CB board version 4.1 SSC CB firmware revision \geq 4.14 <p>Start Command Mode</p> <p>Write OWT28003727EA9 72HEX \rightarrow StrtCmdMd 7EA9HEX \rightarrow Command Mode Authorization Key</p> <p>Read OR_28002 receive 7272HEX \rightarrow Command Mode accepted</p>

3. Channel Calibration

3.1 Channel Selection

GUI Usage	Production Line Usage												
<p>Open the “Calibrate” dialog by clicking the “Calibrate” button.</p>  <p>Select “CJ Comp” from the drop-down menu adjacent to “Channel” on the resulting “Calibration” dialog page (see section 3.2 for an illustration). The calibration procedure must be executed for each channel individually.</p> 	<p>The channel defines which function call from the calibration DLL must be executed. Each channel requires a dedicated function call.</p> <table border="1" data-bbox="828 493 1193 787"> <thead> <tr> <th>Channel</th> <th>DLL Function</th> </tr> </thead> <tbody> <tr> <td>CJ Comp</td> <td>Cal7()</td> </tr> <tr> <td>TC1 Comp</td> <td>Cal6()</td> </tr> <tr> <td>TC2 Comp</td> <td>Cal6()</td> </tr> <tr> <td>TC1 Check</td> <td>ChkTc1()</td> </tr> <tr> <td>TC2 Check</td> <td>ChkTc1()</td> </tr> </tbody> </table>	Channel	DLL Function	CJ Comp	Cal7()	TC1 Comp	Cal6()	TC2 Comp	Cal6()	TC1 Check	ChkTc1()	TC2 Check	ChkTc1()
Channel	DLL Function												
CJ Comp	Cal7()												
TC1 Comp	Cal6()												
TC2 Comp	Cal6()												
TC1 Check	ChkTc1()												
TC2 Check	ChkTc1()												

3.2 Data Acquisition

GUI Usage	Production Line Usage
<p>Acquire data from the ZSSC4175D-01: The GUI reads the Product Version Code and NVM User0 and User1 pages.</p>  <p>The screenshot shows the 'IDT Sensor Signal Conditioner 41xx ZSSC41xx Demonstrator' GUI. It features a channel selector set to 'CJ Comp', a table for 'NVM page data: USER0 and USER1' with columns for address (00-07) and data values (all 0x0000), and a 'Coefficients: Cond.Task Polynomial' table with columns for coefficient (C0-C42, Shift) and value (all 0x0000). Below these are 'Calibration Parameters' including Product ID (0x75D3), Tzero (273.15), Tgain (200), Tseffgain (-40.07), Tseffoff (1.06), TcoldZseff (0), and buttons for 'Acquire data', 'Calculate', and 'Write to RAM'.</p>	<p>Read Product Version Code</p> <p>Write OW_280017C 7CH_{HEX} → RdProductVerCode</p> <p>Read OR_28003 receive 7CH_{HEX} → Command accepted receive 75D3H_{HEX} → Product Version Code</p> <p>Read NVM Page User0</p> <p>Write OW_280052602C0003F 26H_{HEX} → RdNvmPgBurst 02C0H_{HEX} → Start Address 003FH_{HEX} → Amount of data read (64 Words)</p> <p>Read OR_28129 receive 26H_{HEX} → Command accepted, receive 64 Words → User page content</p> <p>Read NVM Page User1</p> <p>Write OW_28005260300003F 26H_{HEX} → RdNvmPgBurst 0300H_{HEX} → Start Address 003FH_{HEX} → Amount of data read (64 Words)</p> <p>Read OR_28129 receive 26H_{HEX} → Command accepted receive 64 words → User page content</p>
<p>Important Note: “Acquire data” is required once during the calibration procedure. User0 and User1 page content is constant, but unique for each DUT.</p>	

3.3 Set Parameters

GUI Usage	Production Line Usage
<p>Set up calibration parameters for the following sections:</p> <p>CJ Comp</p> <div style="border: 1px solid gray; padding: 5px;"> <p>Calibration Parameters</p> <p>Product ID: <input type="text" value="0x75D3"/> Tzero: <input type="text" value="273.15"/> Tgain: <input type="text" value="200"/></p> <p>Tselfgain: <input type="text" value="40.07"/> Tselfoff: <input type="text" value="1.06"/> Tcold2self: <input type="text" value="0"/></p> </div> <p>TC1/2 Comp</p> <div style="border: 1px solid gray; padding: 5px;"> <p>Calibration Parameters</p> <p>Product ID: <input type="text" value="0x75D3"/> Vzzero: <input type="text" value="0.02"/> Vgain: <input type="text" value="500000"/></p> </div> <p>TC1/2 Check</p> <div style="border: 1px solid gray; padding: 5px;"> <p>Calibration Parameters</p> <p>Product ID: <input type="text" value="0x75D3"/> Input MUX: <input type="text" value="BR1"/></p> </div>	<p>The calibration parameters must be defined as arrays that are used as input for the calibration function calls.</p> <p>Refer to the application programming interface (API) header file found in the DLL zip file for functions and parameter declarations and the <i>ZSSC4175D-01 Functional Description</i> document (included with the product delivery) for pseudocode examples.</p>

Parameter	Default Value	Description
Product ID	–	Product version code, as acquired with steps in section 3.2
TselfGain	40.07	PCB-specific value (must be evaluated during PCB design; see the <i>ZSSC4175D-01 Functional Description</i> document for details)
TselfOff	1.06	PCB-specific value (must be evaluated during PCB design; see the <i>ZSSC4175D-01 Functional Description</i> document for details)
Tcold2Self	0	PCB-specific value (must be evaluated during PCB design; see description in the <i>ZSSC4175D-01 Functional Description</i> document for details)
Tzero	273.15	Constant value (see description in <i>ZSSC4175D-01 Functional Description</i>)
Tgain	200	Constant value (see description in <i>ZSSC4175D-01 Functional Description</i>)
Vzzero	0.02	Constant value (see description in <i>ZSSC4175D-01 Functional Description</i>)
Vgain	500000	Constant value (see description in <i>ZSSC4175D-01 Functional Description</i>)
Input MUX	–	Select the bridge input (BR1 or BR2) for each thermocouple (TC1 and TC2)

3.4 Calculate

GUI Usage	Production Line Usage
<p>Click on the "Calculate" button on the "Calibration" screen</p>	<p>Call the channel specific calibration function from the DLL. The following functions are to be used:</p> <p>PTAT Compensation (CJ Comp): Use DLL function call Cal7 (refer to the "PTAT Compensation" section of the ZSSC4175D-01 <i>Functional Description</i>)</p> <p>Cal7 (userPages, params, resCoeffs, logMsg, LOG_MESSAGE_MAX_LENGTH):</p> <ul style="list-style-type: none"> userPages 2 * 64 words (as acquired in procedures in section 3.2) params Product Version Code (as acquired in procedures in section 3.2), Tzero, Tgain, TselfGain, TselfOff, Tcold2Self resCoeffs Result array logMsg Char array for calibration solver log output LOG_MESSAGE_MAX_LENGTH Length of logMsg for example 32000 <p>Thermocouple Compensation use DLL function call Cal6 (refer to the "Thermocouple Compensation" section of the ZSSC4175D-01 <i>Functional Description</i>)</p> <p>Cal6 (userPages, params, resCoeffs, logMsg, LOG_MESSAGE_MAX_LENGTH):</p> <ul style="list-style-type: none"> userPages 2 * 64 words (as acquired in procedures in section 3.2) params Product Version Code (as acquired in procedures in section 3.2), Vzzero, Vgain resCoeffs Result array logMsg Char array for calibration solver log output LOG_MESSAGE_MAX_LENGTH Length of logMsg for example 32000 <p>Thermocouple Check use DLL function call ChkTc1 (refer to the "Thermocouple Compensation" section of the ZSSC4175D-01 <i>Functional Description</i>)</p> <p>ChkTc1 (userPages, params, resCoeffs, logMsg, LOG_MESSAGE_MAX_LENGTH):</p> <ul style="list-style-type: none"> userPages 2 * 64 words (as acquired in procedures in section 3.2) params Product Version Code (as acquired in procedures in section 3.2) resCoeffs Result array logMsg Char array for calibration solver log output LOG_MESSAGE_MAX_LENGTH Length of logMsg for example 32000

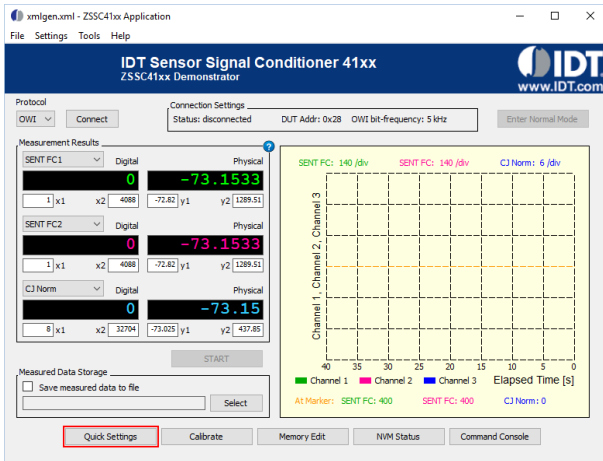
3.5 Write Data into Data Buffer

GUI Usage	Production Line Usage																																																																																																																																																									
<p>Write the new coefficients into the RAM by clicking on the “Write to RAM” button.”</p> <div style="border: 1px solid #ccc; padding: 5px; margin-bottom: 5px;"> <p style="text-align: center; font-weight: bold; color: white; background-color: #0056b3; margin: 0;">IDT Sensor Signal Conditioner 41xx ZSSC41xx Demonstrator</p> <p style="text-align: right; color: white; font-weight: bold; margin: 0;">IDT www.IDT.com</p> </div> <p>Channel: TC1 Check</p> <p>NIM page data: USER0 and USER1</p> <table border="1" style="width: 100%; border-collapse: collapse; font-size: 8px;"> <thead> <tr> <th>Addr</th> <th>00</th> <th>01</th> <th>02</th> <th>03</th> <th>04</th> <th>05</th> <th>06</th> <th>07</th> </tr> </thead> <tbody> <tr><td>0x2C0</td><td>0x0051</td><td>0x2C1C</td><td>0x22B2</td><td>0x2C26</td><td>0x2C1D</td><td>0x3141</td><td>0x039B</td><td>0xAC59</td></tr> <tr><td>0x2C8</td><td>0x0061</td><td>0x20B0</td><td>0x1B06</td><td>0x2B9E</td><td>0x67D6</td><td>0x03DD</td><td>0x1F48</td><td>0xB257</td></tr> <tr><td>0x2D0</td><td>0x0053</td><td>0x2C27</td><td>0x246B</td><td>0x2C34</td><td>0x2C23</td><td>0x3145</td><td>0x029D</td><td>0x9EB5</td></tr> <tr><td>0x2D8</td><td>0x0063</td><td>0x22AD</td><td>0x1CD7</td><td>0x3E12</td><td>0x6788</td><td>0x0367</td><td>0x1D7A</td><td>0xD1E4</td></tr> <tr><td>0x2E0</td><td>0x8057</td><td>0x2C1D</td><td>0x233F</td><td>0x2C31</td><td>0x2C0E</td><td>0x312C</td><td>0x017E</td><td>0x5C23</td></tr> <tr><td>0x2E8</td><td>0x8067</td><td>0x2236</td><td>0x1DD6</td><td>0x5E48</td><td>0x6738</td><td>0x0267</td><td>0x1BBE</td><td>0xC000</td></tr> <tr><td>0x2F0</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> <tr><td>0x2F8</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> <tr><td>0x300</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> <tr><td>0x308</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> <tr><td>0x310</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> <tr><td>0x318</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> <tr><td>0x320</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> <tr><td>0x328</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> <tr><td>0x330</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> <tr><td>0x338</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td><td>0x0000</td></tr> </tbody> </table> <div style="margin-top: 5px;"> <p>Calibration Parameters</p> <p>Product ID: 0x75D3 Input MUX: BR1</p> </div> <div style="margin-top: 10px; text-align: center;"> Acquire data Calculate Write to RAM </div>	Addr	00	01	02	03	04	05	06	07	0x2C0	0x0051	0x2C1C	0x22B2	0x2C26	0x2C1D	0x3141	0x039B	0xAC59	0x2C8	0x0061	0x20B0	0x1B06	0x2B9E	0x67D6	0x03DD	0x1F48	0xB257	0x2D0	0x0053	0x2C27	0x246B	0x2C34	0x2C23	0x3145	0x029D	0x9EB5	0x2D8	0x0063	0x22AD	0x1CD7	0x3E12	0x6788	0x0367	0x1D7A	0xD1E4	0x2E0	0x8057	0x2C1D	0x233F	0x2C31	0x2C0E	0x312C	0x017E	0x5C23	0x2E8	0x8067	0x2236	0x1DD6	0x5E48	0x6738	0x0267	0x1BBE	0xC000	0x2F0	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x2F8	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x300	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x308	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x310	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x318	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x320	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x328	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x330	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x338	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	<p>Update the production line data buffer with the newly calculated coefficients.</p> <p>The register locations of the coefficients can be derived from the ZSSC4175_0500_01_CRS file.</p> <p>Store the calculated coefficients in the data buffer. The locations of the bit fields are described in the CRS file.</p>
Addr	00	01	02	03	04	05	06	07																																																																																																																																																		
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0x338	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000	0x0000																																																																																																																																																		
<p>Close the “Calibrate” dialog.</p> <p>Note: Writing the coefficients into the RAM is required after each channel calibration step (CJ Comp, TC1 Comp, TC1 Check, TC2 Comp, TC2 Check)</p>																																																																																																																																																										

4. Write the Configuration into the ZSSC4175D-01

GUI Usage

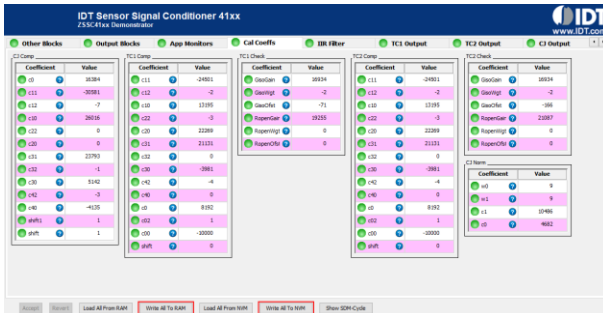
Open the “Quick Setting” dialog by clicking on the “Quick Settings” button.



Navigate to the “Cal Coeffs” tab, and click the “Revert” button. After reverting the red marked data, the GUI loads the calculated coefficients into the “Cal Coeffs” tab.



Select “Write All to RAM” or “Write all to NVM” to complete the calibration procedure. Additional application-specific settings are not affected.



Production Line Usage

Write the final configuration in the ZSSC4175D-01 (refer to the “Product Line Handling” section of the ZSSC4175D-01 Functional Description)

Write Pages in Shadow Memory

Write **OW_2813323XXXX003FY...Y**
23HEX → WrShdwBurst
XXXXHEX → 4 nibble page address
003FHEX → Amount of data read(64 words)
Y...YHEX → 256 nibble page data

Read **OR_28002**
 receive **23**HEX → Command accepted
 receive **YY**HEX → First page data

Request NVM Write Authorization

Write **OW_28003153C5B**
15HEX → WrNvmWrAuth
3C5BHEX → NVM Mode Authorization Key

Write **OW_2800114**
14HEX → RdNvmWrAuthVld

Read **OR_28003**
 receive **14**HEX → Command accepted
 receive **0001**HEX → NVM authorization permitted

Update Internal Register

Write **OW_280031BFFFF**
1BHEX → CpShdwToReg
FFFFHEX → Constant value

Copy Shadow Pages to NVM Pages

Write **OW_280031AXXXX**
1AHEX → CpShdwToNvmPg
XXXXHEX → 4-nibble page identifier (see the “CpShdwtoNVMpg” section in the ZSSC4175D-01 Functional Description)

Read **OW_28002**
 receive **0000**HEX → Chip is still busy (keep polling)

Read **OW_28002**
 receive **1A**HEX → Command accepted
 receive **XX**HEX → first page data

Check NVM Page CRCs

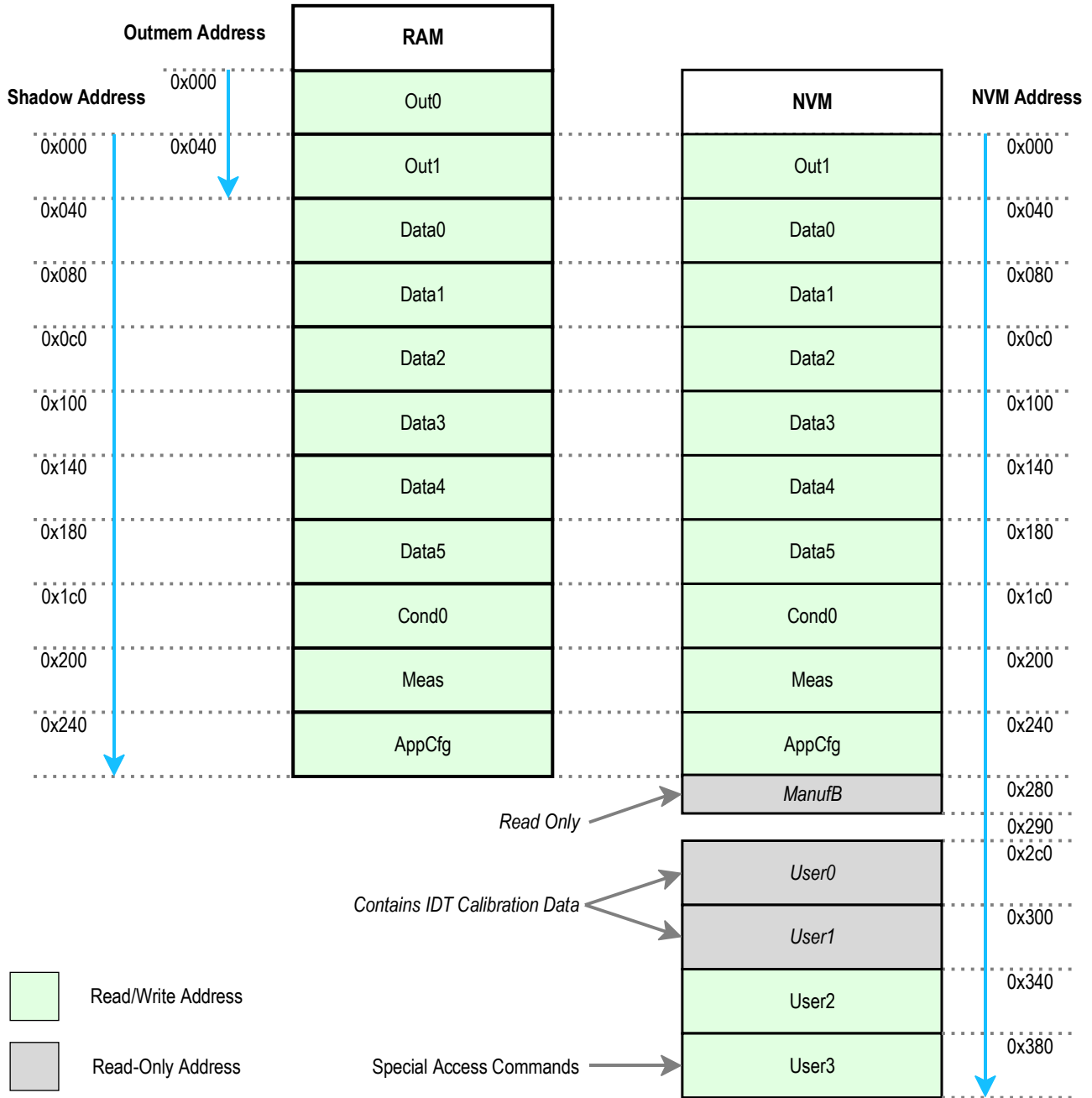
Write **OW_2800324XXXX**
24HEX → RdNvmWord
XXXXHEX → 4 nibble CRC address

Read **OR_28003**
 receive **24**HEX → Command accepted
 receive **XXXX**HEX → CRC from page

Important Note: To verify the data copied to NVM, read the page's CRC and compare it with a locally calculated CRC. Refer to the *ZSSC4175D-01 Functional Description* for a pseudocode example for calculating the CRC (see "Calculating Page CRC" in the *ZSSC4175D-01 Functional Description*).

5. ZSSC4175D-01 RAM and NVM Structure

Figure 1. ZSSC4175D-01 RAM and NVM Structure



6. Revision History

Revision Date	Description of Change
March 13, 2019	Full revision.
February 12, 2019	Initial release.
October 5, 2020	<ul style="list-style-type: none"> • Correcting product name from "ZZSC4175D" to "ZSSC4175D-01" • Implementation of the new calibration behavior
October 6, 2020	<ul style="list-style-type: none"> • Changing CDR to Functional Description