SERMA
PRODUCTIVITY ENGINEERING

Documentation

GUI EVA5004 User Guide

Table of Content

1 Revision History

Version	Date	Changes	Page
Initial Version V1.0	01/2010		
V1.1	03/2010	Changes for new PE5004	
V2.2	11/2010	Addet Point 6 “Configuring PE5004 for proper Sensor Readout”	

2 Overview

The EVA5004 is especially designed to evaluate the PE5004 Capacitive Sensor Matrix Control IC of Productivity Engineering GmbH featuring for very fast stimulating and reading of capacitive sensor arrays and self capacitance sensors. A number of up to 100 sensors per chip can be selected by user, multiple sensor arrays can be cascaded.

The EVA5004 serves as a demonstrator and evaluation kit with these features:

- First PE5004 for board sensors
- Second PE5004 for external user defined sensors
- USB communication to PC per human protocol interface
- 2 x OLED from Novaled
- µC CY7C64356 (firmware for EVA5004 board)
- Display S64128K from Displaytech
- 8x7 Touch Matrix (extern 10x10)
- Detailed representation of data in various windows on PC with graphical view
- Save and load of presets

Evaluation Kit PE5004 v1.1

3 Controlling software „EVA5004“

3.1 Installation

The software to control the EvaBoard a PC is a simple executable which don’t needs to be installed separately, just run the actual downloadable version EVA5004_V2.x.exe

The EVA5004 comes with a graphical user interface for WindowsXP ™ platforms. It is recommended to start with this simple software interface to learn about the basic functionality of the chip on the board.

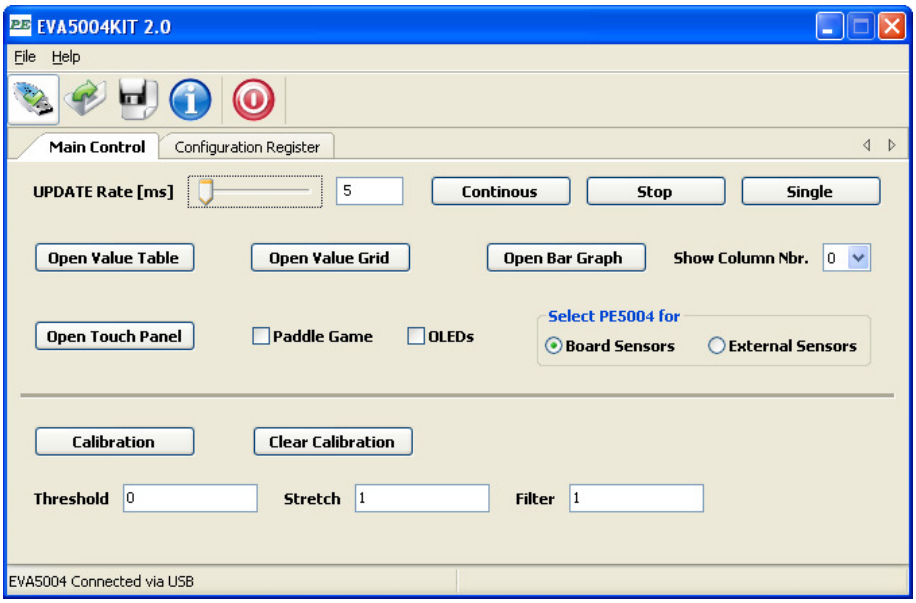
For the operation of the software the USB Human Interface Device (USB-HID) is required, these driver is a part of for WindowsXP ™ platform.

For more precise display of graphs it is recommended to use the Windows XP-Design

(Control panel->View->Designs)

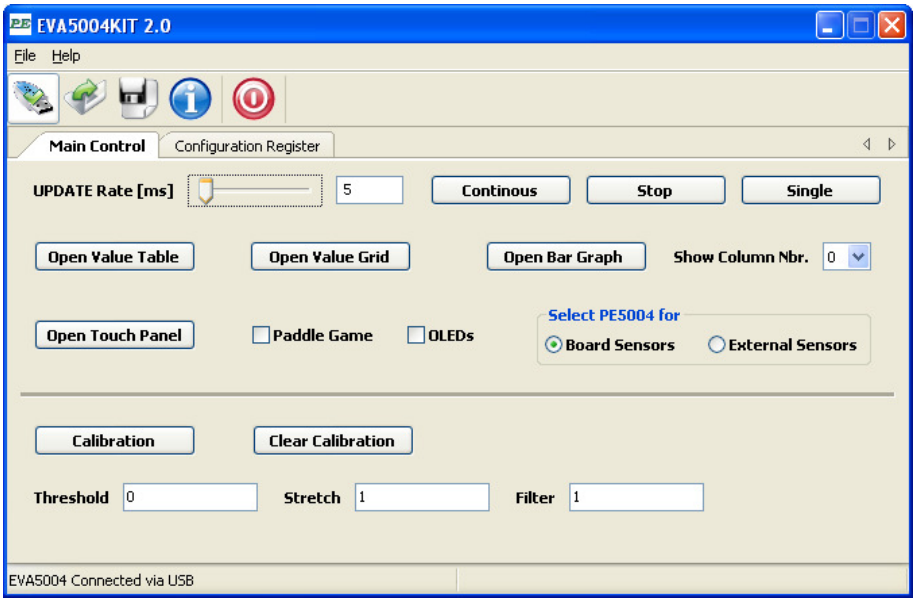
3.2 Software description – Connect EvaKit to USB device

After starting the software (over “Start” Menu) it is necessary to connect EvaBoard. For this action the menu **"File"** → **"Connect"** or the icon should be used. After connection it is possible to disconnect the EVABORD with the same buttons.



3.3 Software description – Main Control

The tab Main Control shows all functions to use the software and the EvaKit. The functions on these tab manipulate the board directly and set showable frames with configured register. With load preset on menu “File” → “Load Preset” or icon load preset it is possible to load self defined and saved presets (“File”→”Save Preset” or icon save preset).

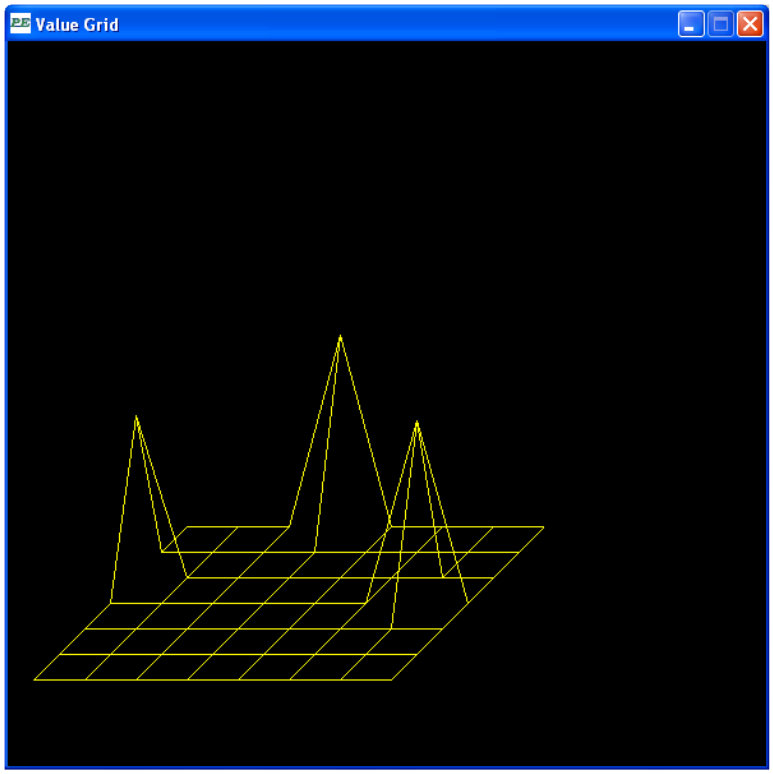


Update Rate [ms] Slider, Text	- Set the time between data transfer to PC in continuous mode
Continuous button	- Start the sensoring cycle continuously on EvaBoard
Stop button	- Stop sensoring mode on EvaBoard
Single button	- Start the sensoring mode for one cycle
Open Value Table button	- Open a window with value table
Open Value Grid button	- Open a window with graphical display of value grid
Open Bar Graph button	- Open a window with bar graph display for selected Column
Show Column Nbr coice	- Select displayed column number in Bar Graph window
Open Touch Panel button	- Open a window with touch points as display
Paddle Game check box	- Select pin pong game on Touch Panel
OLED check box	- Select the OLED sensors on EvaBoard
Select PE5004 radio box	- Select the used PE5004 on EvaBoard for internal or external sensors

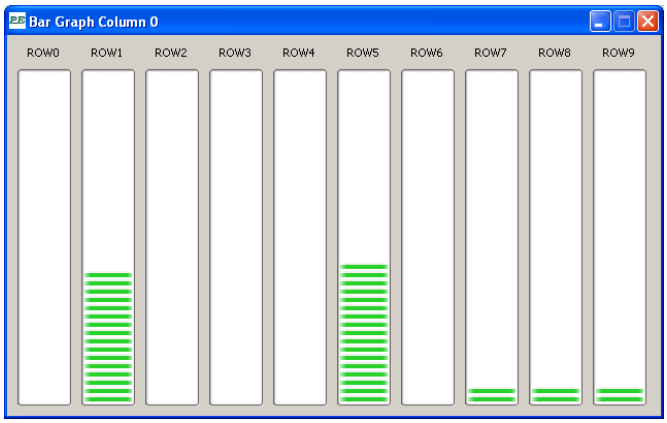
All functions on used windows will be started with Single or Continuous button.

Value Table uses 10 columns and 10 rows for External Sensors and 9 columns and 8 rows for Internal Sensors (matrix field). Start and End rows/columns are also selectable. Column 1, 2 and row 0 are used when OLEDs selected.

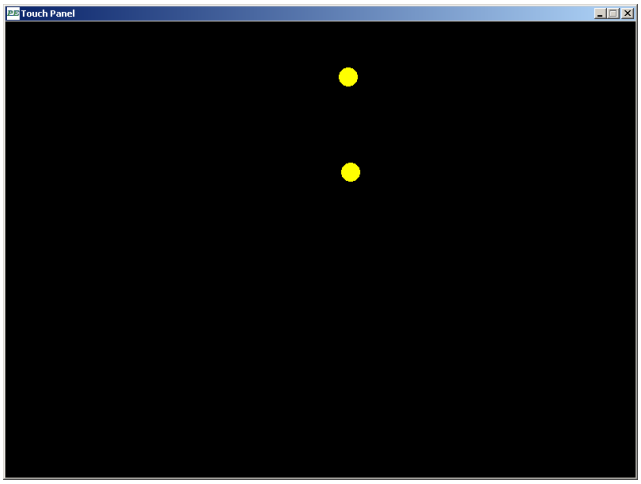
Value Grid. The calibration function and the invert check box shows various presentations.



Bar Graph shows bar graph of selected column



Touch Panel with multitouch points. It is necessary to calibrate the board to use this Window.

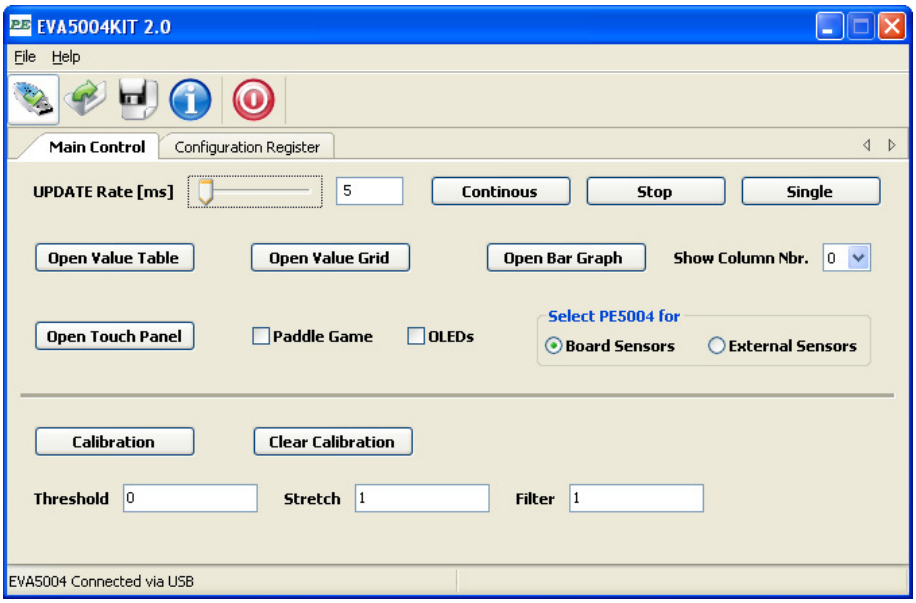


Touch Panel with paddle game. It is necessary to calibrate the board to use this Window.

To play the game use the left and right vertical sensor line on EvaBoard (shift up and down) in continuous mode.

3.4 Software description – Main Control Calibration

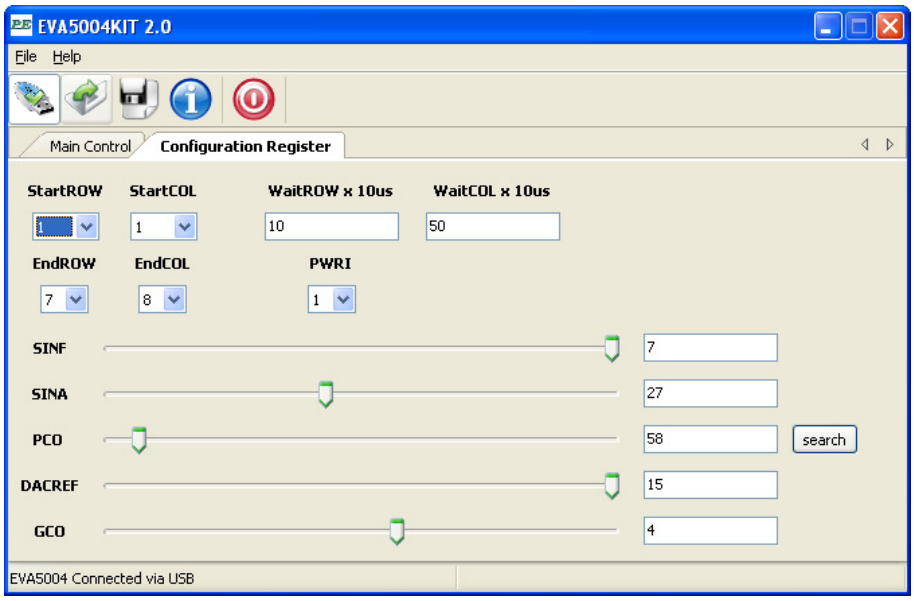
The tab Main Control shows all functions to use the software and the EvaKit. Under a gray line the calibration functions are defined. After a swap between OLEDs, Board Sensors and External Sensors, the calibration should be carried out again.



Calibration button	- Start a self calibration function and set all necessary registers - This is a white balance function for display in Touch Panel and Value Grid
Clear Calibration button	- Clear all variables of calibration for white balance
Threshold text	- Set the threshold variable for Touch Panel and Value Grid
Stretch text	- Set the stretch variable for Touch Panel and Value Grid
Filter text	- Set an average for Touch Panel and Value Grid

3.5 Software description – Configuration Register

To manipulate the configuration register of EvaBoard the tab **"Configuration Register"** can be used.



StartRows choice	- Select the start number of used rows to sense
StartCol choice	- Select the start number of used columns to sense
EndRows choice	- Select the end number of used rows to sense (7 on EvaBoard)
EndCol choice	- Select the end number of used columns to sense (8 on EvaBoard)
WaitROW text	- Select the number of wait cycles between every row in 10µs cycles
WaitCOL text	- Select the number of wait cycles between every column in 10µ cycles
PWRI choice	- Select power mode of IU converter
SINF slide, text	- Frequency of sine generator in MHz
SINA slide, text	- Amplitude of sine generator in mV
PCO slide, text	- Phase shifter value
DACREF slide, text	- Digital analog converter reference value
GCO slide, text	- Gain value of IU converter
Search	- Auto search of best PCO value

4 Introduction of EVA5004 Hardware

Features PE5004:

- Suitable for two capacitive measurement styles:
  - Sensing of small capacity changes in 10x10 mutual capacitance sensor arrays
  - Sensing of self capacitance approximation and touch sensors
- Controllable stimulation for wide spread of suitable sensor capacitance, layout and material
- Highly sensitive, coatings of over 30mm for self capacitance sensors possible
- Very low acquisition time of 15ms for 100 sensors in a matrix
- High resolution of 10bit for each sensor
- Sleep mode with programmable wake up intervals
- Low operating current (< 3mA at max. speed)
- Low-Power Mode for large Sensor shapes
- Very low standby current during sleep (1µA)
- Programmable Number of Sensors for optimal acquisition time and current consumption
- No need for grounding of scanned object
- No need for sampling capacitors or external resistors
- High sensitivity to large parasitic capacitances
- Very robust against noise
- Temperature drift compensation
- Multiple sensor arrays and PE5004 chips controllable with one µC:
  Up to 700 sensors through I²C, up to 2000 sensors through SPI

4.1 PE5004 General Description

The PE5004 is a high precision capacitive sensing circuit which uses amplitude modulation for very fast stimulating and reading of capacitive sensor arrays and self capacitance sensors. A number of up to 100 sensors per chip can be selected by user, multiple sensor arrays can be cascaded. By implementing a controllable sinusoidal generator with a wide range of frequencies and amplitude the spectrum of suitable sensor capacitance is significantly increased for a large range of applications. The implemented DAC with variable reference voltages guaranties proper function over varying environmental conditions and provides digital controlled self calibrating capability. For low power operation a sleep mode with ultra low standby current and programmable wake-up intervals is implemented. Additionally Power consumption of internal Blocks can be programmed to a third of normal if full 10bit-Resolution is not necessary or large Sensor shapes are used. By means of a multimaster I²C interface several detector circuits can be controlled by one MCU.

5 Description of EvaBoard

The EVA5004 is especially designed to evaluate the PE5004 Capacitive Sensor Matrix Control IC of Productivity Engineering GmbH featuring for very fast stimulating and reading of capacitive sensor arrays and self capacitance sensors. The EvaBoard serves as a demonstrator and evaluation kit with these features:

- First PE5004 for board sensors
- Second PE5004 for external user defined sensors
- USB communication to PC per human protocol interface
- 2 x OLED from Novaled
- µC CY7C64356 (firmware for EVA5004 board)
- Display S64128K from Displaytech
- 10x10 Touch Matrix
- Detailed representation of data in various windows on PC with graphical view
- Save and load of presets

This board can be used as stand alone board with separate functions and a calibration over the GUI software. Or it is usable fully with the GUI software with USB connection.

The structural description of the EvaBoard is shown in a separate file.

6 Operation on GUI software

6.1 Using software for PC-EvaBoard interaction

Essentially steps to use the EvaBoard on PC:

- Connect the EvaBoard via USB on PC
  - If this is the first connection a new USB-HID will be installed
- Start the software “EVA5004_V2.x.exe”
- Connect the EvaBoard with software
  - Connect icon
  - File → Connect
- Optional – load preset configuration
  - Load icon
  - File → Load Preset
  - If no correct file is usable the default values will be loaded

Value Table usability:

- Click button “Open Value Table”
- Click “Continous” to start sensing
- Touch on sensor matrix of EvaBoard
- A “Calibration”, Threshold, Stretch and/or Filter variation show the functional effects on table and displays variants of implementations

Value Grid usability:

- Click button “Open Value Grid”
- Click button “Calibration”
- Click “Continous” to start sensing
- Touch on sensor matrix of EvaBoard
- Threshold, Stretch and/or Filter variation show the functional effects on table and displays variants of implementations
- On tab “Configuration Registers” the sensitivity is controllable and is shown directly in windows
- Optional: load “ConfigMatrix.txt”, all calibration and opening of needed Windows is done automatic

Bar Graph usability:

- Select number of “Shown Column Nbr.”
- Click button “Open Bar Graph”
- Click “Continous” to start sensing
- Slide over selected column on sensor matrix of EvaBoard
- A “Calibration”, Threshold, Stretch and/or Filter variation show the functional effects on table and displays variants of implementations

Touch Panel usability:

- Click button “Open Touch Panel”
- Click button “Calibration”
- Click “Continous” to start sensing
- Touch on sensor matrix of EvaBoard, multitouch is possible
- Threshold, Stretch and/or Filter variation show the functional effects on table and displays variants of intensitations
- Optional: load “ConfigTouchDetection.txt”, all calibration and opening of needed Windows is done automatic

Paddle Game usability:

- Click button “Open Touch Panel”
- Select “Paddle Game”
- Click button “Calibration”
- Click “Continous” to start sensing
- Touch on sensor matrix of EvaBoard, left half for player 1, right half for player 2
- Threshold, Stretch and/or Filter variation show the functional effects on table and displays variants of intensitations
- Optional: load “ConfigPaddle.txt”, all calibration and opening of needed Windows is done automatic

Stop and **Single** usability:

- To stop sensing on EvaBoard click button “Stop”
- A single sense is possible by touching the sensing matrix and click “Single”

Select PE5004 for usability:

- If an external sensor is designed for the EvaBord (user specific definitions) it is possible to switch to this option by selection of “external Sensors”. All internal sensor function are deselected at this moment
- By default “Board Sensors” are selected

Save PE5004 Preset usability:

- After all configurations and probing of functions a saving of presets is possible
- Select “File” → “Save Preset” or click on icon save preset

6.2 Using software only for register calibration on EvaBoard

For a detailed configuration of internal PE5004 register the configuration function is possible.

Essentially steps to use the EvaBoard on PC:

- Connect the EvaBoard via USB on PC
  - If this is the first connection a new USB-HID will be installed
- Start the software “EVA5004_V10.exe”
- Connect the EvaBoard with software
  - Connect icon
  - File → Connect
- Optional – load preset configuration
  - Load icon
  - File → Load Preset
  - If no correct file is usable the default values will be loaded

Configuration Register usability:

- Click on tab “Configuration Register”
- Select various register configurations via slider or text field and show results on EvaBoard
- For the PCO-register is automatically a good value to be set using the search button

Load PE5004 Preset usability:

- To use a predefined register configuration it is possible to load a saved preset
- Select “File” → “Load Preset” or click on icon load preset

Save PE5004 Preset usability:

- After all configurations and probing of functions a saving of presets is possible
- Select “File” → “Save Preset” or click on icon save preset

6.3 Using only EvaBoard

The GUI software is not necessary to use EvaBoard internal functions. The function of EvaBoard is shown on display and is described in separate file.

7 Configuring PE5004 for proper Sensor Readout

Software versions 2.3 and newer are preconfigured for use with the on board sensor matrix. After every start of the software it is sufficient to open the Value Grid ore Value Table and press the continuous button.

The PE5004 features a lock in amplifier, if the phase shift is not canceled (PCO Value) the sensing will not work!

Therefore, if external Sensors are used the sliders in the “Configuration Register” tab must be adjusted. It is also recommendable to try different settings with the on board matrix to get familiar with the configurations and their impact on the sensor signal.

Important difference between On Board and external Sensors:

The GUI is designed to process full 10Bit Sensor data. The on board matrix is only read out with 8 Bit as this is sufficient enough for the application. To prevent distortion in display of the data a “Stretch” factor of 4 shall be used when not calibrated.
When using external Sensors full 10Bit Sensor data is transferred via USB. A Stretch factor of 1 leads to natural resolution.

1. In “Main Control” choose continuous button and open “Value Grid”
   (make sure that threshold is “0”, and stretch on “4” for board or “1” for external sensors)
2. Got to “Configuration Register” set SINF, SINA and DACREF to max, GCO to 4
3. Set StartROW, StartCOL, EndROW, EndCOL according to the sensor Layout, if you not shure what values fit set all Start to 0 and all End to 9
4. Increasing PCO slider slowly starting from approx. 20 up to 300; there will appear a maximum of the sensor grid at some point, this is the optimal value for phase shift canceling
5. If you exceed the maximum range (whole grid is plain at the top or all values in “Value Table” are at 1023) decrease SINA and start at Point 4. again.

If using very small sensor capacitances, the measured sensor Data can even with the correct PCO value and with maximum SINF and SINA be very low. By decreasing the DACREF value the upper reference voltage of the internal ADC is lowered, leading to a higher sensitivity but also to a higher impact of noise. The minimum recommended DACREF value is 3, lower values may need more settling time which makes it necessary to increase the WAITROW value.

8 Notes

9 Contact

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