

Acquiring source data for calibration

Initial measurements need to be executed prior determining and writing calibration values. The capacitance of each individual beam in actuated state, Cmin (0,0) and Cmax (7F,7F). The data has to be saved in csv-file. The first row has column names, and the rest of the rows are measurement values. The tool looks for the following column names:

- "Package Number"
- "Beam reg2"
- "Beam reg3"
- "Frequency MHz" for LCR-measurement or "Frequency (MHz)" for VNA measurement
- "Capacitance fF" for LCR-measurement or "Capacitance (pF)" for VNA measurement

Frequency value is not applicable for LCR measured data. An example of beam data measured with an LCR-meter:

Package_Number,Beam_reg2,Beam_reg3,Frequency_MHz,Capacitance_fF

3,0,0,1,265.238

3,7F,7F,1,2754.35

3,40,0,1,348.479

3,20,0,1,486.477

3,10,0,1,482.384

3,8,0,1,464.758

3,4,0,1,464.719

3,2,0,1,466.232

3,1,0,1,460.809

3,0,40,1,314.784

3,0,20,1,373.59

3,0,10,1,495.017

3,0,8,1,462.705

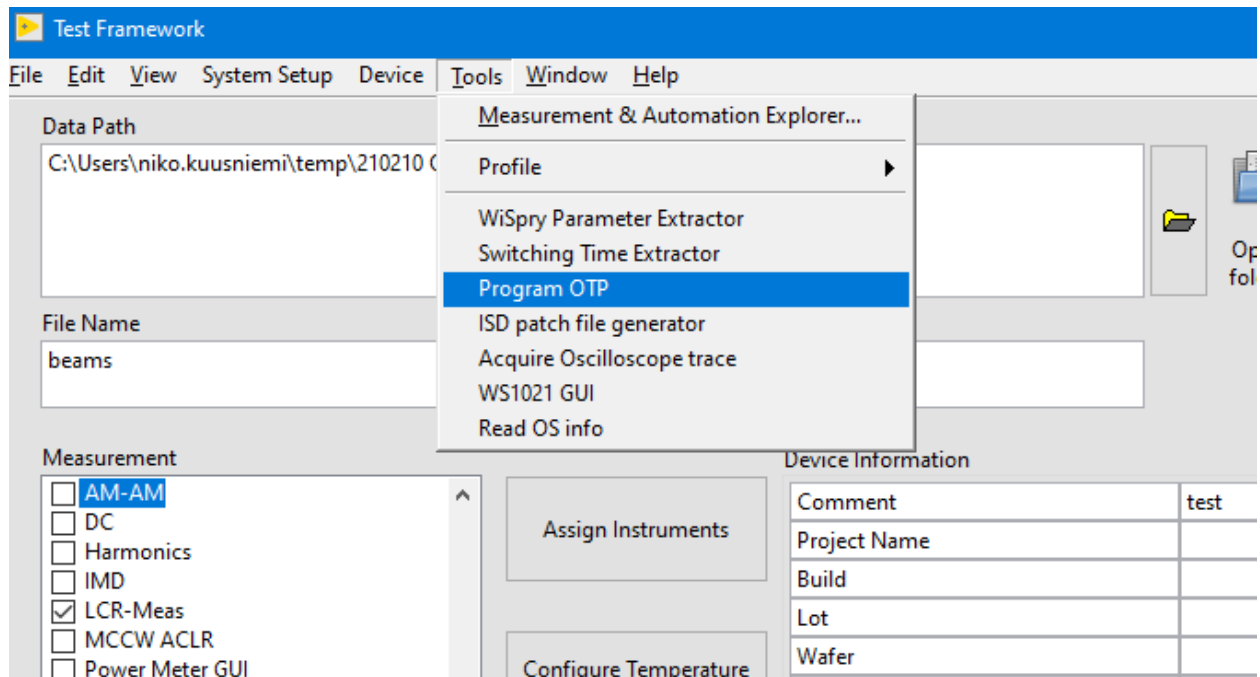
3,0,4,1,463.483

3,0,2,1,461.214

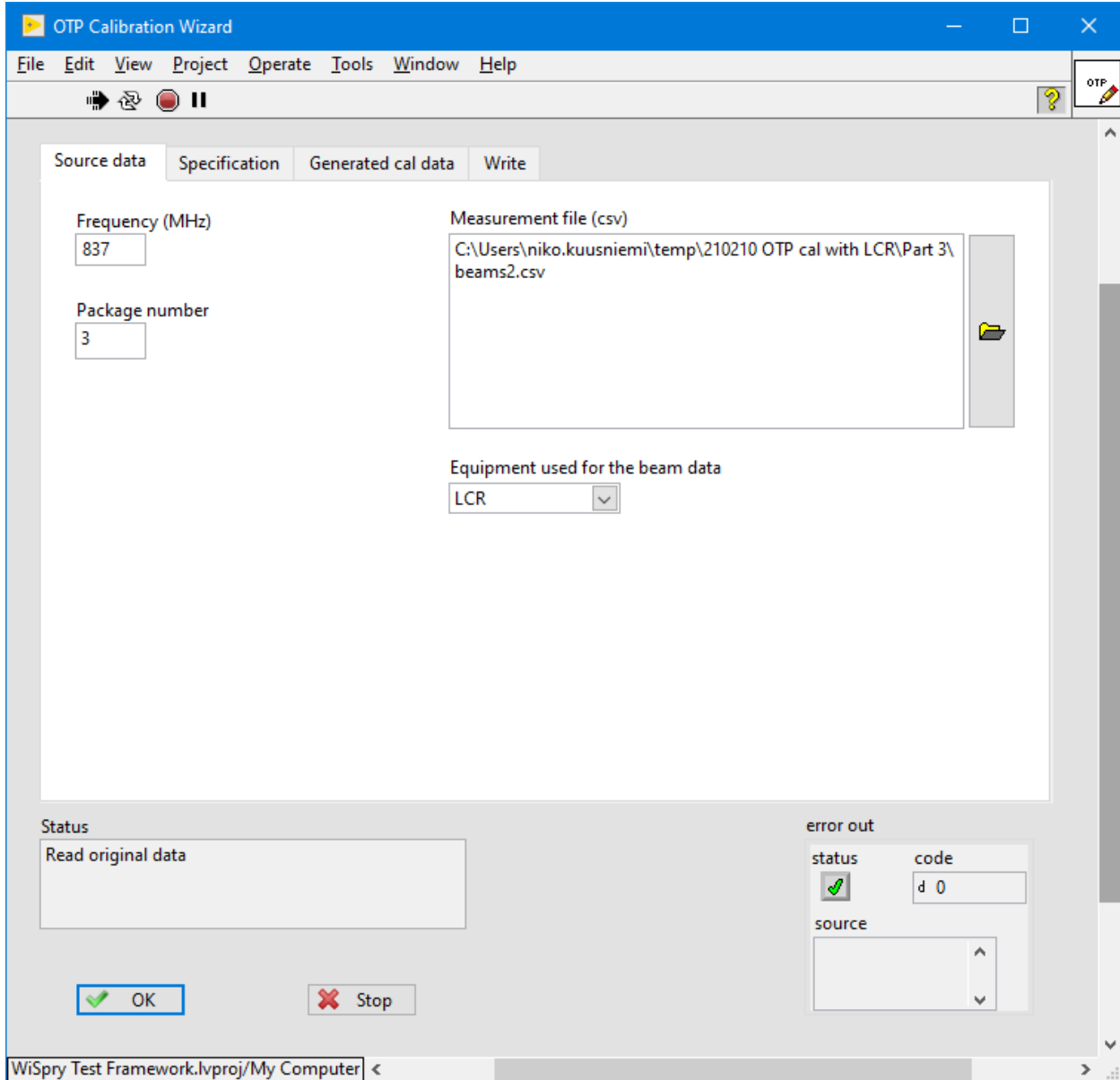
3,0,1,1,460.171

Writing OTP data

Launch WiSpry Test Framework -software and click “Program OTP” in Tools menu.



Select measurement file and data format, LCR or VNA. Make sure package number is in the same format as in the csv-file. Choose desired frequency point if VNA-data is used. Click ok to proceed.



The screenshot shows the 'OTP Calibration Wizard' application window. The title bar includes standard Windows window controls and the text 'OTP Calibration Wizard'. The menu bar contains 'File', 'Edit', 'View', 'Project', 'Operate', 'Tools', 'Window', and 'Help'. Below the menu bar is a toolbar with icons for file operations and a status bar on the right with a question mark and 'OTP' label. The main window has four tabs: 'Source data' (selected), 'Specification', 'Generated cal data', and 'Write'. The 'Source data' tab contains three input fields: 'Frequency (MHz)' with the value '837', 'Package number' with the value '3', and 'Measurement file (csv)' with the path 'C:\Users\niko.kuusniemi\temp\210210 OTP cal with LCR\Part 3\beams2.csv'. Below these is a dropdown menu for 'Equipment used for the beam data' set to 'LCR'. At the bottom left, there is a 'Status' section with a text box containing 'Read original data' and two buttons: 'OK' (with a green checkmark icon) and 'Stop' (with a red X icon). At the bottom right, there is an 'error out' section with a 'status' field showing a green checkmark, a 'code' field with the value 'd 0', and a 'source' field with a list box. The bottom status bar shows the file path 'WiSpry Test Framework.lvproj/My Computer'.

OTP Calibration Wizard

File Edit View Project Operate Tools Window Help

Source data Specification Generated cal data Write

Frequency (MHz)
837

Package number
3

Measurement file (csv)
C:\Users\niko.kuusniemi\temp\210210 OTP cal with LCR\Part 3\beams2.csv

Equipment used for the beam data
LCR

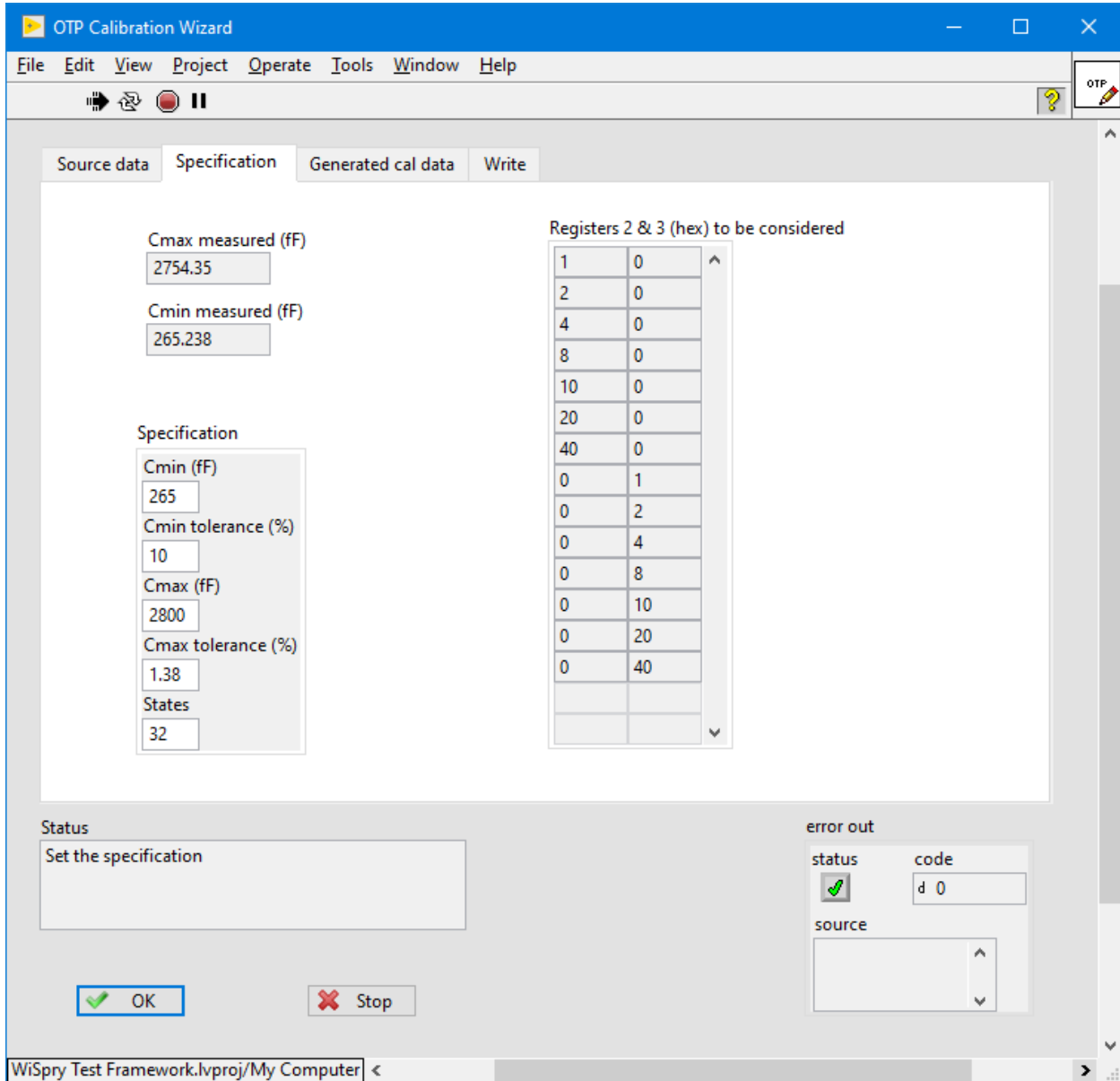
Status
Read original data

OK Stop

error out
status code
d 0
source

WiSpry Test Framework.lvproj/My Computer

Make sure that the tool read the Cmax and Cmin values correctly. Set the specification values, Cmin, Cmax and number of states (tolerance values are ignored at this time). The list on the right shows what register values are going to be used for calibration. It should be 14 rows for 14 beams. Click ok to proceed.



OTP Calibration Wizard

File Edit View Project Operate Tools Window Help

Source data Specification Generated cal data Write

Cmax measured (fF)
2754.35

Cmin measured (fF)
265.238

Specification

Cmin (fF)
265

Cmin tolerance (%)
10

Cmax (fF)
2800

Cmax tolerance (%)
1.38

States
32

Registers 2 & 3 (hex) to be considered

1	0
2	0
4	0
8	0
10	0
20	0
40	0
0	1
0	2
0	4
0	8
0	10
0	20
0	40

Status
Set the specification

OK Stop

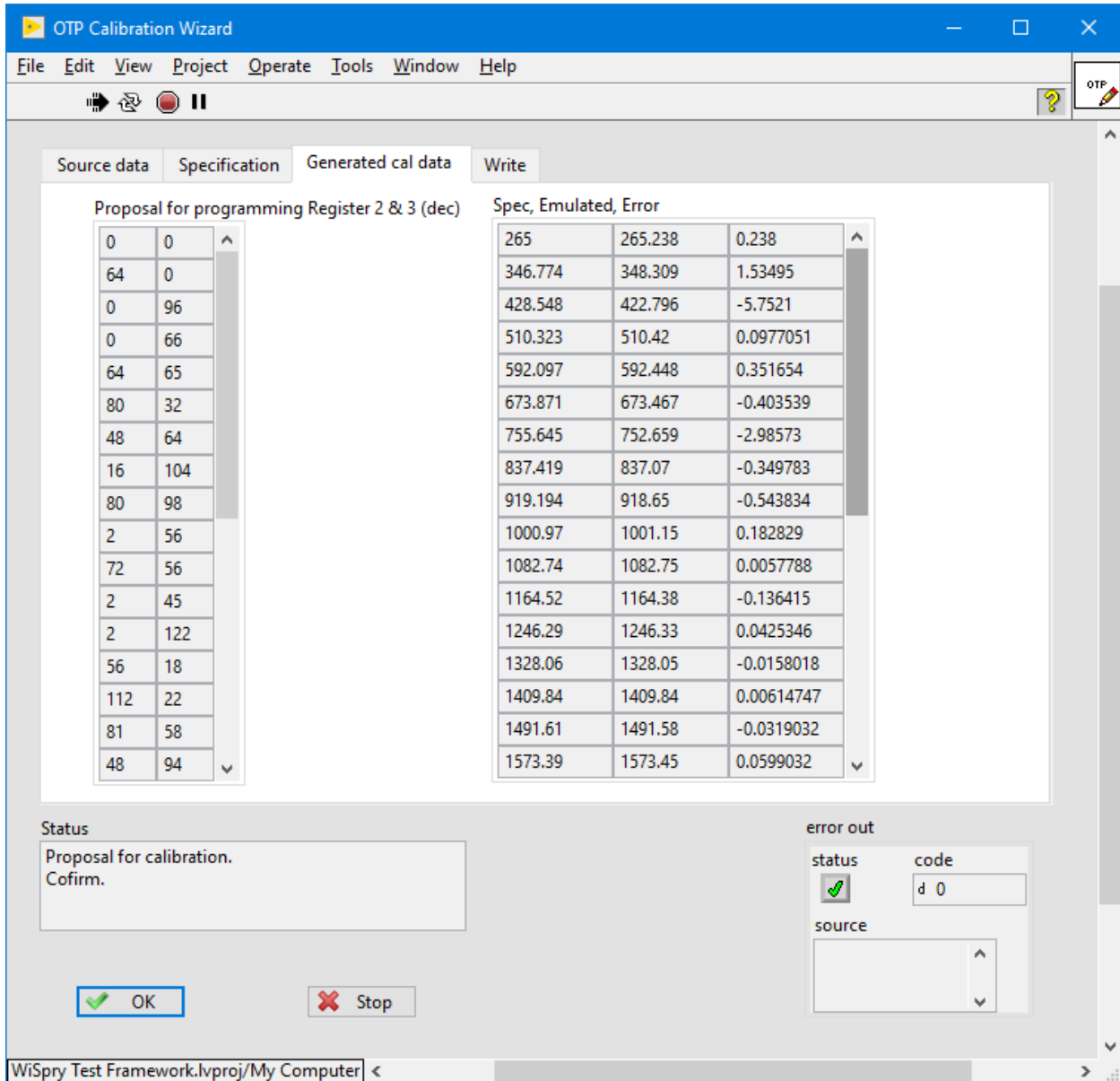
error out

status code
d 0

source

WiSpry Test Framework.lvproj/My Computer

Inspect the proposed calibration registers on the left. The table on the right shows the target capacitance, emulated capacitance (calculated based on the original data in csv-file) and error. Click ok to proceed.



OTP Calibration Wizard

File Edit View Project Operate Tools Window Help

Source data Specification **Generated cal data** Write

Proposal for programming Register 2 & 3 (dec)

0	0
64	0
0	96
0	66
64	65
80	32
48	64
16	104
80	98
2	56
72	56
2	45
2	122
56	18
112	22
81	58
48	94

Spec, Emulated, Error

Spec	Emulated	Error
265	265.238	0.238
346.774	348.309	1.53495
428.548	422.796	-5.7521
510.323	510.42	0.0977051
592.097	592.448	0.351654
673.871	673.467	-0.403539
755.645	752.659	-2.98573
837.419	837.07	-0.349783
919.194	918.65	-0.543834
1000.97	1001.15	0.182829
1082.74	1082.75	0.0057788
1164.52	1164.38	-0.136415
1246.29	1246.33	0.0425346
1328.06	1328.05	-0.0158018
1409.84	1409.84	0.00614747
1491.61	1491.58	-0.0319032
1573.39	1573.45	0.0599032

Status

Proposal for calibration.
Cofirm.

OK Stop

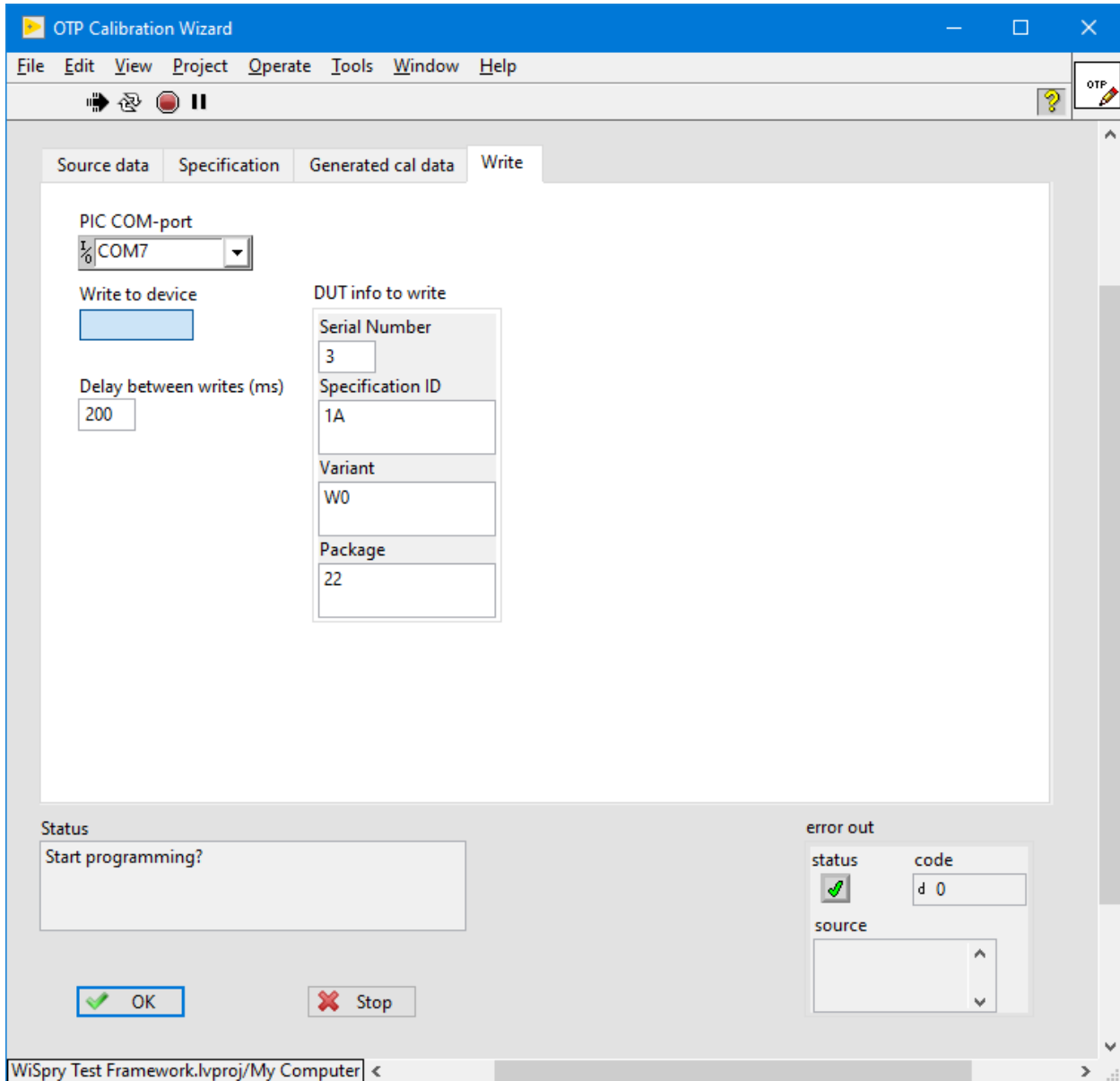
error out

status code

source

WiSpry Test Framework.lvproj/My Computer

Select COM-port for the PIC and make sure that “Write to device” is selected. In case there were problems programming previously, the delay between the writes can be increased to give the device more time. Fill in additional information about the device. Click ok to proceed.



The screenshot shows the 'OTP Calibration Wizard' application window. The 'Write' tab is active, displaying fields for configuring the write operation. The 'PIC COM-port' is set to 'COM7'. The 'Write to device' checkbox is checked. The 'Delay between writes (ms)' is set to 200. The 'DUT info to write' section includes fields for 'Serial Number' (3), 'Specification ID' (1A), 'Variant' (W0), and 'Package' (22). The 'Status' section shows 'Start programming?'. The 'error out' section shows a green checkmark for 'status' and 'd 0' for 'code'. The 'source' field is empty. The 'OK' button is highlighted with a green checkmark, and the 'Stop' button is highlighted with a red X. The bottom status bar shows 'WiSpry Test Framework.lvproj/My Computer'.

OTP Calibration Wizard

File Edit View Project Operate Tools Window Help

Source data Specification Generated cal data Write

PIC COM-port
COM7

Write to device
☒

Delay between writes (ms)
200

DUT info to write

Serial Number
3

Specification ID
1A

Variant
W0

Package
22

Status
Start programming?

error out

status
☒

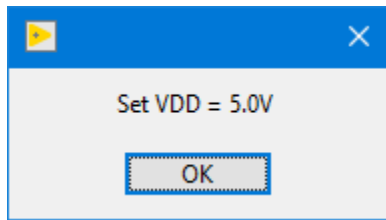
code
d 0

source

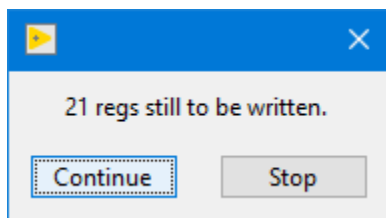
OK Stop

WiSpry Test Framework.lvproj/My Computer

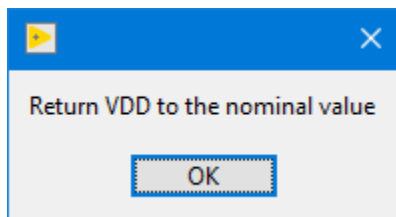
Before starting programming, the tool will ask to set Vdd to 5V.



The tool reads back the written registers and checks if they were written correctly. If not, it will pop up a window showing how many registers were not correct. The tool continues trying to write the registers until Stop is clicked.

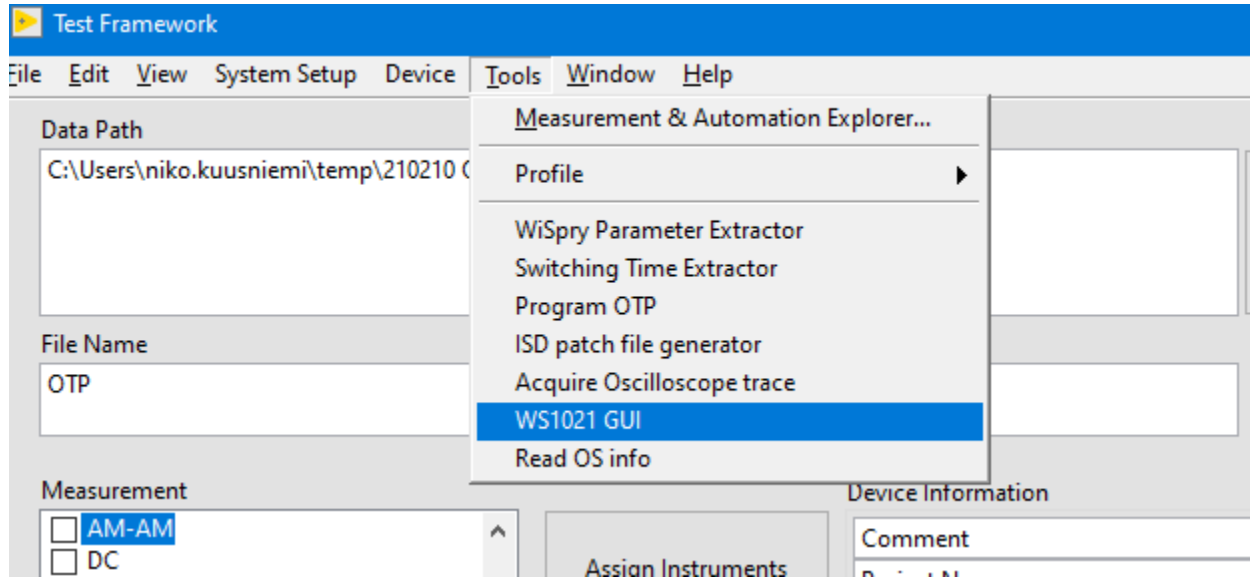


After successful write or if Stop was clicked, the tool will ask to return Vdd back to normal value.

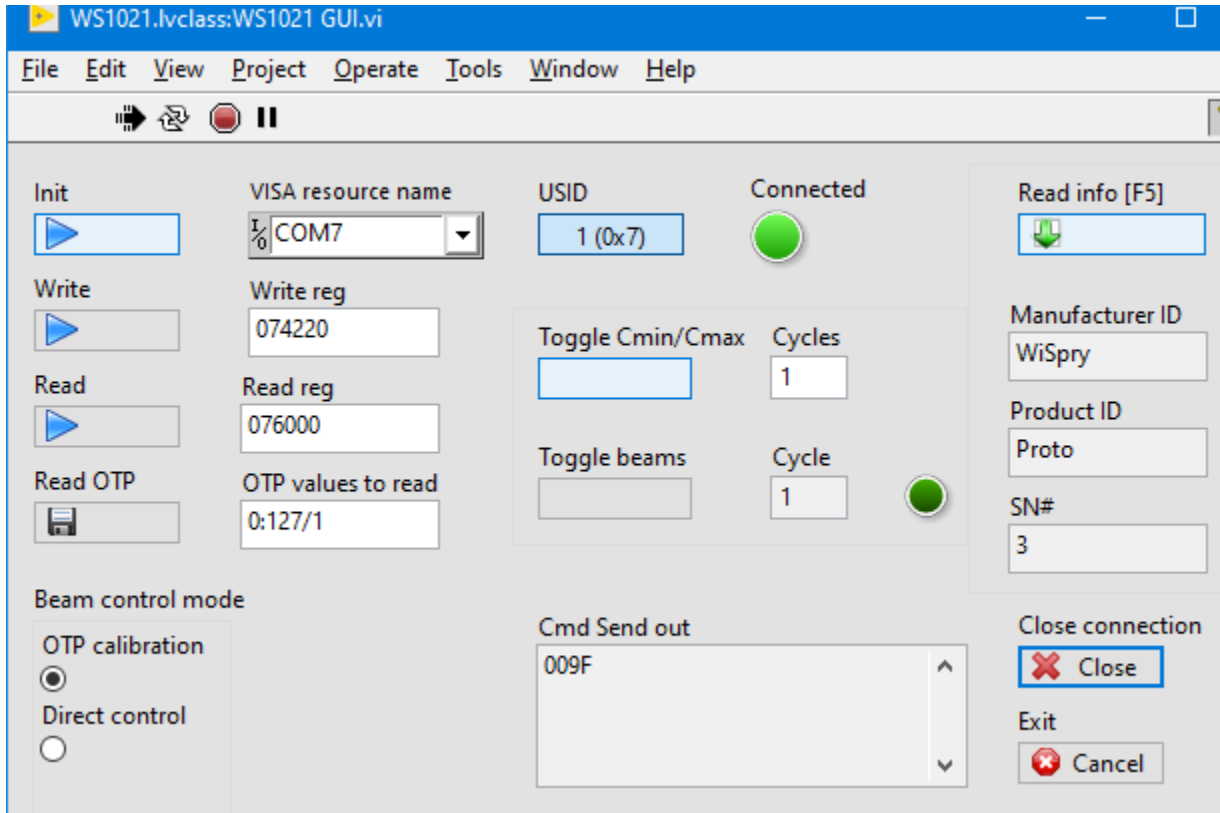


Checking the OTP data

In WiSpry Test Framework -software, click “WS1021 GUI” in Tools menu.



Select COM-port and correct USID (typically 0x7) and click “Init”. “Connected” LED should lit up. Click “Read info”, the newly written serial number should show up below. Clicking “Toggle Cmin/Cmax” should make the part switch between 0 and 31 state using the OTP-calibration. The whole OTP-header can be downloaded by clicking “Read OTP” button.



The screenshot shows the WS1021 GUI with the following elements:

- Menu Bar:** File, Edit, View, Project, Operate, Tools, Window, Help.
- Buttons:** Init (blue arrow), Write (blue arrow), Read (blue arrow), Read OTP (disk icon), Read info [F5] (green arrow), Close connection (red X), Exit (red X), Cancel (red X).
- VISA resource name:** A dropdown menu showing "COM7".
- USID:** A text field containing "1 (0x7)".
- Connected:** A green LED indicator that is lit.
- Write reg:** A text field containing "074220".
- Read reg:** A text field containing "076000".
- OTP values to read:** A text field containing "0:127/1".
- Toggle Cmin/Cmax:** A blue button.
- Cycles:** A text field containing "1".
- Toggle beams:** A grey button.
- Cycle:** A text field containing "1".
- Beam control mode:** Two radio buttons: "OTP calibration" (selected) and "Direct control".
- Cmd Send out:** A text area containing "009F".
- Manufacturer ID:** A text field containing "WiSpry".
- Product ID:** A text field containing "Proto".
- SN#:** A text field containing "3".