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PICOCAP®

Data Sheet

PCapØ2plus

Evaluation Software for PICOCAP Devices

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Content

1 Evaluation Software

1.1 Installing the Software

The PCapØ2plus Evaluation software runs under the following operating systems

- Windows 2000
- Windows XP
- Windows Vista (please use the software/drivers for Windows 7)
- Windows 7/8

Please follow the described procedure to install the software and driver:

NOTE: Ensure that the PicoProg V2.0 programmer is disconnected before starting the procedure.

The steps are slightly different for Windows XP and Windows 7/8. Please note as follows.

Installation on Windows 7/8 systems:

- Install the PCapØ2plus Evaluation software from *PCapO2plus_Evaluation_Software\setup.exe* from the CD. This .exe file installs the evaluation software and the respective drivers for the PicoProg V2,0 programmer too.
- At the end of step 1, a batch file comes up in a separate window. Eventually, it will ask you to unplug the PicoProg V2.0 programmer. Please follow further the instructions on the window.
- The driver will be installed; a windows message may pop up asking you to install the driver though it is not signed. Please install it anyway.
- The batch file asks you to plug in the programmer and it is now enumerated.
- You will be asked to restart the system at this point, please do so. After restart connect the evaluation board to the PicoProg V2.0 programmer.

Installation on Windows XP systems:

- Install the PCapØ2plus Evaluation software from *PCapO2plus_Evaluation_Software\setup.exe* from the CD. This .exe file installs the evaluation software and the respective drivers for the PicoProg V2.0 programmer too.
- At the end of step 1, a batch file comes up in a separate window. It will ask you to reconnect the PicoProg V2.0 programmer.
- You will then be asked to restart the system at this point, please do so.

- On restart, Found New Hardware wizard comes up. Please select 'No, not this time' and continue further with 'automatic installation'.
- The driver will be installed; a windows message may pop up asking you to install the driver though it is not signed. Please install it anyway.

1.2 The Graphical User Interface

The software comes up with a small window offering selections for the operating mode. In general, start with the standard mode as it offers all options.

Next, the main front panel comes up. Overall, the graphical user interface offers various windows for on-line configuration, for parameter and calibration data setting, and of course for the graphical and numerical display of the measurement data. The various windows will be explained in this chapter.

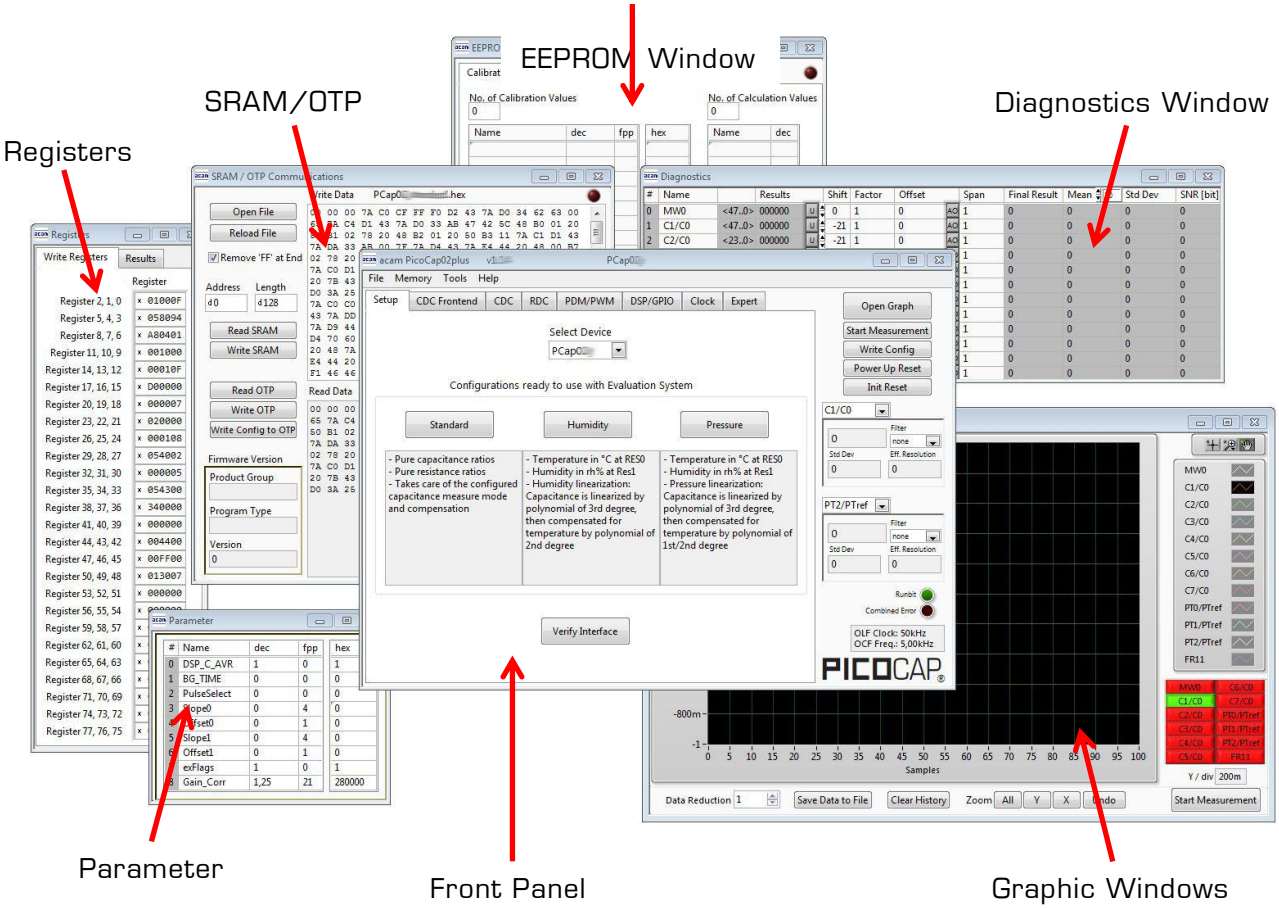


Figure 1-1: GUI Overview

1.3 Front Panel

This is the major window. On the right side, the front panel shows five general buttons:

Open Graph	Open a window for graphic representation of measurement data
Start Measurement	Start or stop a running measurement
Write Config.	Transfer once more, the present settings in the evaluation software to the chip (in case of doubt)
Power up Reset	After Power up reset, 'Write Config.' may be necessary.
Init Reset	With a init reset, the chip is re-initialized with respect to its frontend and processor.

1.3.1 Setup Page

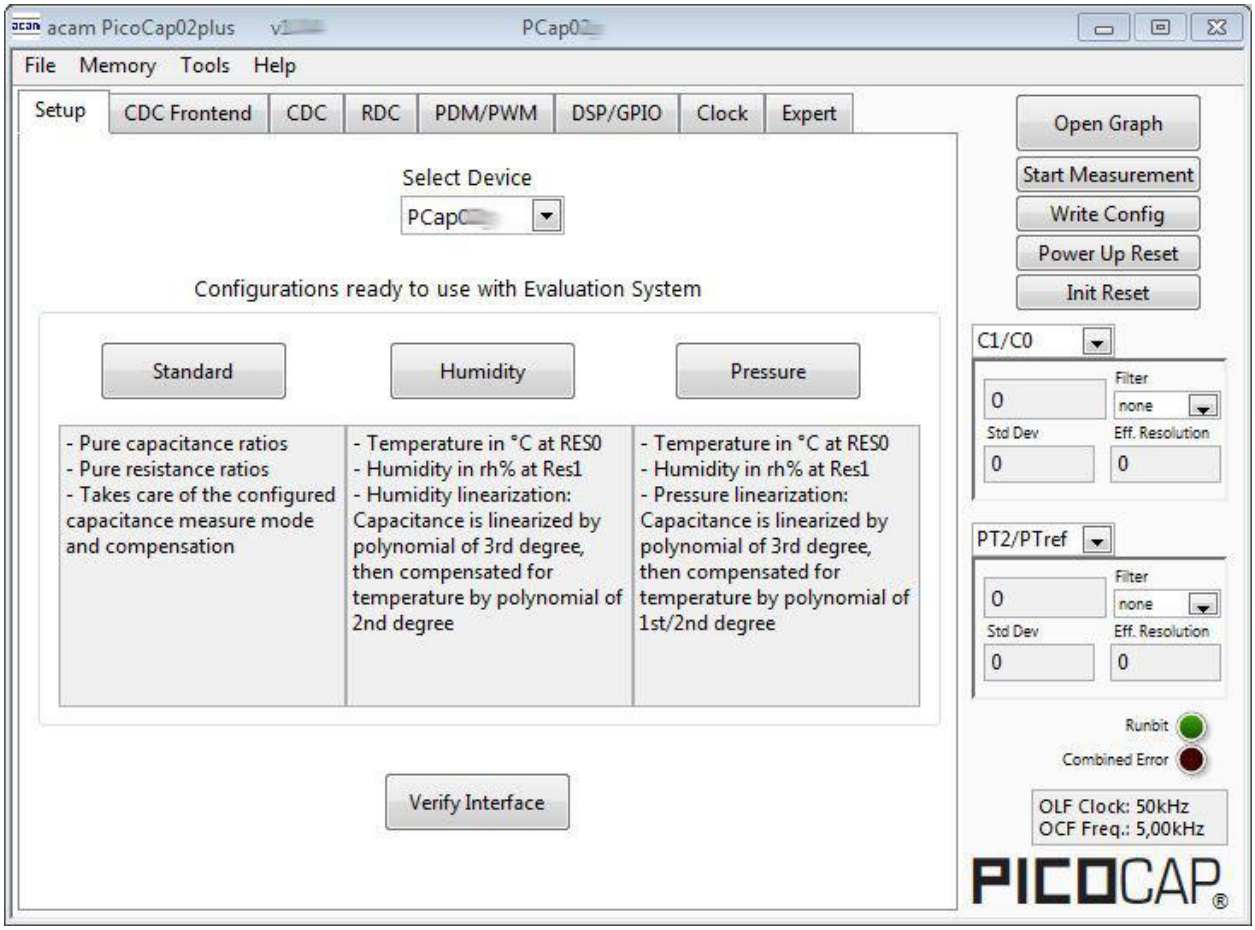


Figure 1-2: Setup page

Options on 'Setup' page:

Select Device	Select the PICOCAP device which you use.
Standard	Opens the *<Selected Device>*_standard.prj project file with Configuration and Firmware.
Humidity	Opens the *<Selected Device>*_humidity.prj project file with Configuration and Firmware.
Pressure	Opens the *<Selected Device>*_pressure.prj project file with Configuration and Firmware.
Verify Interface	When everything is in order, then pressing this button will indicate the release version number of the software and of the PicoProg V2.0 Firmware. It also confirms with 'SRAM read/write: OK' if a supported PICOCAP device is present.

1.3.2 CDC Frontend Page

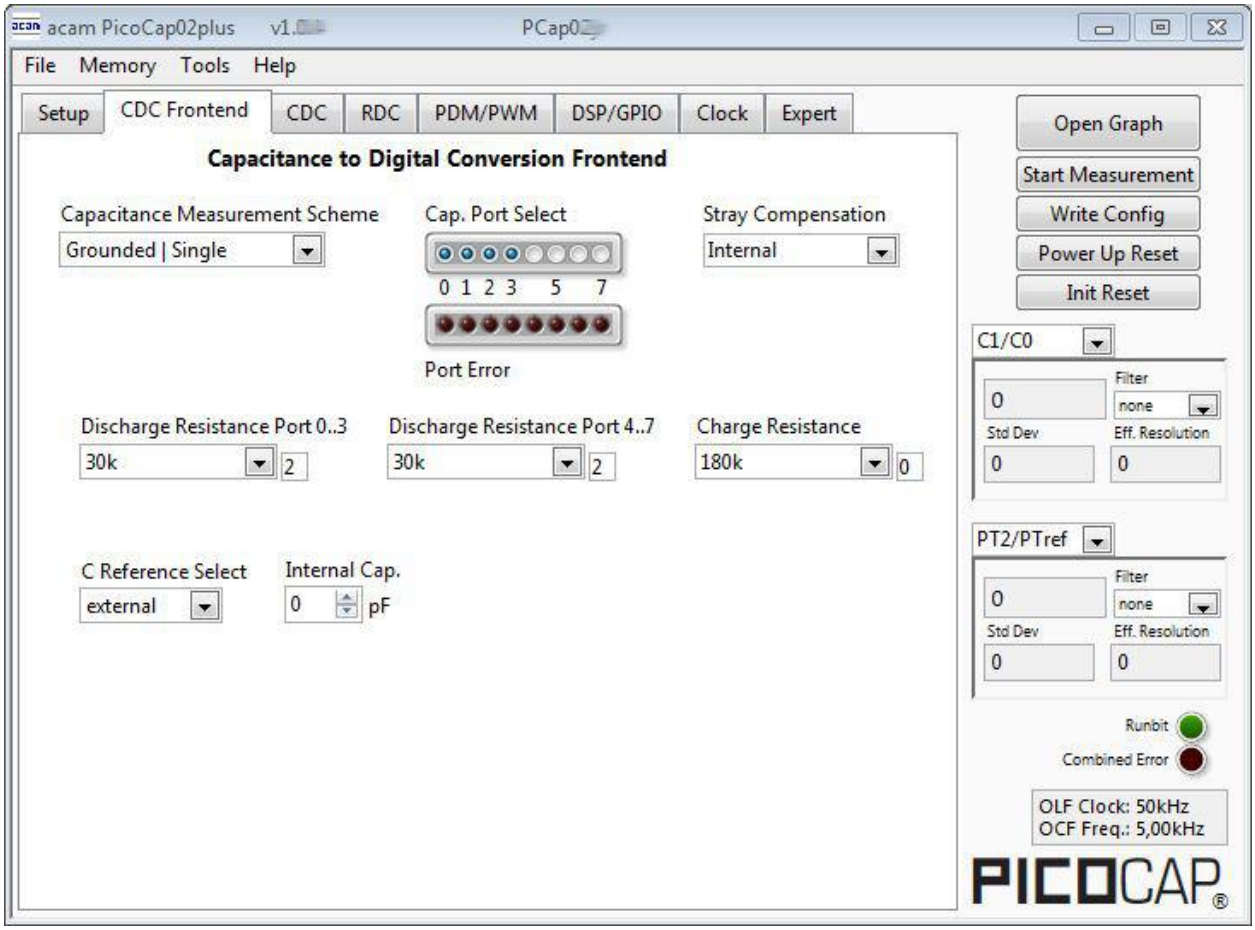


Figure 1-3: CDC Frontend page

Options on 'CDC Frontend page:

Capacitance Measurement Scheme	**Grounded | Single** – Single capacitive sensor connected between a port and ground. **Grounded | Differential** – Differential capacitive sensor connected between 2 ports with the middle tap of the sensor connected to ground. **Floating | Single** – Single capacitive sensor connected between 2 ports. **Floating | Differential** – Differential capacitive sensor connected between 2 ports with the middle tap of the sensor connected to another 2 ports.
Cap. Port Select	Select which capacitive ports have to be measured (Ports 0-7), i.e. at which ports the sensors have been connected in hardware.
Stray Compensation	**None** – No compensation **Internal** – One additional measurement performed through only the chip-internal stray capacitance with respect to ground. **External** – One additional measurement per port pair, performed through a parallel connection of the capacitance at the two ports with respect to ground. **Both** – Both internal and external compensation together.
Discharge Resistance Port 0..3	Selects the value of the internal resistance (1000k, 180k, 90k, 30k, 10k) for measurements on port PC0 to PC3 through which the discharge cycles during measurement are to be performed. This value has to be selected in accordance with the capacitance value of the sensor.
Discharge Resistance Port 4..7	Selects the value of the internal resistance (180k, 90k, 30k, 10k) for measurements on port PC4 to PC7 through which the discharge cycles during measurement are to be performed. This value has to be selected in accordance with the capacitance value of the sensor.
Charge Resistance	Choice of one out of 4 on-chip charging resistors (180k, 90k, 30k, 10k) for the CDC. Permitting to limit the charging current and avoiding transients.
C Reference Select	Switching between external and internal reference capacitance.
Internal Cap	Selection of internal reference capacitance value. (0..31pF)

1.3.3 CDC Page

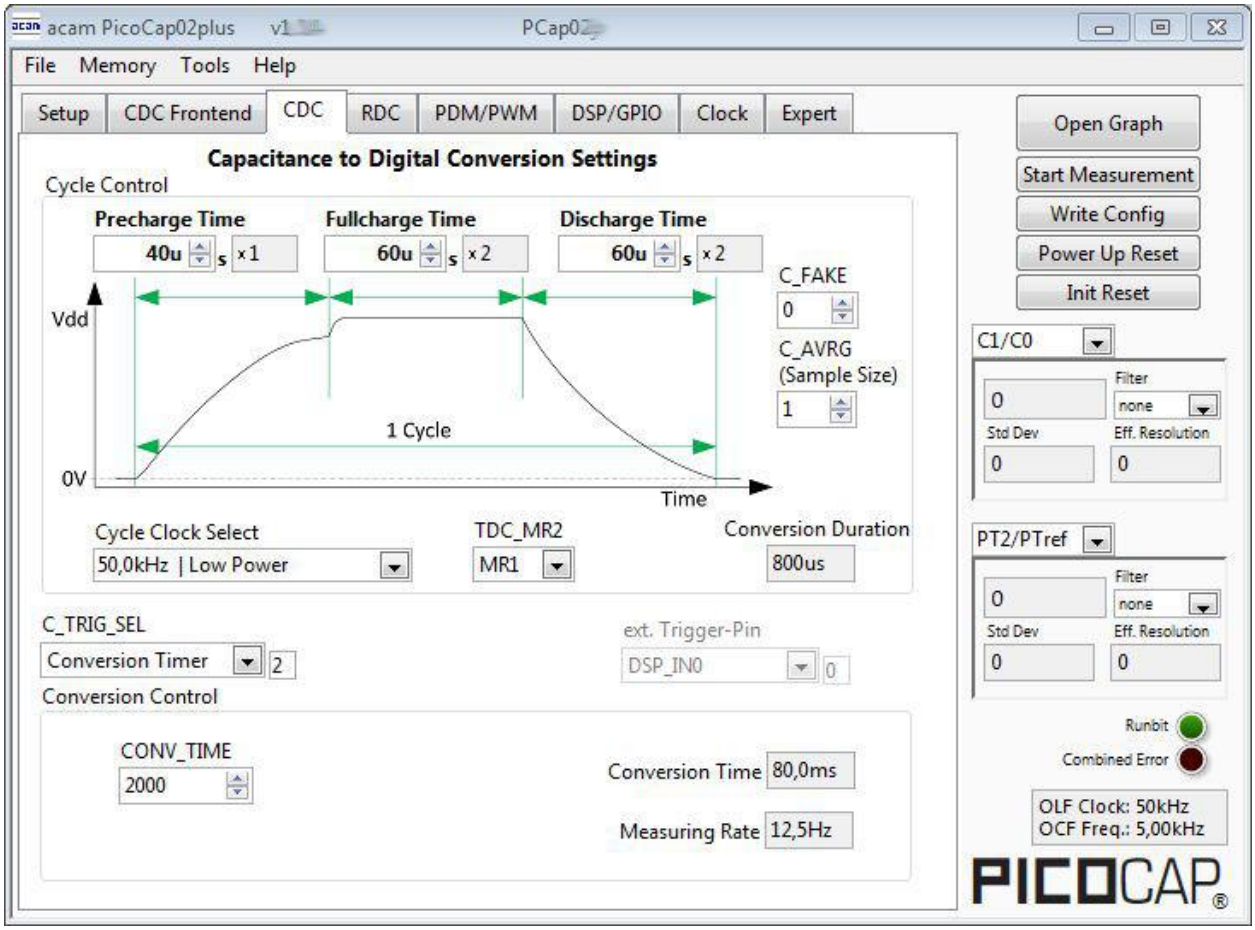


Figure 1-4: CDC page

Options on 'CDC page:

Cycle Control

Precharge Time	Time to charge via resistor for current limitation, can be set in multiples of the cycle clock
Fullcharge Time	Time for final charge without current limitation, can be set in multiples of the cycle clock
Discharge Time	Time to discharge the capacitor, can be set in multiples of the cycle clock
C_FAKE	Number of fake measurements per measurement cycle. Performing fake measurements may help in reducing noise.
C_AVRG	Enables averaging the measurement results over multiple measurement cycles. Setting to 1 → No averaging, Setting to any number N, will result in averaging over N measurement cycles for generating one measurement result. (0..8191)

Cycle Clock Select	**50,0kHz | Low Power** – Single capacitive sensor connected between a port and ground. **1,00MHz | High Speed/4** – Differential capacitive sensor connected between 2 ports with the middle tap of the sensor connected to ground. **4,00MHz | High Speed** – Single capacitive sensor connected between 2 ports.
TDC_MR2	Select the measure mode, On = Measure range 2
Conversion Duration	Displays the entire conversion duration per cycles for averaging and fake measurements.
C_TRIG_SEL	Selects the source that triggers the start of a capacitance measurement **Off | Stretched** – Started by SPI Command 0x8C **Continuous** – Continuous measurement, self-triggering. Recommended when no temperature measurement is made in parallel. **Conversion timer** – Depending on the setting the 'Conversion Time'. Generally recommended setting → less prone to error conditions. **Pin triggered**- Triggered by external Pin, selectable from option ext.Trigger-Pin
Ext. Trigger-Pin	Used to select the pin to be used as the source of trigger for the capacitance measurement. NOTE: In the delivered EVA module, the pins DSP_IN0 and DSP_IN1 are part of the SPI communication interface, hence only DSP_IN2 and DSP_IN3 selections are relevant.

Conversion Control

CONV_TIME	Sets the conversion time in multiples of twice the period of the low-frequency clock
Conversion Time	Displays the entire conversion time per measurement.
Measuring rate	Displays the frequency at which capacitive measurement data is transferred from the DSP to the interface (SPI or I2C).

1.3.4 RDC Page

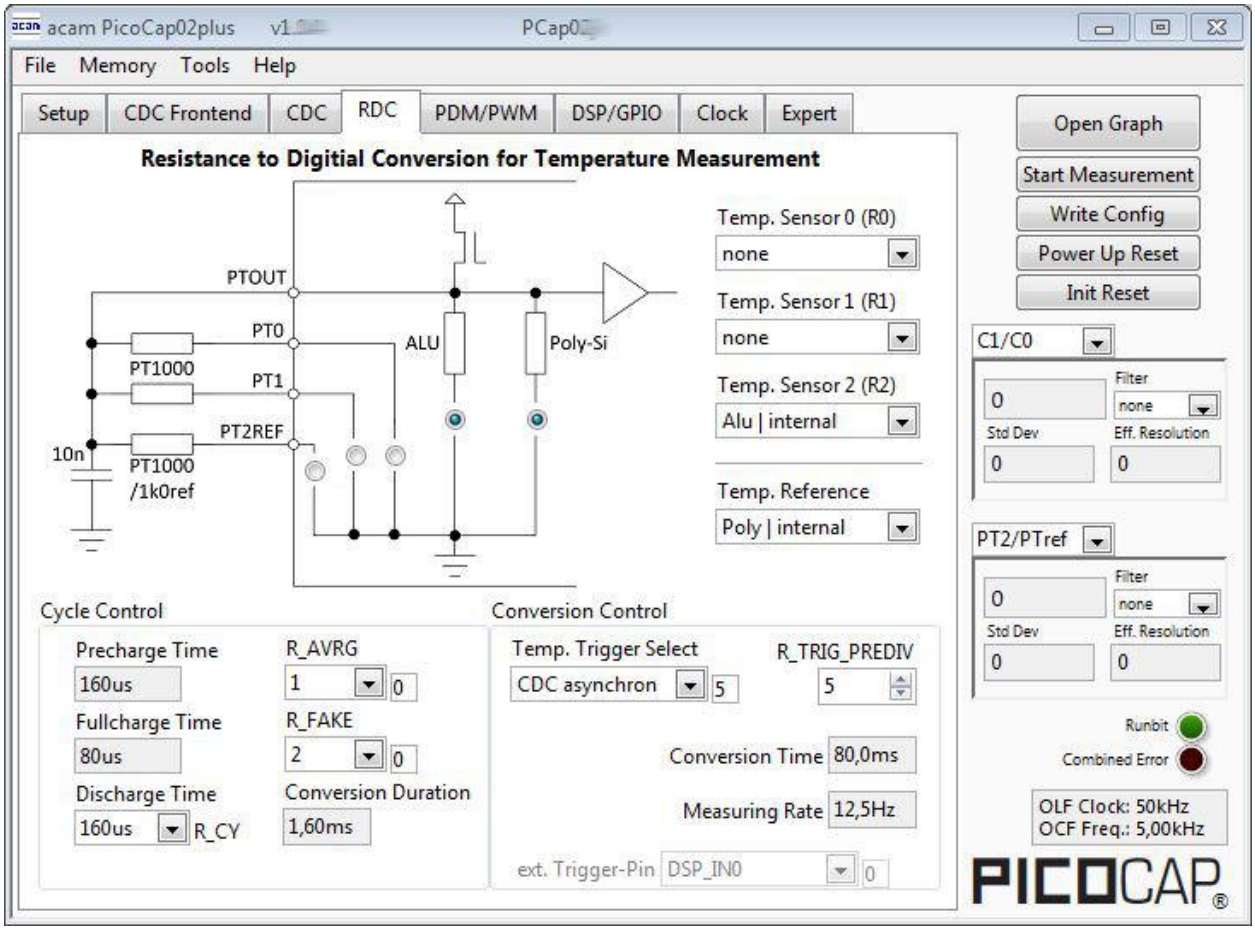


Figure 1-5: RDC page

Options on 'RDC' page:

Temp.Sensor0 (R0)	To select a thermistor connected to port PT0 for temperature measurement. This could be e.g. an external PT1000.
Temp.Sensor1 (R1)	To select a thermistor connected to port PT1 for temperature measurement.
Temp.Sensor2 (R2)	To select either the internal aluminum thermistor or an external reference resistor at port PT2REF for temperature measurement.
Temp. Reference	To select either the internal Poly or external resistor at port PT2REF as the reference resistance to be used in temperature measurement.

Cycle Control

Precharge Time	Displays the precharge time. It depends on R_OLF_DIV.
Fullcharge Time	Displays the fullcharge time It depends on R_OLF_DIV.

Discharge Time	Set the discharge time. It depends on R_OLF_DIV.
R_AVRG	Set averaging for temperature measurement.
R_FAKE	Set number of fake measurements per temperature measurement cycle.
Conversion Duration	Displays the entire conversion duration per cycles for averaging and fake measurements.

Conversion Control

Temp. Trigger Select	Selects the source that triggers the start of a temperature measurement ▪ **Off**: Default setting when no temperature measurement is wanted. In this case, a temperature measurement can still be started by SPI Command 0x8E. ▪ **OLF_CLK**: Triggered by Low-frequency oscillator. ▪ **Pin-Triggered**: Triggered by external Pin, selectable from option ext.Trigger-Pin ▪ **CDC asynchronous**: Depending on the setting in the 'T_TRIG_PREDIV' counter on the RDC page. The DSP is triggered by the RDC end of conversion. If RDC rate is less than CDC rate the DSP is triggered directly from the CDC for inactive RDC conversions. ▪ **CDC synchronous**: Depending on the setting in the 'T_TRIG_PREDIV' counter on the RDC page. The DSP is triggered by the RDC end of conversion. Assuming that RDC rate is less than the CDC rate, the inactive RDC conversions are replaced by a delay.
R_TRIG_PREDIV	For CDC and OLF options the RDC measure rate can be reduced by setting a divider.
Conversion Time	Displays the entire conversion time per measurement.
Measuring Rate	Displays the frequency at which capacitive measurement data is transferred from the DSP to the interface (SPI or I2C).
Ext. Trigger-Pin	Used to select the pin to be used as the source of trigger for the capacitance measurement. NOTE: In the evaluation module, the pins DSP_IN0 and DSP_IN1 are part of the SPI communication interface, hence only DSP_IN2 and DSP_IN3 selections can be used.

1.3.5 PDM / PWM Page

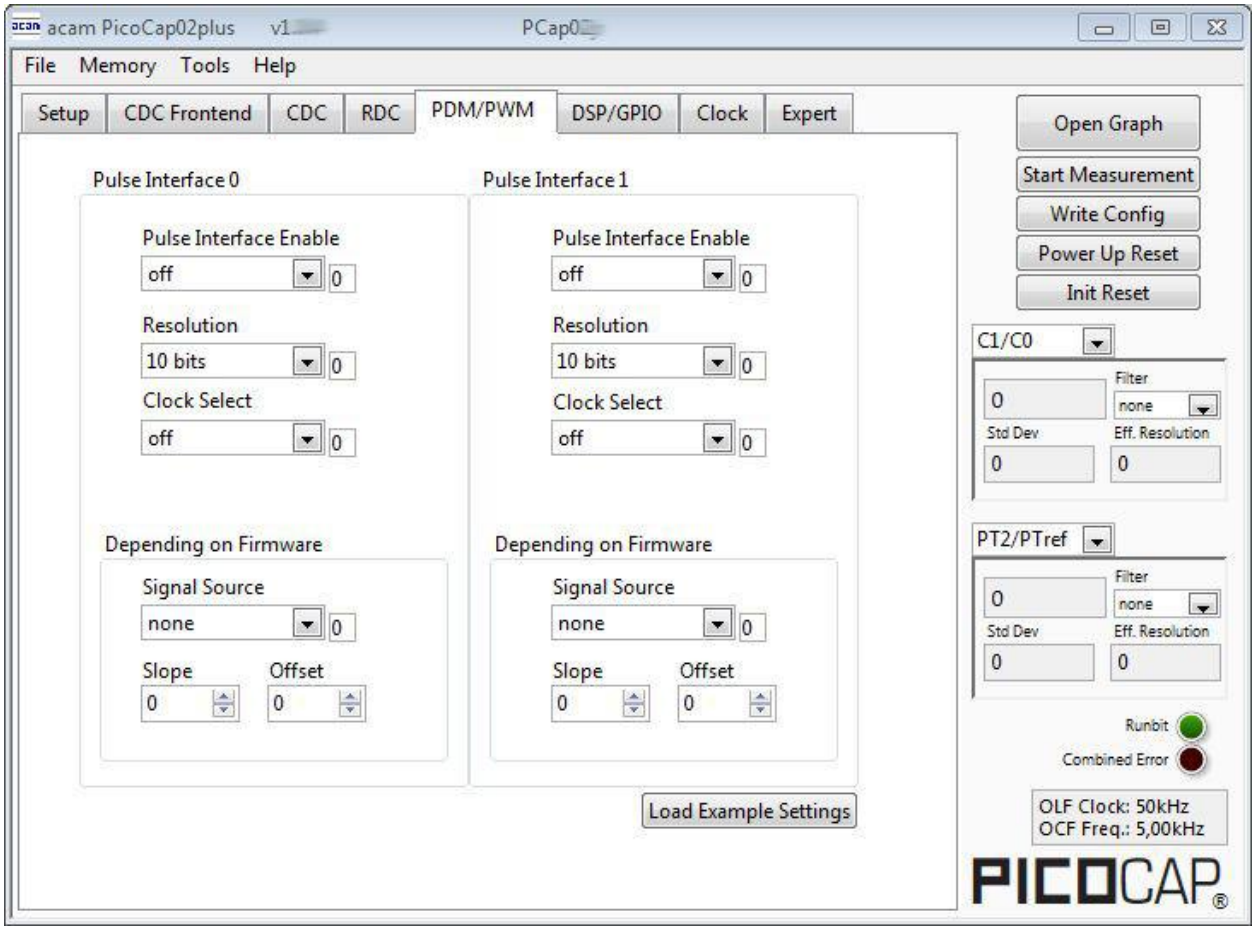


Figure 1-6: PDM/PWM page

Options on 'PDM / PWM' Page:

Pulse Interface Enable	Select the pulse interface – Pulse Width Modulated Output (PWM) or Pulse Density Modulated (PDM) Output. Of the two, the PDM is the recommended interface. With PWM option, 100 kHz clock and 10-bit resolution the resulting PWM output frequency = (100 kHz / 1024) ~ 100 Hz.
Resolution	Resolution of the output in bits. This resolution also determines the pulsed output range.
Clock_select	Selects the clock frequency to be used for the PWM/PDM generation.
Signal source	Select the measurement result which has to be given out as pulsed output – any of the capacitance or temperature measurement results.
Slope	Used to set the slope (m) of the linearization function used to scale the range of the PWM / PDM output generation.

Offset	Used to set the offset (b) of the linearization function. This value determines the range of the PWM / PDM output in the y direction.
Load Example Settings	Used to load example settings of PDM/PWM parameters.

1.3.6 DSP/GPIO Page

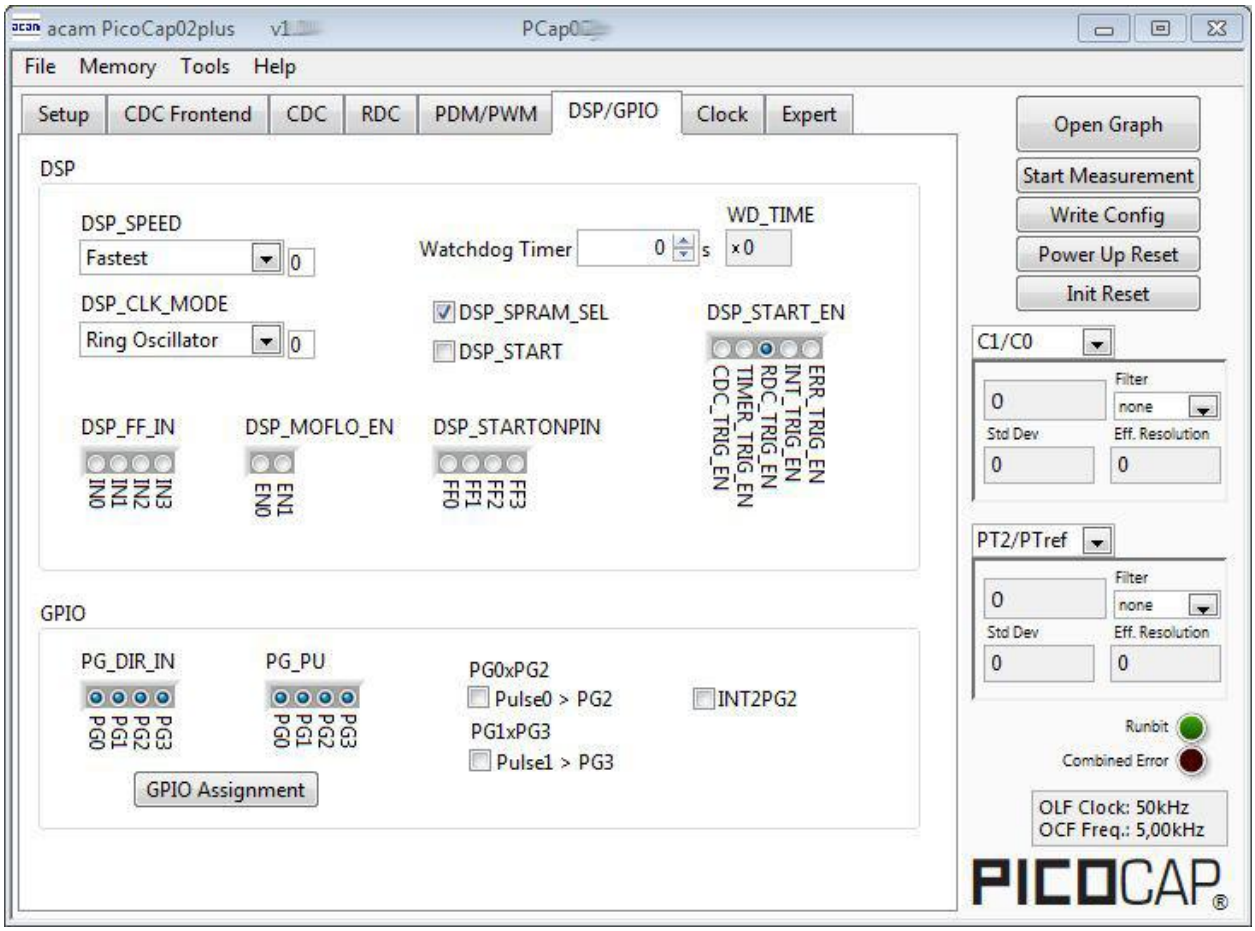


Figure 1-7 DSP/GPIO page

Options on 'DSP/GPIO' Page:

DSP

DSP_SPEED	Select the DSP Speed. Choose between Fastest, Fast, Slow and Slowest.
DSP_CLK_MODE	Select the clock source for the DSP. Choose between Ring Oscillator, LF Clock and HF Clock.
Watchdog Timer	Normally in multiples of 50 milliseconds, provided OCF is tuned to 5 kHz as it should. Watchdog is started together with DSP and designed

	to be reset by a DSP command before the watchdog time is reached. Otherwise a power-up reset is initiated.
WD_TIME	Displays the Watchdog Time as a hex value (4 Byte)
DSP_FF_IN	Pin mask for latching flip-flop activation (PG0 to PG3)
DSP_MOFLO	Activates anti-bouncing filter in PG0 and PG1 lines
DSP_STARTONPIN	Not supported by standard firmware The DSP can be started externally by a signal on a pin; these buttons select the pin that has to be sensed for detecting the start signal.
DSP_START_EN	Mask for activating various trigger sources for starting the DSP

GPIO

PG_DIR_IN	To configure the ports PG0-PG3 as input (otherwise output)
PG_UP	To enable the internal pull up on the ports PG0-PG3
PG0_X_PG2	Possible only when the selected interface for communication is IIC. Interchange PortG0 with PortG2. This is useful when the Pulsed output is needed on Port PG0 instead of PG2.
PG1_X_PG3	Possible only when the selected interface for communication is IIC. Interchange PortG1 with PortG3. This is useful when the Pulsed output is needed on Port PG1 instead of PG3.
INT2PG2	Map the Interrupt output from chip, INTN to Port PG2. This setting is useful for 24 pin QFN package, because the dedicated INTN pin is absent in this version.
GPIO Assignment	Opens the window with the 5 general purpose ports and their assignment.

1.3.7 Clock Page

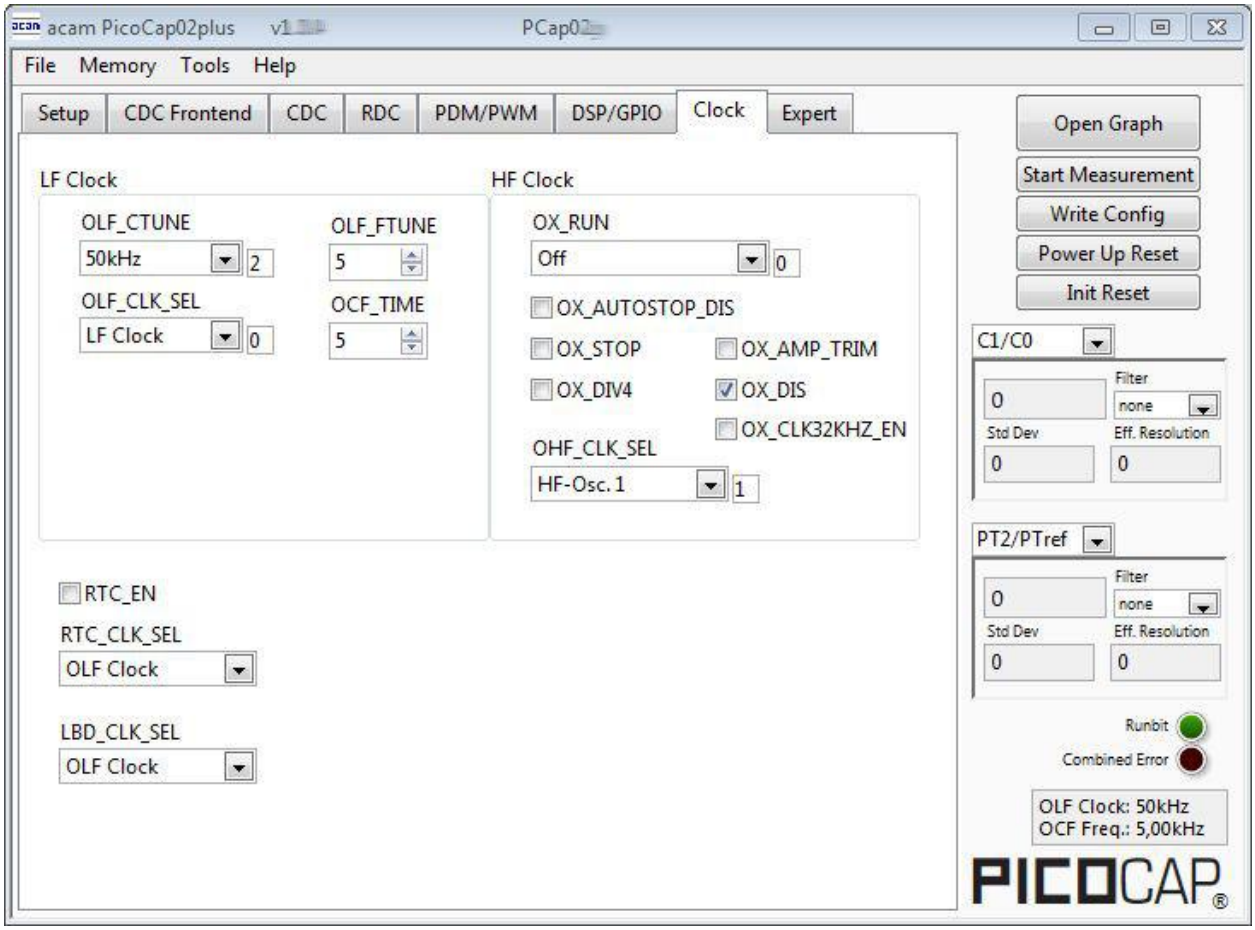


Figure 1-8 Clock page

Options on 'Clock' Page:

LF Clock

OLF_CTUNE	Coarse-tune the low frequency clock. (10kHz, 50kHz, 100kHz, 200kHz)
OLF_CLK_SEL	Select the low frequency clock. (LF Clock, external OX)
OLF_FTUNE	Fine-tune the low frequency clock. (0..15)
OCF_TIME	Controls the OCF frequency, serving the EEPROM, must be adjusted so that f_ocf=5kHz. OCF is derived from OLF via a counter. (0..63)

HF Clock

OX_RUN	Controls the permanency or the latency of the OX generator. Latency means an oscillator settling time before a measurement starts.
OX_AUTOSTOP_DIS	Disables the automatic stop function of the OX generator between the individual measure sequences.

OX_STOP	Stop the OX-generator
OX_DIV4	OX clock frequency := raw freq./4
OX_AMP_TRIM	Trim the OX clock feedback gain.
OX_DIS	Disable the OX clock.
OX_CLK32KHZ_EN	Enable the 32 kHz quartz clock generator.
OHF_CLK_SEL	Choice of HF clock source; if no HF quartz or ceramic oscillator is connected, nor any other off-chip HF clock signal available, chooses "internal". **HF-Osc. 1** – internal clock source #1 **HF-Osc. 2** – internal clock source #2 **External OX** – external clock source
RTC_EN	Enable clock for real time counter
RTC_CLK_SEL	Select clock for real time counter (OLF Clock, ext. HF Osz.)
LBD_CLK_SEL	Clock source selection for the low battery detection (OLF Clock, OLF Clock/16)

1.3.8 Expert Page

Please modify the settings on the Expert page only in consultation with acam Support team.

1.4 Front Panel Menus

1.4.1 File Menu

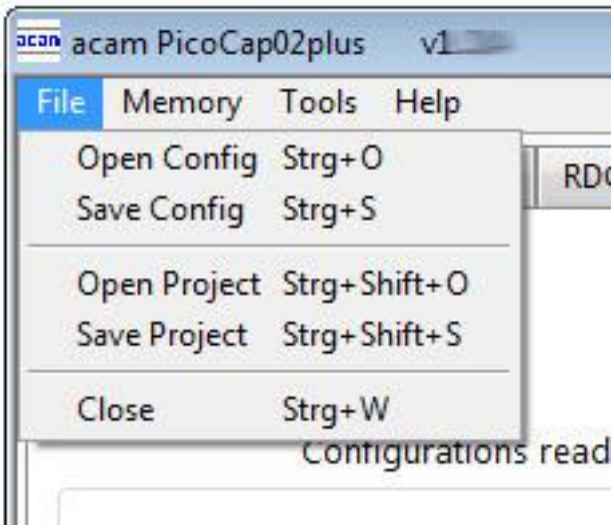


Figure 1-9: File Menu

Open Config	Open configuration file *.cfg that contains the content for the configuration registers.
Save Config	Here you can save your own configuration.
Open Projekt	Open project file *.prj that subsumed the firmware and configuration filenames and the settings and EEPROM data
Save Projekt	Here you can save your own project file.
Close	Close the evaluation software

1.4.2 Memory Menu

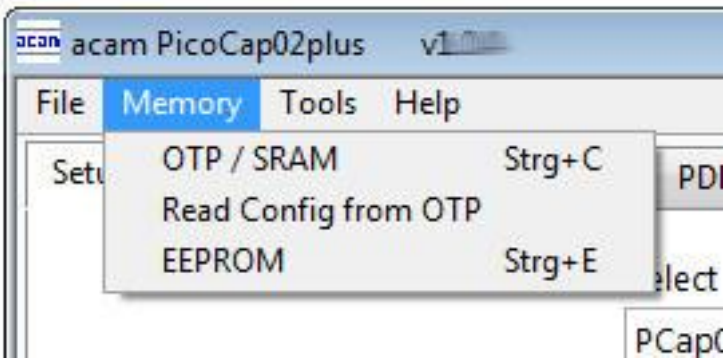


Figure 1-10: Memory Menu

OTP / SRAM	Opens the window to download the firmware. (section 3.5.1.)
Read Config from OTP	Reads back the configuration information in the OTP.
EEPROM	Opens the EEPROM window (section 3.5.2)

1.4.3 Tools Menu

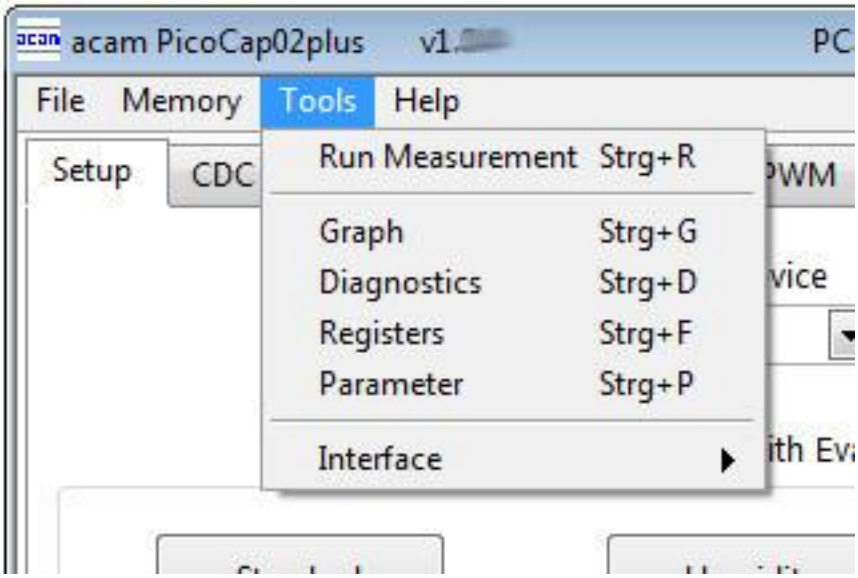


Figure 1-11: Tools Menu

Run Measurement	Start the measurement
Graph	Opens the window for graphical display of the various measurement results (section 3.5.4)
Diagnostics	Opens the window for numerical display of the various measurement results (section 3.5.3)
Register	Opens the Register window (section 3.5.5)
Parameter	Opens the Parameter/Calibration window (section 3.5.6)
Interface	Select between SPI and I2C interface

1.4.4 Help Menu

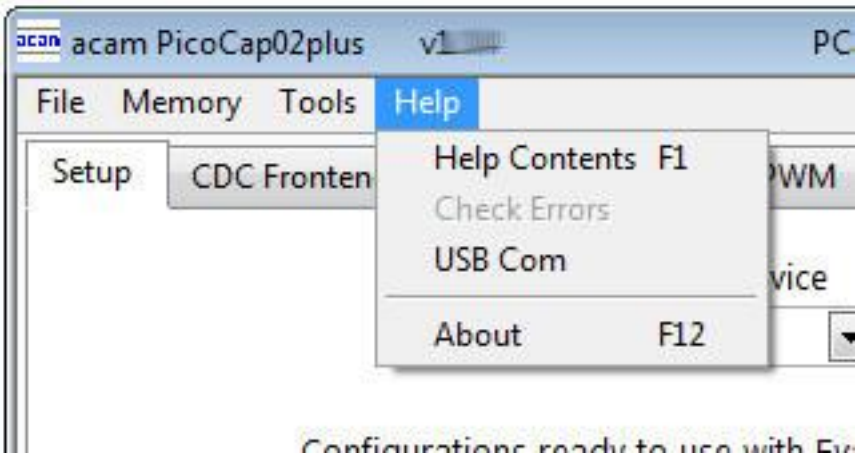


Figure 1-12: Help Menu

Help Contents	Opens the help window
Check Errors	Opens the error message window if there is an inconsistency after plausibility check.
USB Com	Opens the USB Communications window with PicoProg V2.0 Settings and the possibility to send opcodes
About	Version

After each change in settings, the evaluation software automatically performs a plausibility check in the background. If a setting is not allowed or doesn't fit with the setting of the other parameters, the faulty setting is highlighted in red color.

For example, changing TDC_MR2 into MR2 shows following window:

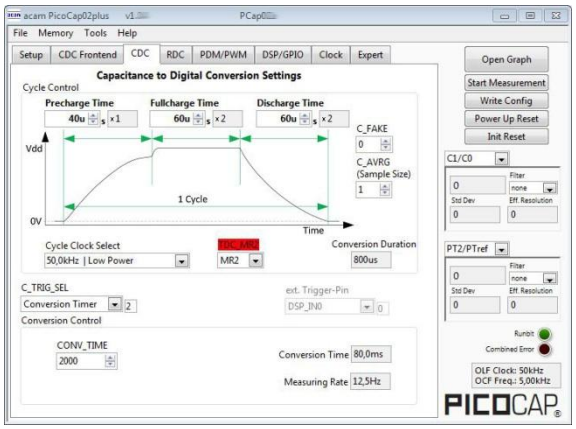


Figure 1-12b: Error Message MR2

New Feature

Highlighted parameter: What doesn't fit with the setting of the other parameters? If you want to know, please open the window under *'Help'→'Check Errors'*.

Figure 1-12c: Error Message

Explanation: Measurement range 2 requires the high frequency clock.

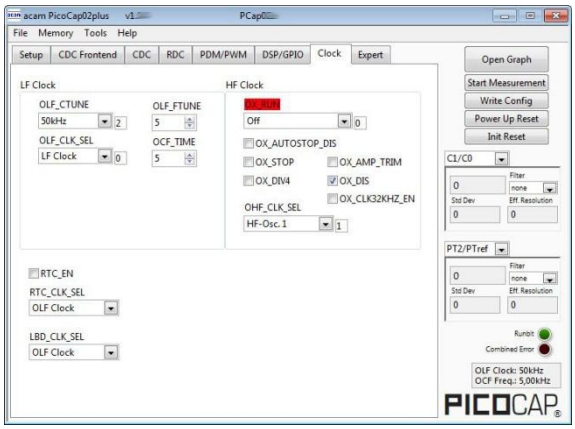


Figure 1-12d: Error Message OX_RUN

Solution: Turn HF clock on, then the highlighting disappears.

New Feature

1.5 Special Windows

1.5.1 SRAM/OTP Communications Window

In the 'SRAM/OTP Communications' Window the write data can be edited.

If the SRAM or OTP is read ('Read SRAM' or 'Read OTP' buttons), the content is automatically compared with the 'Write Data' window content. If contents are equal this will be indicated by a green illuminated LED.

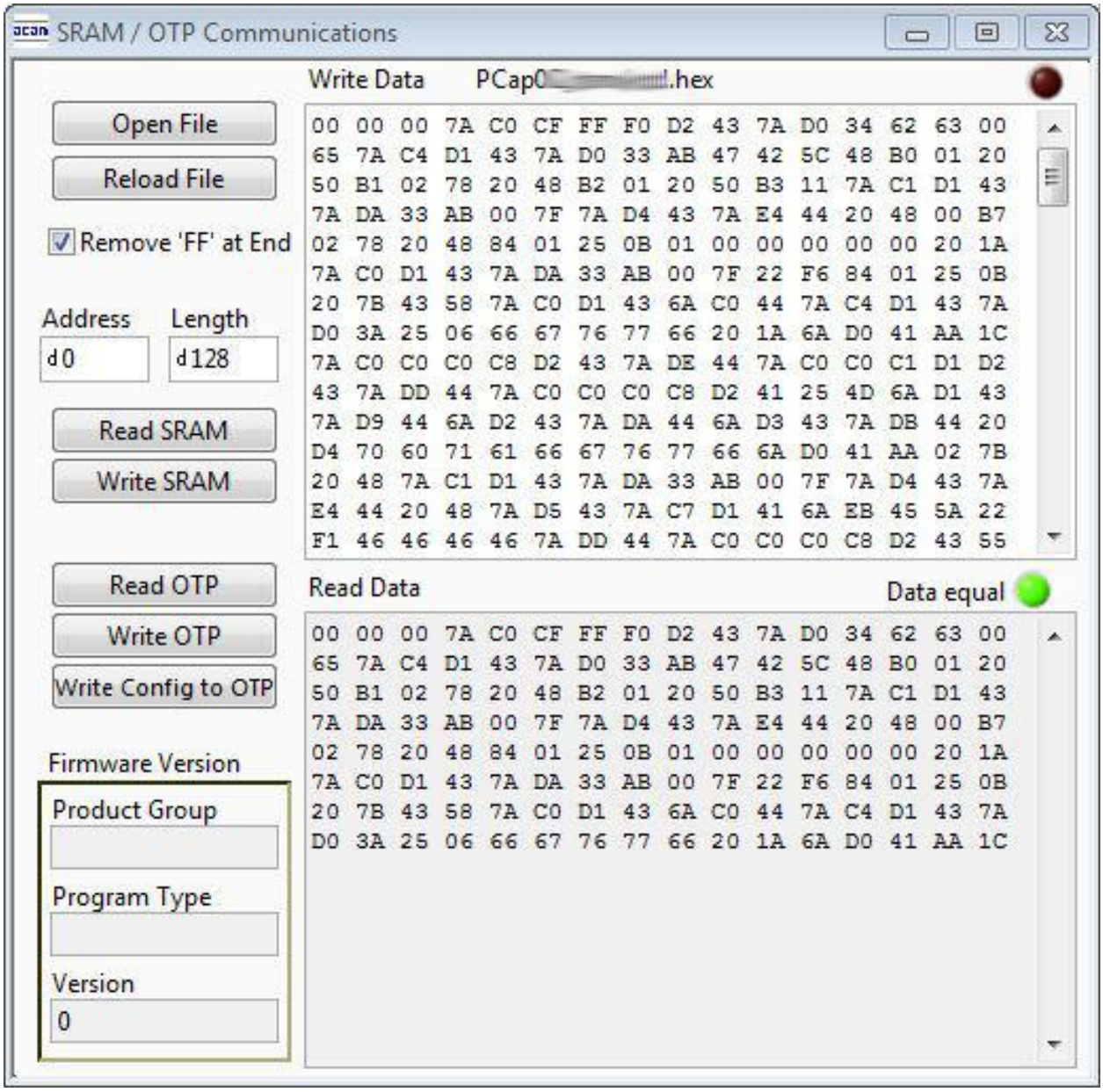


Figure 1-13: SRAM/OTP Communications

Open File	Select and open a firmware file (.hex). The content is shown in the 'Write Data' window.
Reload File	Reload the last opened firmware file (.hex). The content is shown in the 'Write Date' window again.
Read SRAM	Pressing this button, the content of the SRAM is read and shown in the 'Read Data' window. In 'Address' and 'Length' you can specify how many bytes you want read, starting at which address.
Write SRAM	Writes the firmware into the chip's SRAM. The status of the write process is indicated by the green bar. The successful end is indicated by a pop-up window. For verification we recommend to read back the SRAM afterwards and compare it with the source.
Read OTP	Pressing this button the content of the OTP is read and shown in the 'Read Data' window. In 'Address' and 'Length' you can specify how many bytes you want read, starting at which address.
Write OTP	Writes the firmware into the chips OTP. Attention: This option should be used only if you really want to test the OTP functionality. The status of the write process is indicated by the green bar. The successful end is indicated by a pop-up window. For verification we recommend to read back the OTP afterwards and compare it with the source.
Write Config to OTP	Writes to current content of the configuration registers into the reserved OTP space.
Firmware Version	In the firmware, a specific address is reserved to save 3 byte information about the application and the version of the software. The coding is specified in the header file of the supported PICOCAP device, for example: *PCapO1a.h* . The header file is found in the library directory of the assembler.

1.5.2 EEPROM Window

New Feature

The EEPROM provides the possibility to store data like linearization coefficients, division steps, alert levels etc.. This way, one and the same firmware can be used for various types of sensors.

The EEPROM data are part of the project file. After opening a project, the EEPROM data need to be written manually. Therefore please open the "Memory / EEPROM" menu and then press "Write".

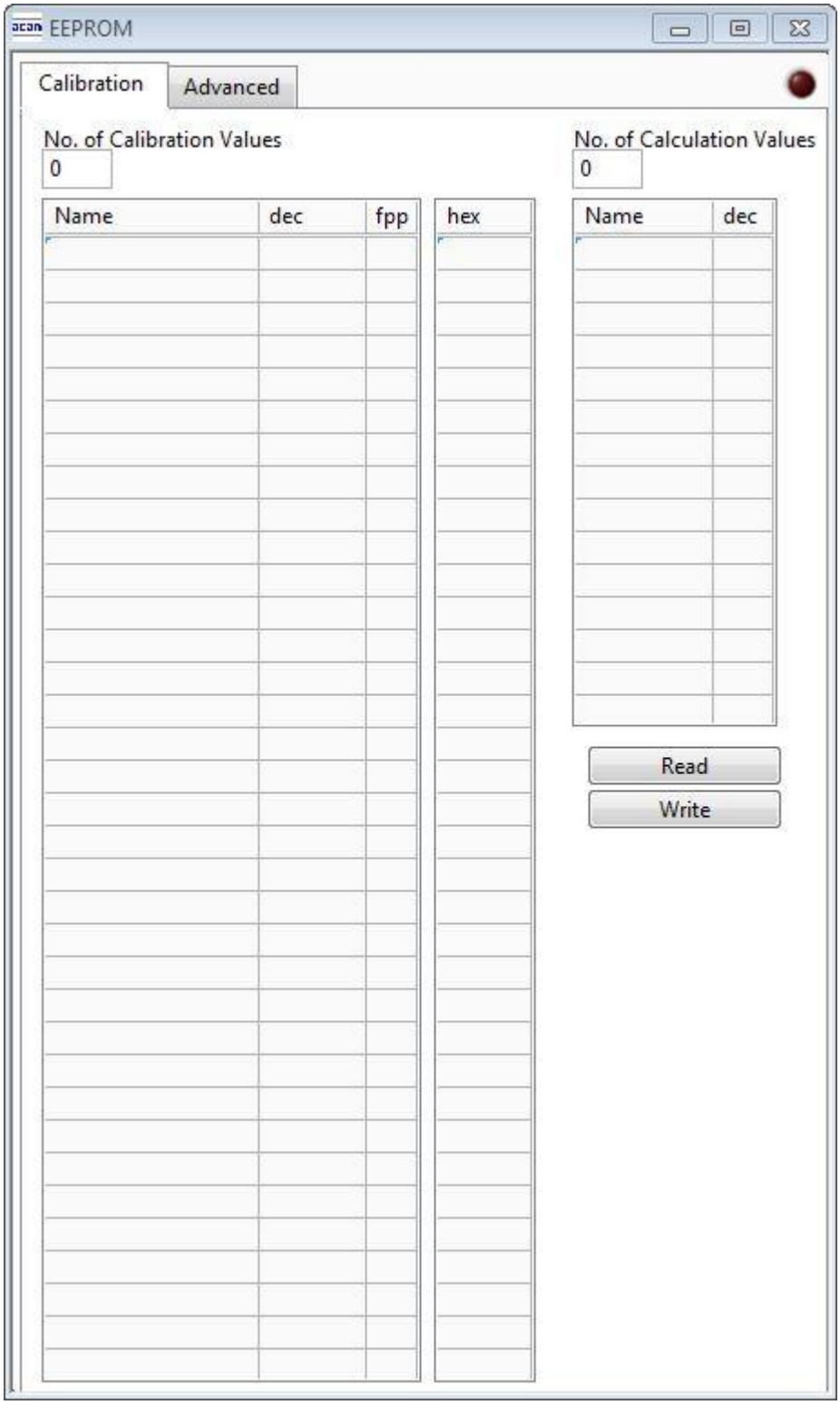


Figure 1-14: EEPROM Window

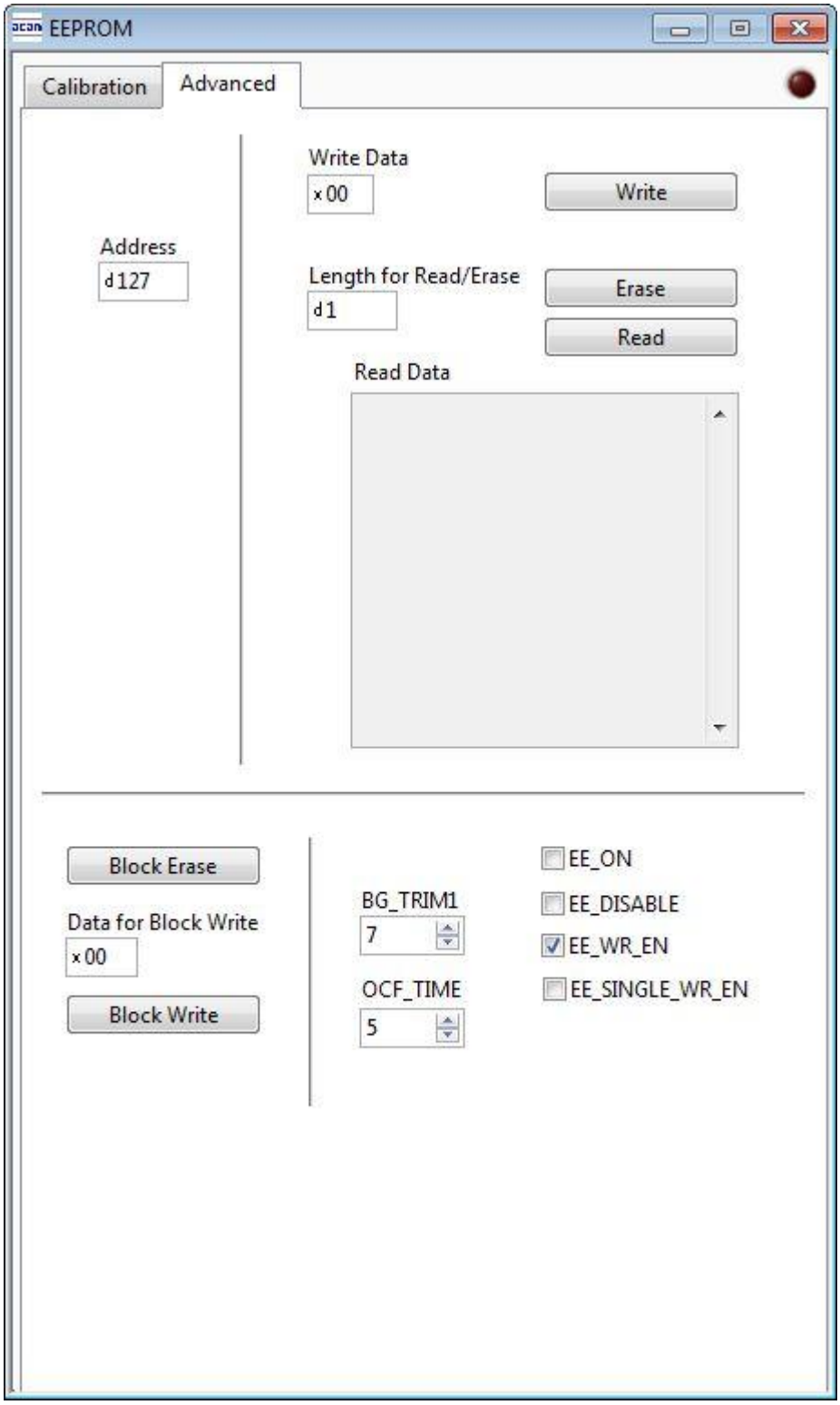


Figure 1-15: EEPROM Window

1.5.3 Diagnostics Window

Diagnostics

#	Name		Results		Shift	Factor	Offset		Span	Final Result	Mean 20	Std Dev	SNR [bit]
0	MW0	<47..0>	00F319	U	0	1	0	AO	1	62,233k	62,225k	10,8385	-3,438
1	C1/C0	<47..0>	1FEE3A	U	-21	1	0	AO	1	997,83m	997,735m	187,664u	12,38
2	C2/C0	<23..0>	203C06	U	-21	1	0	AO	1	1,00733	1,00734	209,913u	12,22
3	C3/C0	<23..0>	203463	U	-21	1	0	AO	1	1,00639	1,00665	213,548u	12,19
4	C4/C0	<23..0>	000000	U	-21	1	0	AO	1	0	0	0	Inf
5	C5/C0	<23..0>	000000	U	-21	1	0	AO	1	0	0	0	Inf
6	C6/C0	<23..0>	000000	U	-21	1	0	AO	1	0	0	0	Inf
7	C7/C0	<23..0>	000000	U	-21	1	0	AO	1	0	0	0	Inf
8	PT0/PTref	<23..0>	000000	U	-21	1	0	AO	1	0	0	0	Inf
9	PT1/PTref	<23..0>	000000	U	-21	1	0	AO	1	0	0	0	Inf
10	PT2/PTref	<23..0>	1A0991	U	-21	1	0	AO	1	813,668m	813,71m	55,3413u	14,14
11	FR11	<23..0>	0062AD	U	0	1	0	AO	1	25,261k	25,2602k	3,86992	-1,952

Figure 1-16: Diagnostics Window

The 'Diagnostics' window is used for real-time numerical display of the measurement results. In principal it shows the content of the read registers. The content itself depends on the firmware. Figure 1-16 shows the content as it is given with the standard firmware. The first eight rows show the capacitance ratios, the last two rows show the temperature result (resistance ratio or linearized temperature).

The 'Diagnostics' window has 12 columns of information, defining labels, data format, resolution specification (white background) and results (grey background). The information in the white fields increase convenience of reading and is stored in the project files (*.prj). All number may get a character to indicate the well-known prefixes for denoting the factor in thousands ('p', 'f', 'a', 'k'...).

Name	Label for the register content, depends on the firmware.
Results	Raw hex data display of the result register content. The column before shows the width. The button column after shows whether the result is signed or unsigned.
Shift	This column shows the size of the fractional part of the fixed point number and the necessary shift. Depends on the firmware.
Factor	The factor is a scaling factor that allows to scale the result according to the reference capacitor. Factor = '1' gives back the initial capacitance ratio in column 'Final result'.
Offset	Offset to be added or subtracted in the evaluation software.
Span	Number that defines the maximum span of the sensor. Is relevant only for the calculation of the resolution in column SNR [bit].

Final Result	Display of the final result, scaled by 'Factor' and the 'Offset' added.
Mean	Display of the mean value. The sample size can be selected.
Std.Dev	Standard deviation of the 'Final Result'.
SNR [bit]	Signal-to-Noise ratio in bit, calculated as 'Span'/ 'Std.Dev.'

1.5.4 Graph Window

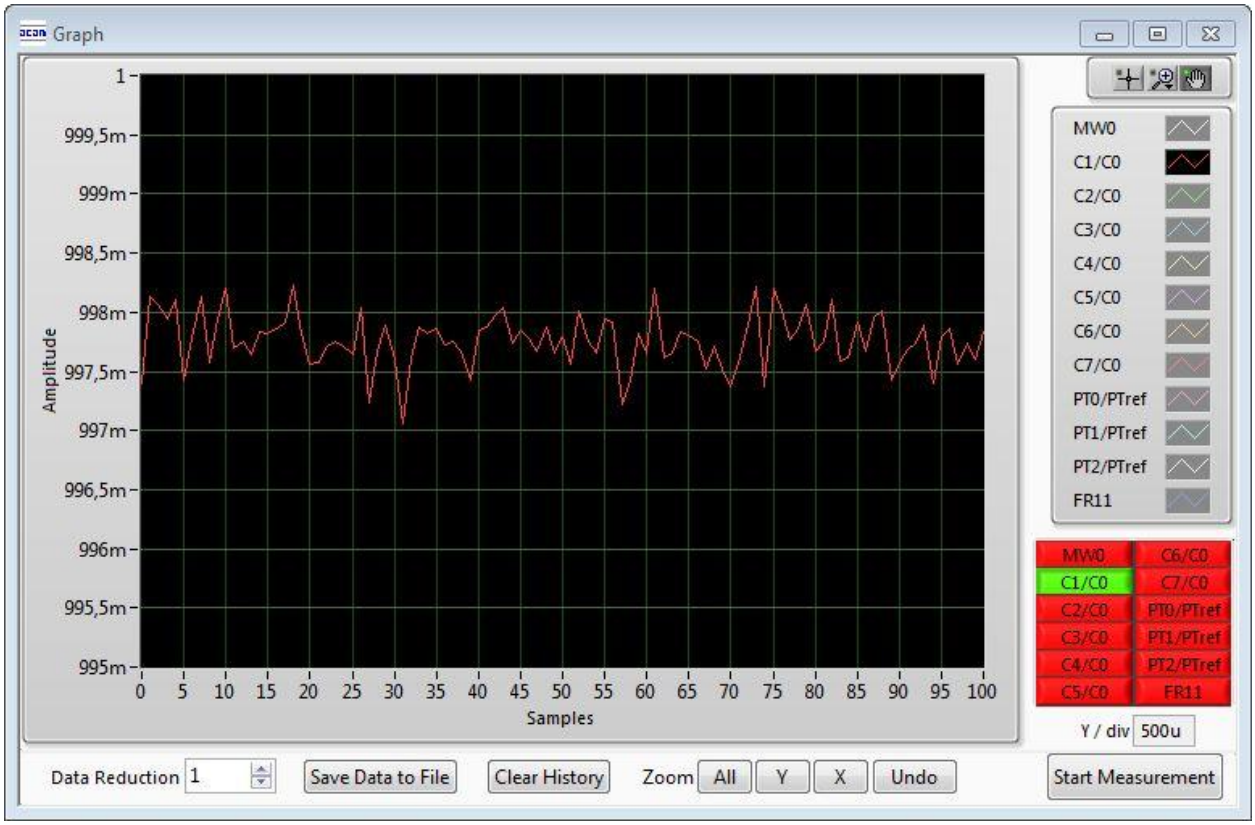


Figure 1-17: Graph Window

The data to be displayed are selected in the field at the bottom right. The labels in the buttons are the same as in the diagnostics window. To display data press the corresponding button so that it gets green. Top right of the 'Graph' Windows are various options for automatic zoom in/out, center or scale in other ways. Below the graph are various automatic zoom functions for the x-axis and the y-axis.

Y-Zoom will be chanced with the keys [+], [-] and X-Zoom with the keys [*], [/]. With the cursor control keys [←], [→], [↑], [↓] is it possible to move the graph.

New Feature

The data displayed can be stored into a text file. For long-term investigations it is possible to reduce the data displayed and stored. The field 'Data Reduction' allows to define the level of data reduction.

1.5.5 Registers Window

These windows display the configuration data in hexadecimal format as they are currently used. Also the result registers' content is shown in hexadecimal format, but updated only when the button is pressed. Finally, the various status bits are shown.

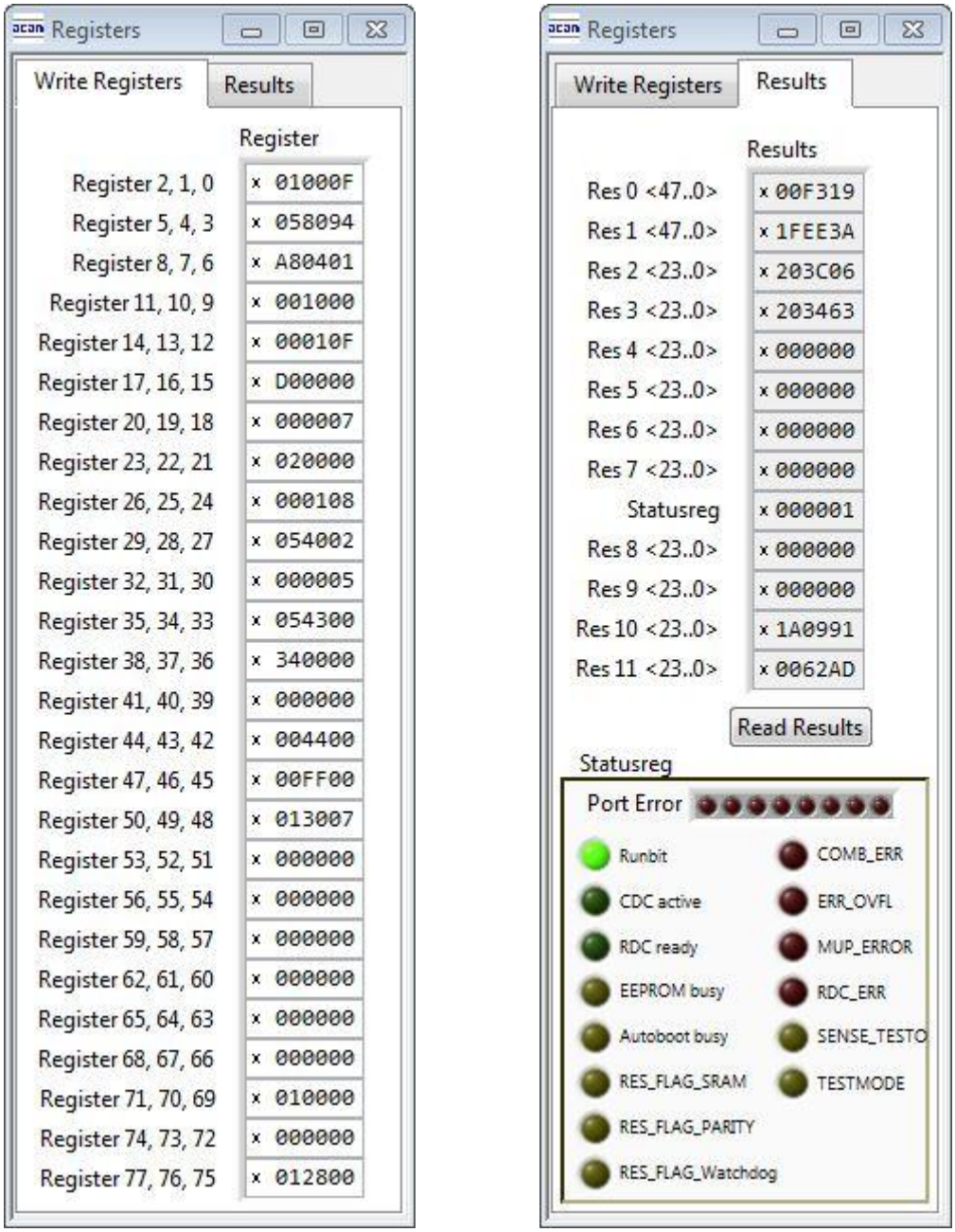
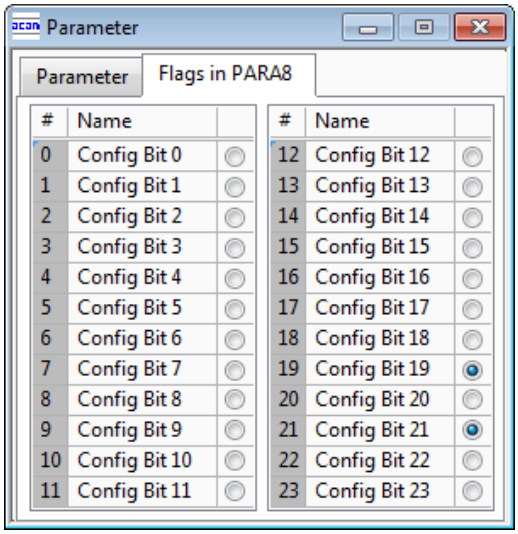


Figure 1-18: Write and Read Registers

1.5.6 Parameter Window

This window shows the content of the parameter registers. The meaning of the content strongly depends on the firmware.

The parameter registers are used e.g. to scale the pulse output interfaces, to set the gain correction factor or to tell the firmware whether differential sensors are used.



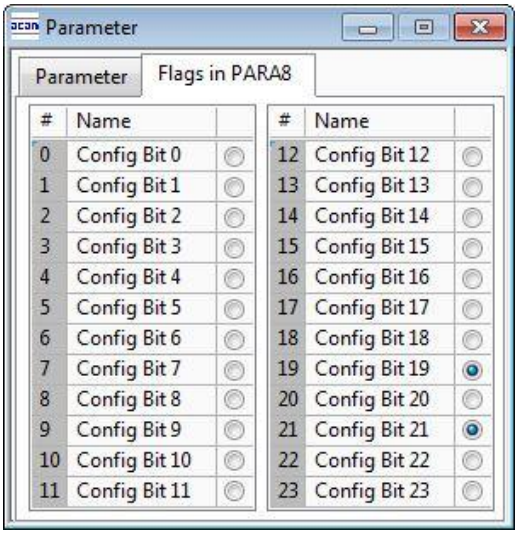


Figure 1-19: Parameter Window

1.6 First Measurement: Step-by-Step

New Feature

Configuration files, Firmware, Settings and EEPROM data are subsumed in a project file. When opening a project file then automatically the configuration and firmware data will be transferred to the chip and the chip is initialized.

Step 1: The first to do after starting the evaluation software is to select the supported PICOCAP device on the setup page. In the initial phase start with our standard firmware that calculates the capacitance ratios and resistance ratios. It automatically recognizes the operation mode and takes care of the set number of capacitors and the kind of connection. But it does no further processing.

Step 2: If you want to change from the default SPI to I2C interface, please select under *Tools → Interface → I2C*. The LED on the PicoProg V2.0 programmer should now turn red. When the LED does not glow at all, then it indicates that the interface is faulty.

Step 3: By pressing the 'Standard'-button, the standard project file will be open. That means the standard firmware is loading into the SRAM of the device and loads the configuration file. The project file contains the configuration and parameter registers content and the settings of the Evaluation software.

You also may load your own project file. In case the project uses the EEPROM it will be necessary to open the EEPROM window and press 'write' to write the EEPROM data into the chip.

Step 4: Open Graph window and press 'Start Measurement'.

2 Miscellaneous

2.1 Literature Guide

Data Sheets

Title	Document-No
PCapØ2A Single Chip Solution for Capacitance Measurement Volume 1: General Data and Front-End Description	DB_PCapO2A_Vol1_en.pdf
PCapØ2Ax-DSP Single Chip Solution for Capacitance Measurement Volume 2: Digital Signal Processor	DB_PCapO2A_Vol2_en.pdf
PCapØ2-EVA-Kit Evaluation System for PCapØ2	DB_PCapO2-EVA-Kit_en.pdf
PCapØ2plus Evaluation Software for PICOCAP Devices	DB_PCapO2plus_en.pdf
PCap Assembler Assembler Software for PICOCAP Devices	DB_PCap-Assembler_en.pdf

White Papers

Title	Document-No

Application Notes

Title	Document-No

The latest versions of the available documents can be downloaded from the acam website at:

http://www.acam.de/download-center/picocap

2.2 Document History

19.01.2013	First release

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