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Preliminary Datasheet

PCapØ1-EVA-KIT

Evaluation System for PCap01A

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1 Introduction

1.1 General

The PCapØ1 EVA-KIT evaluation system provides a complete system for generally evaluating the PCapØ1 chip. It comprises of a main board, a plug-in module, a Windows based evaluation software and the PICOPROG programming device. The PCapØ1 -EVAL system is connected to the PC's USB interface through the PICOPROG V2.0 programming device.

The evaluation kit offers user friendly configurations for evaluating the PCapØ1single chip solution for capacitance measurement. This kit can be used to evaluate the capacitance measurement, temperature measurement and the pulse generation capabilities of the PCapØ1 chip.

For a proper use of the evaluation system it is strongly recommended to refer to the current PCapØ1A datasheet. You can download this datasheet from www.acam.de/download-center/picocap.

1.2 Component List

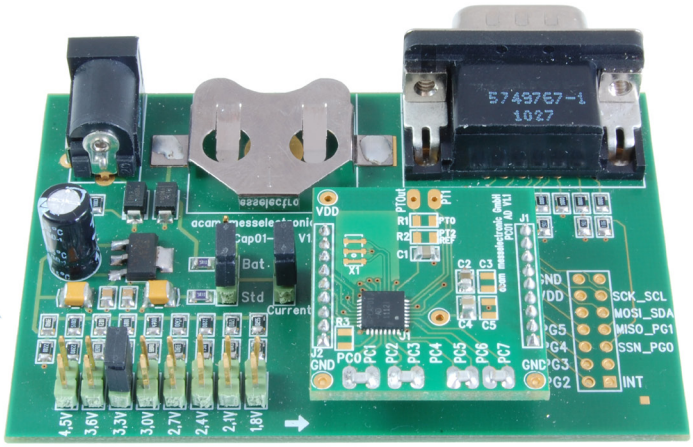
- PCapØ1-MB — Motherboard
- PC01-AD Plug-in module — Based on PCAp01-AD in QFN32 package
- PICOPROG V2.0 — Programmer
- High density DSUB15 cable — Connecting the Evaluation board to the programmer
- USB cable — Connects PICOPROG V2.0 to the PC
- Wall power supply — 9 V
- CD-ROM — Including software and data sheets

2 Connecting Capacitors and Resistors

This evaluation kit can be used for evaluating capacitance measurement by connecting capacitive sensors. Further, it can be used for evaluating temperature measurement by connecting external temperature sensitive resistors or for generating quasi analog voltage (pulse width/density modulated) that is dependent on the sensor connected to the system.

Depending on the purpose of evaluation, a modification has to be made to the same plug-in module. Following is a picture of the Mother board with the plug-in module.

Figure 2-1:

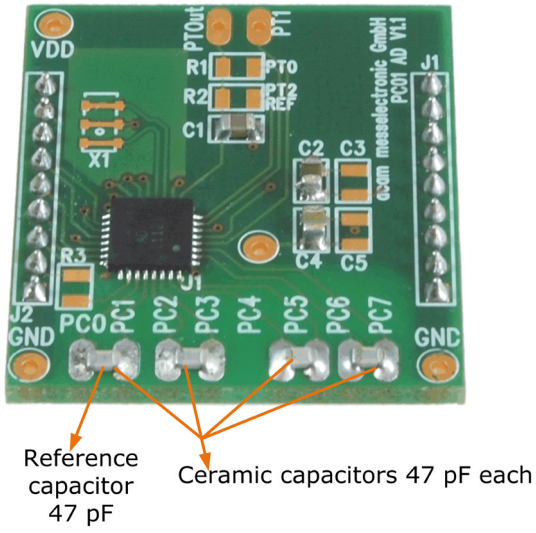


The following sections describe the modifications for each application in detail.

2.1 Capacitance Measurement

For the purpose of evaluating the capacitance measurement using PCapØ1, the plug-in module is pre-assembled with ceramic capacitors, to emulate capacitive sensors. These capacitors, each 47pF in value, are connected to the 8 ports PC0 to PC7. They are connected as single sensors in floating mode, i.e. each capacitor is connected between 2 ports, and thus there are 4 x 47 pF on-board capacitors. Please refer to Section 3.4 of the PCapØ1 Data Sheet for more idea on how to connect capacitors to the chip. The capacitor connected between ports PC0 and PC1 is taken as the reference capacitor.

Figure 2-2:



In the process of evaluation, when you are comfortable with interpreting the measurement results from the chip, these fixed capacitors can be replaced with the actual capacitive sensors of your application.

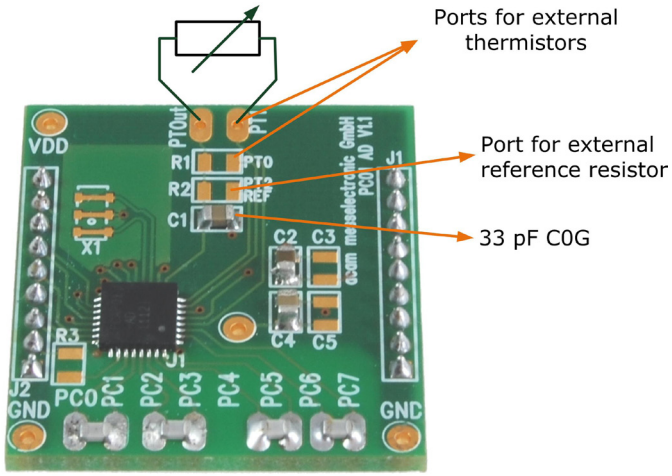
If you want to connect your capacitive sensors in Grounded mode, then GND points are provided at the two ends of the module, where the sensor ground connections ought to be soldered.

The typical value of the capacitive sensors that can be connected to the evaluation kit lies in the range of 30 pF to 3.5 nF. The reference capacitor should be in the same order of magnitude as the sensor. Depending on the value of the sensor, the value of the internal resistor for performing the measurement has to be selected. For the pre-assembled 47pF capacitors, an internal discharge resistor of 180kOhm functions well. See section 3.5 of the PCapØ1 data sheet on how to select the value of the internal discharge resistor.

2.2 Temperature Measurement

Temperature measurement or other resistive tasks may also be of interest for the user of this kit. The evaluation kit offers this possibility through the RDC (resistive-to-digital converter) ports. An on-chip thermistor coupled with an on-chip temperature-stable reference resistor made of polysilicon is sufficient for observing the temperature measurement capability of the PCapØ1 chip.

Figure 2-3:



However, there is a possibility to connect the reference resistor and the thermistor externally to the chip too. In case of external resistors, the temperature-stable reference resistor ought to be connected at port PT2REF on the plug-in module. The module allows you to connect the external thermistor used for temperature measurement at port PT0 or PT1.

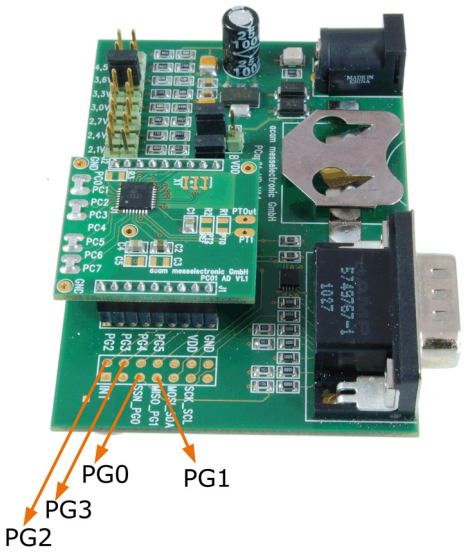
In any case, for the temperature measurement, an external capacitor 33 pF C0G has to be connected to the chip; it is already pre-assembled on board.

2.3 Pulse Code Generation

Any of the capacitance or temperature measurement results from the PCapØ1 chip can be given out as a pulse width modulated or pulse density modulated signal. This output can be filtered to generate an analog output signal that can be used for further controlling.

These pulse width or pulse density codes can be generated at Ports PG0, PG1, PG2 or PG3. Since ports PG0 and PG1 are used for the SPI Interface in the module, the hardware allows to get a valid pulse width/density modulated signal on PG2 or PG3. However, when I2C communication mode is used the pulsed signals can be optionally obtained on the ports PG0 and PG1.

Figure 2-4:



2.4 Motherboard

The motherboard connects to the PICOPROG programmer. It serves the various power options. It also supports a battery power option. There is a jumper 'Current' on the mother board. The current consumption of the PCapØ1 Chip during operation can be directly measured from these jumper terminals.

3 The PCapØ1 -EVA Software

3.1 Installing the PCapØ1 -EVA Software

The PCapØ1 -EVA software runs under the following operating systems

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

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. Please note as follows.

Installation on Windows 7 systems:

- Install the PCapØ1 Evaluation software from Software\ PCapØ1-Evaluation-Software\ setup.exe from the CD. This .exe file installs the evaluation software and the respective drivers for the Picoprog programmer too.
- At the end of step 1, a batch file comes up in a separate window. 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.
- On restart, launch the application from the start menu. The software opens and a pop up window asks to select between a 'Standard' mode and 'Humidity'. Please select 'Standard'.
- The LED on the Picoprog programmer will turn green. The software will initialize and then ask you to connect the evaluation board to the Picoprog programmer.
- Perform Verify Interface from the Eval.Software main window. If every is correctly installed, the verify interface must result in an 'Interface OK' message. Also, under Help -> Programmer -> hdlUSB -> USB0::0x194E::0x100B::NI-VISA ought to be seen.
- If you want to change from the default SPI to I2C interface, please select under Tools -> Interface -> I2C interface. The LED on the Picoprog programmer should now turn red.

Installation on Windows XP systems:

- Install the PCapØ1 Evaluation software from Software\ PCapØ1-Evaluation-Software\ setup.exe from the CD. This .exe file installs the evaluation software and the respective drivers for the Picoprog 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.
- Now, launch the evaluation software application from the start menu. The software opens and a pop up window asks to select between a 'Standard' mode and 'Humidity'. Please select 'Standard'.
- The Found New Hardware wizard comes up again. Please select again 'No, Not this time' and continue further with 'automatic installation'.
- A message would pop up warning that the driver is not digitally signed. Please install the driver anyway.
- Now the driver installation is complete.
- The LED on the Picoprog programmer will turn green. The software will then initialize and ask you to connect the Evaluation board to the Picoprog programmer.
- Perform Verify Interface from the Eval.Software main window. If every is correctly installed, the verify interface must result in an 'Interface OK' message. Also, under Help -> Programmer -> hdlUSB -> USB0::0x194E::0x100B::NI-VISA ought to be seen.
- If you want to change from the default SPI to I2C interface, please select under Tools -> Interface -> I2C interface. The LED on the Picoprog programmer should now turn red. When the LED does not glow at all, then it indicates that the interface is faulty.

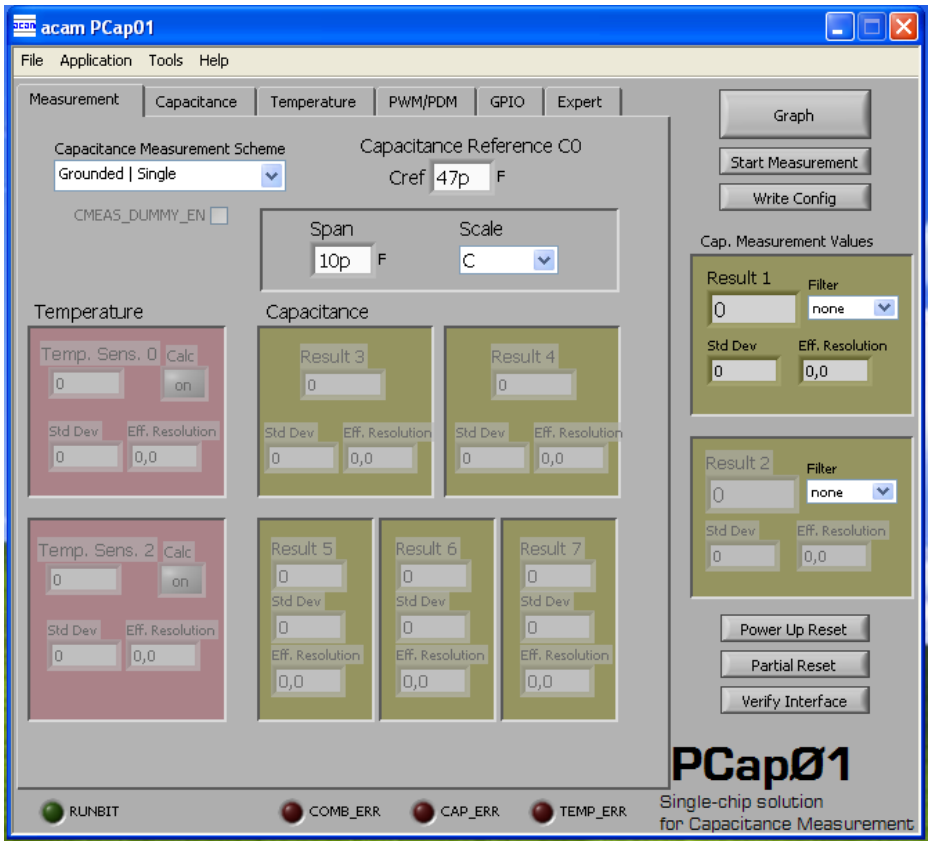
3.2 Running the Evaluation Software

The software comes up with the window shown in figure 3-1. The front panel shows six general buttons:

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.
Partial Reset	With a partial reset, the chip is re-initialized with respect to its frontend and processor.
Verify Interface	When everything is in order, then pressing this button will confirm if an SPI / I2C interface is present. It also indicates the release version number of the software.

3.2.1 Measurement Page

Figure 3-1: Measurement page



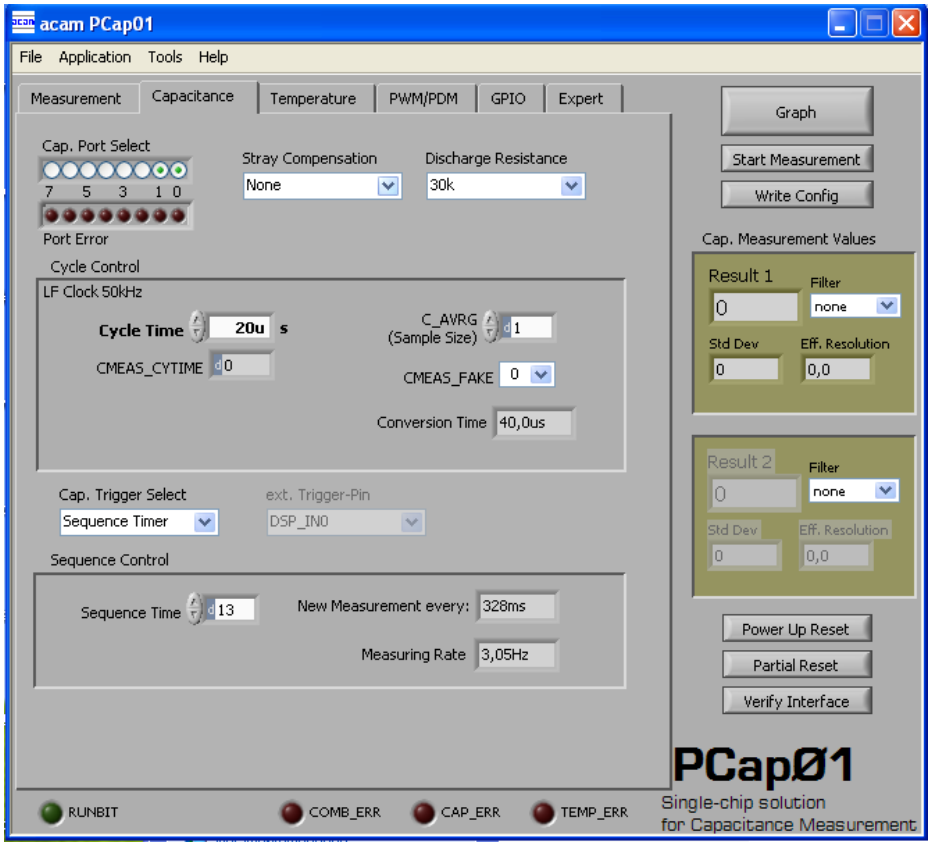
Options on 'Measurement' page:

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. Please see Section 3.4 of PCapØ1 data sheet for more details.
Capacitive Reference C0	Reference capacitance value. This setting has no effect on the chip itself; it is purely a visual aid that helps to interpret the measurement results better.
Span	Maximum span of the reference capacitive sensor connected. This setting has no effect on the chip; it is only used for scaling the "Eff. Resolution" indications.

Capacitance	These fields with an olive green background display the measurement result at capacitive ports 3-7 provided these have been enabled on the 'Capacitance' sheet.
Temperature	These fields with a pink background display the measurement result at each temperature measurement port that has been enabled on the 'Temperature' Sheet. 'on' Button : Pressing the on Button in this part of the sheet comes up with a sub window. This helps to visually manipulate the display of the temperature measurement result – either to display the actual measurement value from chip or to display the temperature directly in Celsius, Fahrenheit or Kelvin (or any other scale) by using polynomial approximation.
Cmeas_dummy_en	Some differential sensors (MEMS) require mirror symmetry with respect to the charges applied on the plates. This is ensured by "dummy charging" and is activated by this option.

3.2.2 Capacitance Page

Figure 3-2: Capacitance page



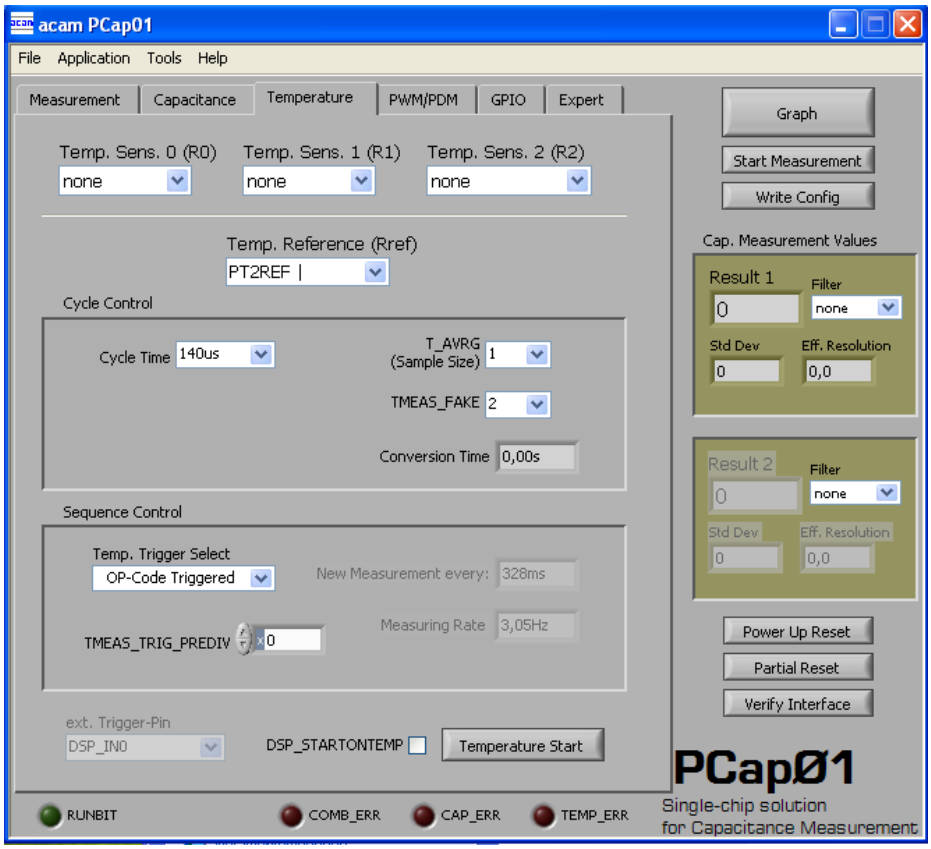
Options on 'Capacitance' page:

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	▪ 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. ▪ None: No compensation
Discharge Resistance	Selects the value of the Resistance internal to the chip 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. Please see Section 3.5 of PCapØ-1data sheet for more details.
Cycle Time	Can be set in multiples of 20 µs that corresponds to one Cmeas_cytime that is displayed below this box.
C_AVRG (Sample size)	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.
CMEAS_FAKE	Number of fake measurements per measurement cycle. Performing fake measurements may help in reducing noise.
Conversion Time	Displays the entire conversion time per measurement, taking into account, the number of ports opened and the the cycles for compensation and fake measurements.
Cap. Trigger Select	Selects the source that triggers the start of a capacitance measurement ▪ Single –Started by SPI Command 0x8C ▪ Continuous – Continuous measurement, self-triggering. Recommended when no temperature measurement is made in parallel. ▪ Sequence timer – Depending on the setting in the 'Sequence control' panel. 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.

Sequence Control : Sequence Control :	When the timer is set to N, the capacitive measurement is triggered once every [2^(N+1) * 20] µs
New Measurement begins every	Displays the rate at which the capacitive measurement is triggered based on the setting of the Sequence timer. It includes the conversion time and the pause time before the beginning of the next cycle
Measuring rate	Displays the frequency at which capacitive measurement data (with fakes and with averaging) is transferred from the DSP to the interface (SPI or I2C).

3.2.3 Temperature Page

Figure 3-3: Temperature page



Options on 'Temperature' page:

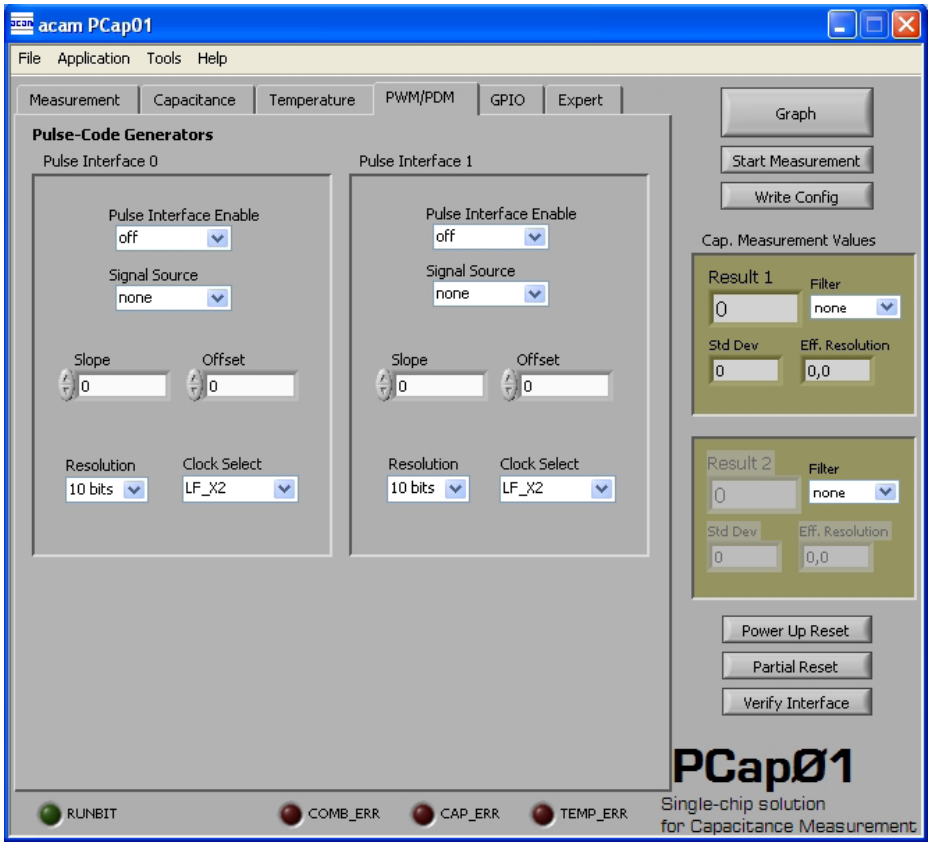
Temp.Sens.0 (R0)	To select a thermistor connected to port PT0 for temperature measurement
Temp.Sens.1 (R1)	To select a thermistor connected to port PT1 for temperature measurement*
Temp.Sens.2 (R2)	To select either the internal aluminium thermistor or an external reference resistor at port PT2for temperature measurement.

(*) Not supported with standard firmaware version 3.0

Temp. Reference (Rref)	To select either the internal Poly or external resistor at port PT2 as the reference resistance to be used in temperature measurement.
Cycle Time	Can be set to 140 µs or 280 µs.
T_AVRG (Sample size)	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.
TMEAS_FAKE	Number of fake measurements per temperature measurement cycle
Conversion Time	Displays the entire conversion time per measurement, taking into account, cycles for averaging and fake measurements.
Temp. Trigger Select	Selects the source that triggers the start of a temperature measurement ▪ Off / Opcode triggered: Default setting when no temperature measurement has to be performed automatically. In this case, a temperature measurement can still be started by SPI Command 0x8E. The SPI Command can be sent by pressing the button 'Temperature Start' ▪ CMEAS triggered: A temperature measurement is triggered every time when a capacitance measurement is complete. -> Recommended setting for woking with temperature measurements. ▪ Timer triggered: Depending on the setting in the 'TMEAS_TRIG_PREDIV' counter in the Sequence Control panel. This counter is steps up in 20 µs steps. Not recommended, not supported by standard firmware. ▪ 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 temperature 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.
DSP_STARTONTEMP	This setting is used to start the DSP on the completion of temperature measurement. With the standard firmware, the DSP is started after every capacitance measurement sequence, the temperature values are processed at this time. If the capacitance measurement is switched off, then setting this option will start the DSP after every temperature measurement completion.
Temperature Start	See Temp. Trigger select -> Off/Opcode triggered above

3.2.4 PWM / PDM Page

Figure 3-4: PWM/PDM page



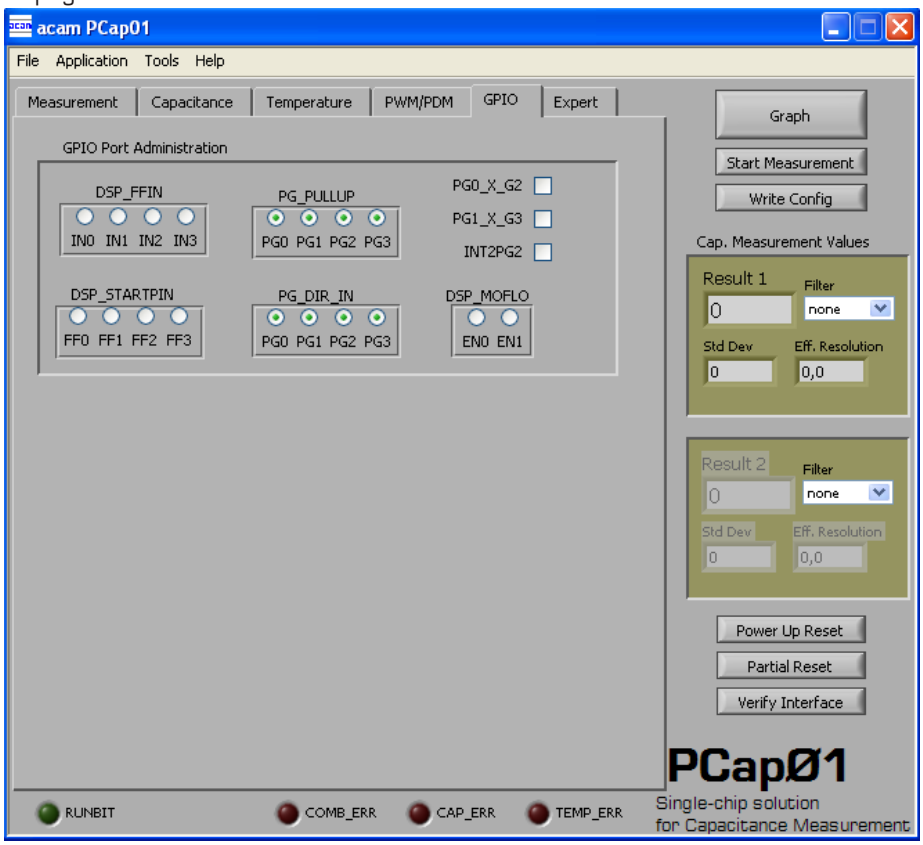
Options on 'PWM / PDM' Page:

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.
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. See Section 4.2 in PCapØ1 data sheet for more details.
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. See Section 4.2 in PCapØ1 data sheet for more details.

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. Recommended setting LF_X2 -> 100 kHz

3.2.5 GPIO Page

Figure 3-5 GPIO page



Options on 'GPIO' Page:

DSP_FF_IN	Pin mask for latching flip-flop activation (PG0 to PG3)
DSP_STARTPIN	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.
PG_PULLUP	To enable the internal pull up on the ports PG0-PG3
PG_DIR_IN	To configure the ports PG0-PG3 as input (otherwise output)
PG0_X_G2	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_G3	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.
DSP_MOFLO	Activates anti-bouncing filter in PG0 and PG1 lines

3.2.6 Expert Page

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

4 Miscellaneous

4.1 Literature Guide

Datasheets

Title	Document-No	Date
PCap01Ax-0301 Single-chip Solution for Capacitance Measurement with Standard Firmware version 3.0	DB_PCap01Ax_0301_en.pdf	April 2011
PCapØ1AK-0101 Single-chip Solution for Humidity Measurement	DB_PCap01AK-0101_en.pdf	February 2011

White Papers

Title	Document-No	Date

Application Notes

Title	Document-No	Date
Cable compensation	AN026 V1.0	In preparation

All available documents can be downloaded from the acam website at:

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

4.2 Document History

29.04.2010 First release

5 Appendix

5.1 Schematics

Figure 5-1: Motherboard schematics

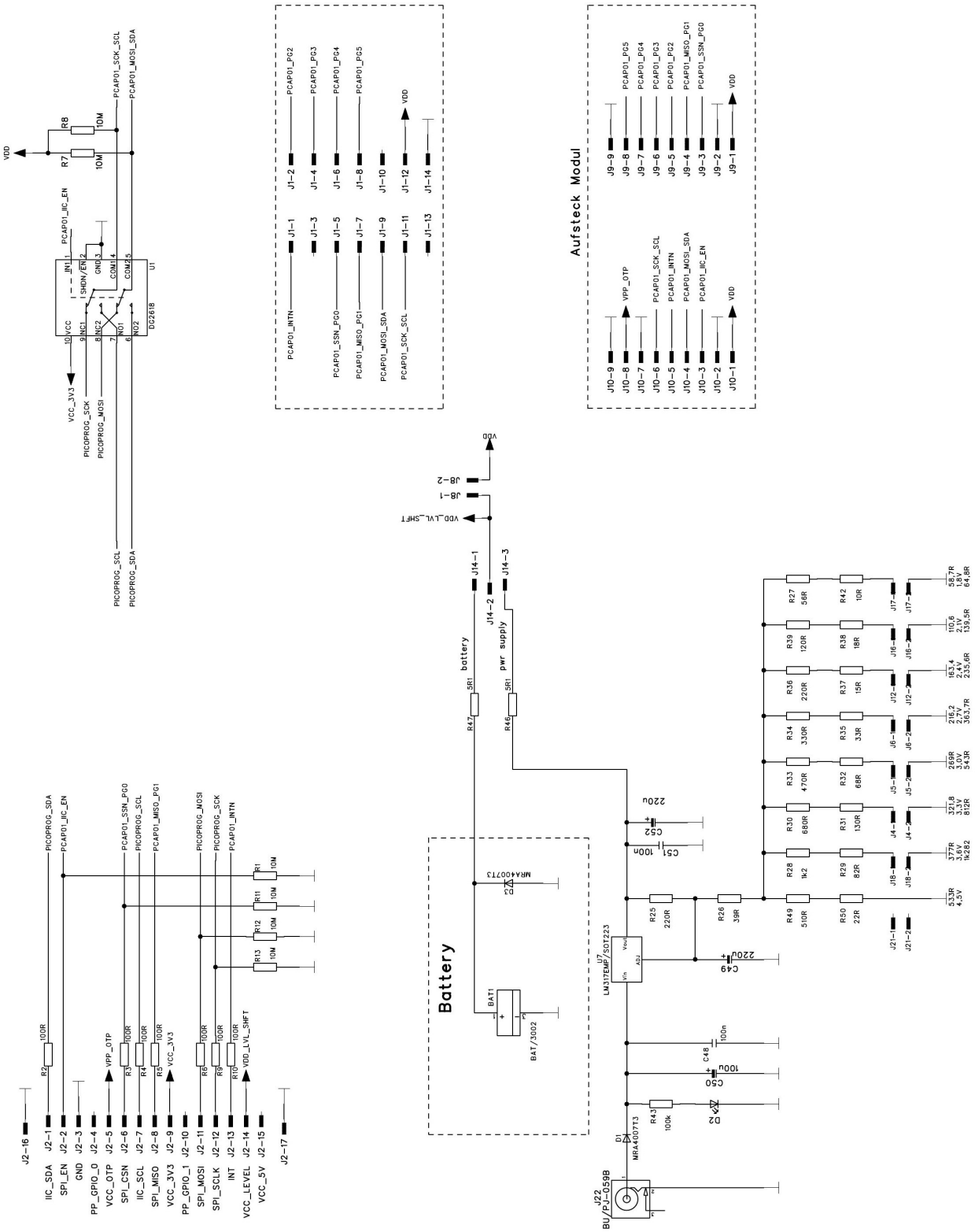
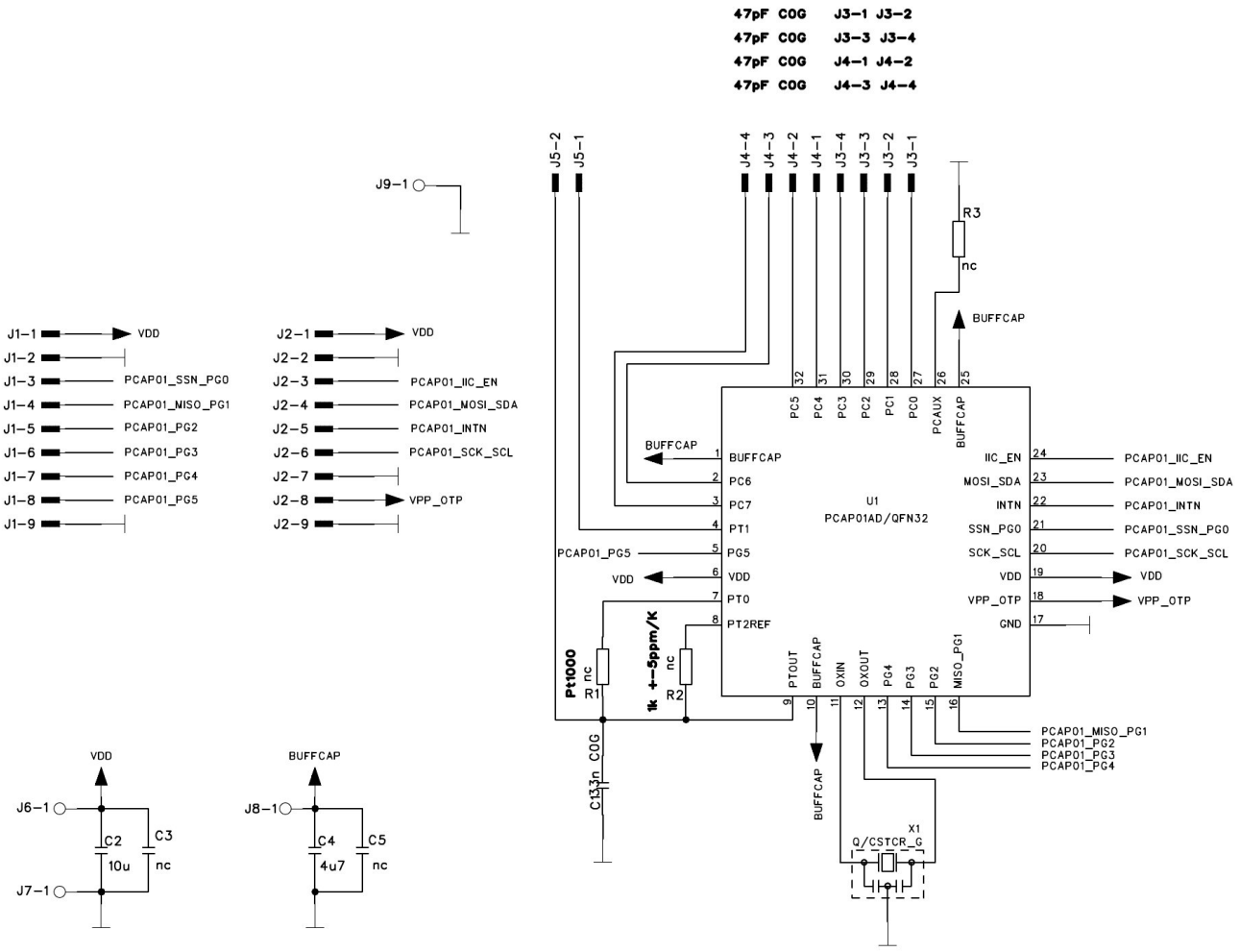
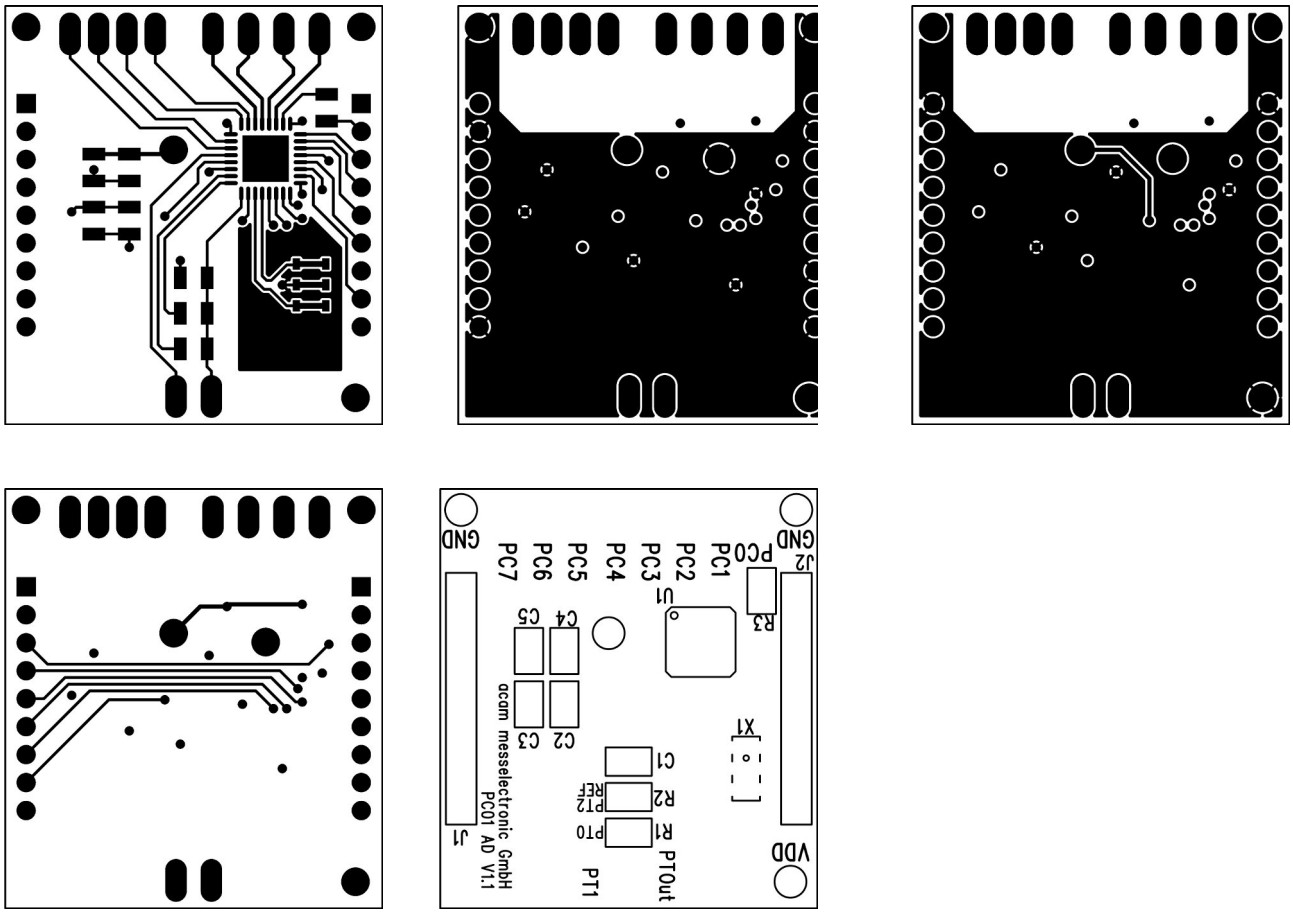


Figure 5-2: PCa01 AD module schematics



5.2 Layout

Figure 5-2: PCa01 AD module layout



acam-messelectronic gmbh

Am Hasenbiel 27

76297 Stutensee-Blankenloch

Germany

ph. +49 7244 7419 - 0

fax +49 7244 7419 - 29

e-mail: support@acam.de

www.acam.de