Manual

CAPmeter

Software Version 5.2

Hardware Rev.3

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1 Introduction

1.1 General

This operating manual describes the CAPmeter software and the CAPmeter hardware interface.

1.2 Installation of the software

Typically the software is delivered as an executable file (CAPmeter5.exe). It does not require special installation and can be executed directly. For convenience you may want to create a folder in your programs directory (e.g. C:\Program Files) and copy the executable into this folder. You may create a shortcut to the executable by dragging it into your Start menu.

1.3 Installation of the interface

When you first plug in the interface into a USB port, Windows will recognize the interface automatically. No specific drivers are required.

2 The CAPmeter interface hardware

2.1 Connection to the PC

The CAPmeter interface is provided as a USB stick that connects directly to an USB port of a PC. The CAPmeter can also be connected to a USB Hub and to an USB extension cable.

In the middle of the PCB there are two pin holes X2, X3 connected with copper traces. It is possible to cut the PCB in two halves between the two pin rows X2, X3. The two halves must be connected with a cable. This allows to place the sensor electronics as close as possible to the sensors.

2.2 Connection to sensors

At the end of the CAPmeter PCB-board there are 7 pin holes to connect the sensors (see figure below).
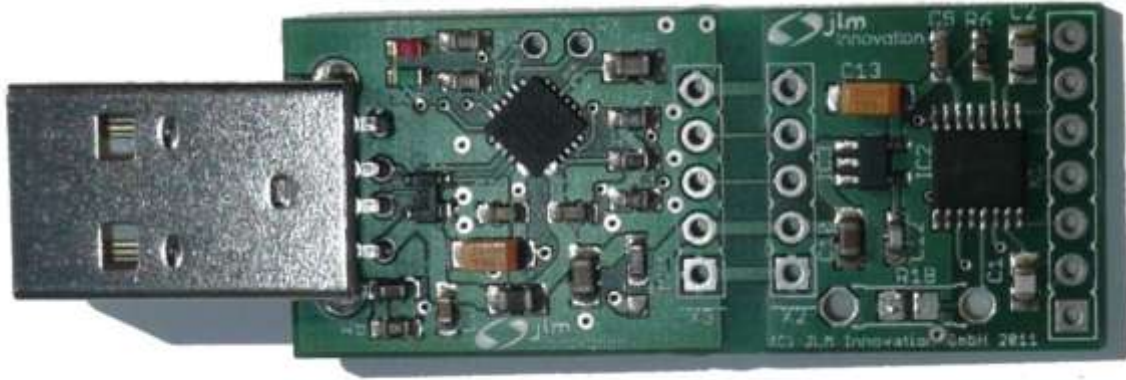
The sensors will typically be attached to these pin holes with cables, soldered directly to the holes. Alternatively a connecter with standard 2.54mm (0.1') spacing can be soldered to the pin holes.

In order to access the PCB the plastic case has to be opened. The case is clipped together and can be opened and closed using a bit of force on the sides.

The square pin hole marks pin 1.

Pin	Name	Description
7	C2+	Positive electrode for capacitance sensor 2
6	C2-	Negative electrode for capacitance sensor 2
5	VCC	+3.3V max 50mA
4	R_In	Resistance input
3	C1+	Positive electrode for capacitance sensor 1
2	C1-	Negative electrode for capacitance sensor 1
1	GND	Gnd

Capacitance sensors will be connected to Pins 2 and 3 for channel 1 / Pins 6 and 7 for channel 2.

2.3 Details of the data acquisition IC

The data acquisition is performed using an Analog Devices AD7746 dual channel 24-Bit Capacitance to Digital Converter. In addition to two capacitive channels this IC has an internal temperature sensor and an external voltage input.

The operating voltage is directly drawn from the USB interface. A PC will typically provide +5V to the USB interface.

Details about this IC are available in the Rev.0 05/2005 datasheet available at:

http://www.analog.com/UploadedFiles/Data_Sheets/AD7745_7746.pdf

2.3.1 Capacitive channels

Both capacitive channels are configured as shown in Figure 35 in the datasheet. A fixed reference capacitor (10pF) is connected to the CIN(-) input of each channel. Channel 1 is connected to EXCA and channel 2 is connected to EXCB. The AD7746 is designed for floating capacitive sensors. The sensors may not be connected to ground!

2.3.2 Resistive channel

The voltage input of the IC is configured as shown in Figure 42 in the datasheet. A reference resistor can be soldered onto the electronics board in the position R1B (either SMD0805 or through hole). This allows to measure resistive sensors in the range of 0 to R1B.

2.3.3 Internal temperature sensor

The IC provides an internal temperature sensor with an accuracy of $\pm 2°C$.

3 The CAPmeter software

The CAPmeter software is a simple data logger application that allows to configure the measurement parameters and stores data directly into a text file and send the data via TCP/IP. Graphs show the data as they are captured from the sensors.

The CAPmeter software will operate all CAPmeter interfaces connected to your PC simultaneously. The operation is synchronized so all interfaces will acquire the data at the same time.

All parameters are automatically loaded when the software is started and saved, when the software is closed. There is no need to save or load settings.

3.1 Configuring interfaces

Please connect the interfaces before starting the CAPmeter software. Upon startup the software scans the computer for all CAPmeter interfaces. The individual interfaces are identified by their Serialnumber. The list of connected interfaces is shown in a box at the right side of the program window.
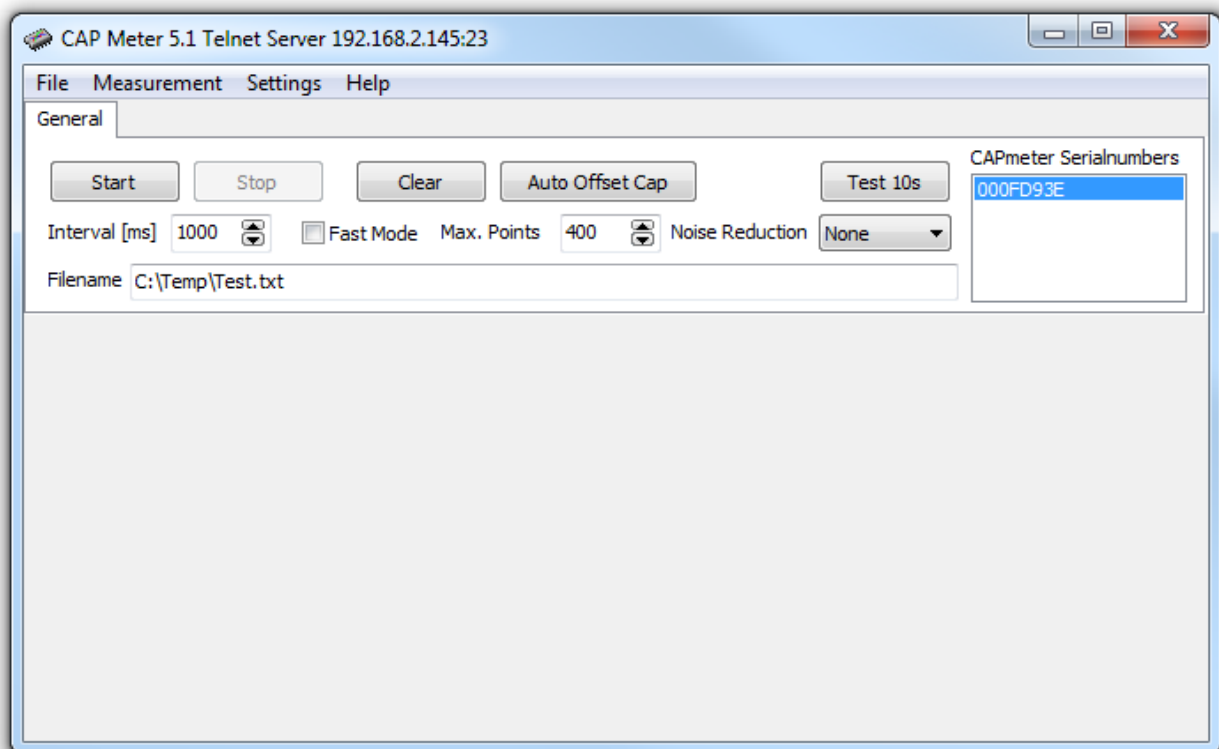
When you start the software for the first time, no measurement has been configured. Each interface is configured individually, as the types and parameters of connected sensors may vary.

Please click on the serial number in the list box to configure an interface. This will bring up a dialog for the corresponding interface:
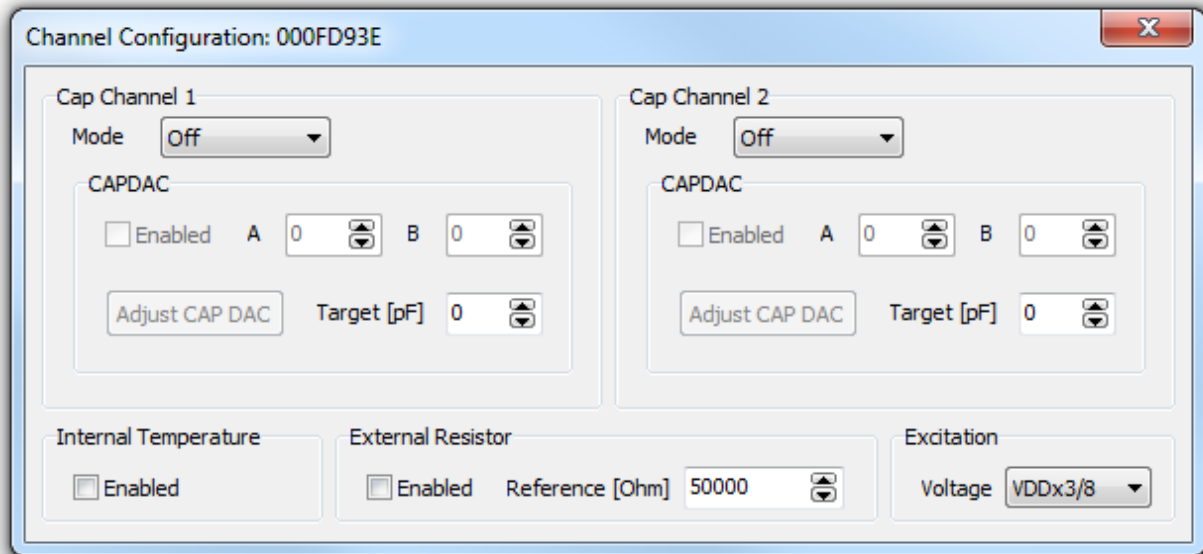
In the Channel Configuration dialog all channels for an interface may be configured.

3.1.1   Configuring a capacitive channel:

The Mode for each capacitive channel may be set to Off, Single or differential.

A channel with Mode Off is disabled. No data will be recorded for this channel.

A channel in Mode Single is measuring the attached capacitor directly. In Mode Differential the interface will measure the difference between the attached capacitance and the reference capacitance (default: 10pF) on the interface.

The dynamic range of the conversion covers ±4pF. In order to extend the range an offset of about ±17pF may be introduced by programming the on-chip CAPDAC registers. The register values my either be set manually or the values can be determined by the software. Clicking on the "Adjust CAP DAC" button will start a short measurement procedure that tries to set the CAPDAC values in a way to generate a reading close to the value entered into the Target parameter. During this process the actual reading is displayed next to the Mode selector.

The conversion time of the capacitive channels is chosen to be 62ms. The chip would allow different timing parameters, however this conversion timing provides a good suppression of 50 and 60Hz noise. (see Figure 21 in the AD7746 datasheet)

The CAPDAC coefficients vary between different IC's. Additional stray capacitances may affect the readings. If absolute capacitance values are needed, capacitors with known capacitance should be used in the place of the sensing capacitance to determine any bias of the measurement.

3.1.2 Configuring the internal temperature channel

The internal temperature sensor provides an accuracy of $\pm2°C$ and a resolution of 0.1°C (see Figure 18 in the AD7746 datasheet). The conversion time for the internal temperature sensor is set to 62.1ms. This channel may only be enabled or disabled in the software.

3.1.3 Configuring the external resistor channel

The external resistor channel may only be enabled or disabled in the software. The value of reference resistor (Reference) should be set to the default value 50000 unless the reference resistor has been exchanged on the electronics board. The value of the reference resistor does not affect the measurement, but is used to convert the AD reading to the corresponding resistance. The conversion time for the external resistor channel is set to 62.1ms.

3.1.4 Choosing an excitation level

The excitation level affects the capacitive channels only. For best performance the highest excitation level ($\pm$VDD/2 = 2.5V) should be used. This results in a low level of 0 and a High Level of 5V on the excitation pin. The excitation level may be reduced if high voltages would affect the readings or damage the connected sensors.

3.2 Performing a measurement

After setting of the parameters, the software will automatically display graphs for the different channels. All active capacitive channels are displayed in one graph, all active temperature channels are displayed in another graph and all resistance channels are displayed in yet another graph. If no channel of a certain type is present, the corresponding graph will not be present in order to preserve more display area for the remaining graphs.

As the data is continuously written to a text file, you need to specify the log file before starting a measurement. Clicking in the Filename textbox will bring up a file dialog to set the log file.

3.2.1 Setting the data acquisition interval

By default the software will measure all channels every second (Interval = 1000ms). If needed you may increase or decrease the interval using the Interval input box. Please be aware that depending on the number of channels and the Interface settings capturing the data may take longer than the set interval. If new data for a measurement point is not available, the software will instead repeat the old value in the graphs and the log files.

3.2.2 Starting the measurement

The measurement is started by clicking on the Start button. If the log file already exists, a warning will be displayed and the user may cancel the start in order to select a different log file.

At the beginning a header is written into the log file, which contains the settings and the date and time of the start.

During each interval the actual measurement data will be stored into the log file in one line. The data is tab delimited. The number format depends on the language settings of the operating system. The log file can directly be opened with Microsoft Excel. Older versions of Excel are limited to 65536 rows. At a rate of 1 measurement per second the log file will grow too large after approximately 18 hours for import into excel.
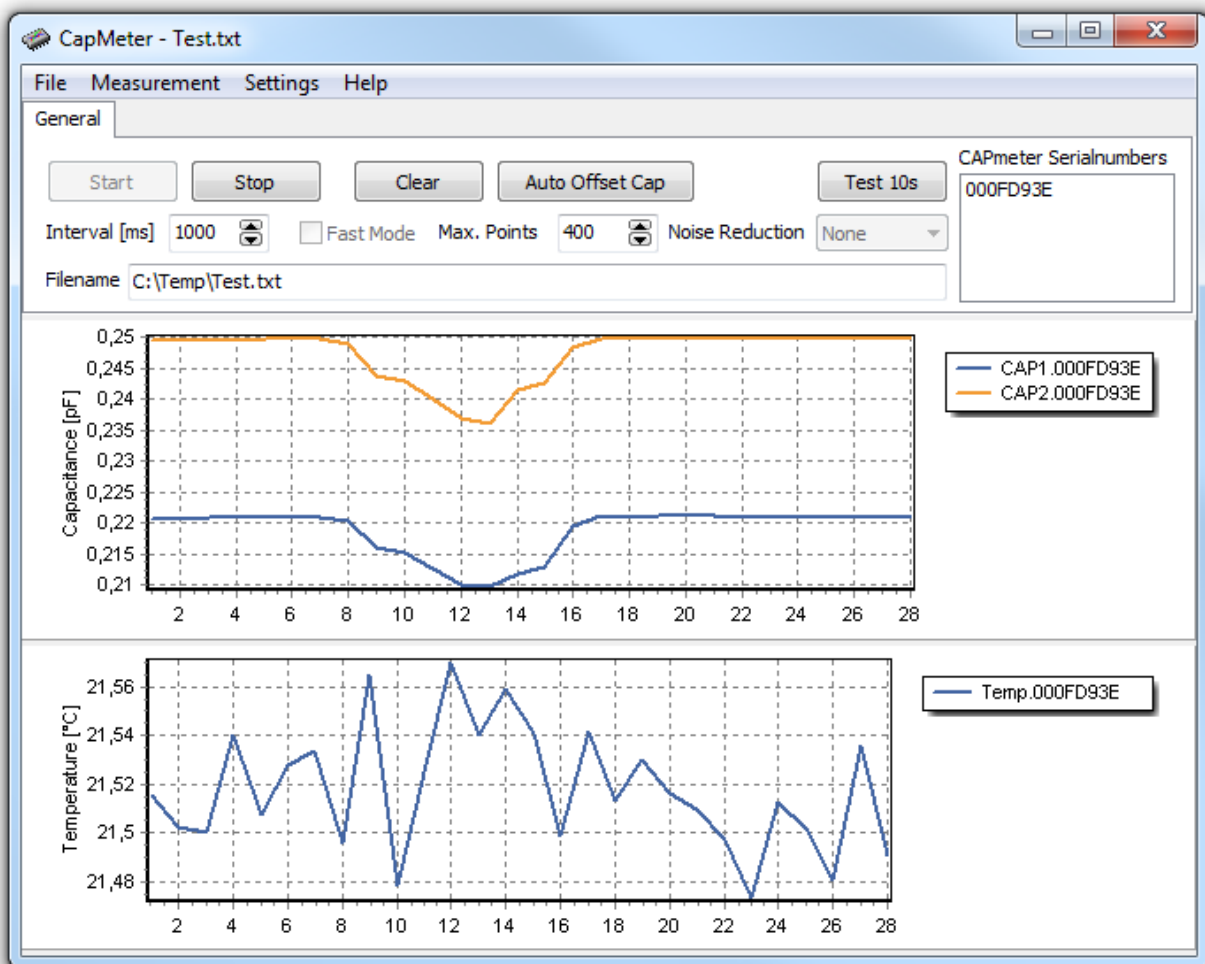
3.2.3 Adjusting the graphs

By default the graphs will display up to 500 data points. This value can be adjusted by changing the Max. Points value. When this value is exceeded, the measurement will continue to run and older measurement data is shifted out of the graphs.

The graphs may be cleared at any time. This does not affect the recorded data in the log file.

The Auto Offset Cap button removes any offset between the different capacitance channels on the graph. It does not affect the measurement or the data in the log file! When this button is clicked, the next few measurements are used to determine the actual values of the individual channels. These values are then subtracted from measurement data before displaying it on the graph. The readings for all channels are thus set to 0 which makes it much easier to identify subsequent signal changes.

The size of each graph may be adjusted by clicking and holding the mouse in the area between each graph.

3.2.4 Noise Reduction

Noise reduction is set to none by default. When Noise Reduction is set to 2 of 3 then for each data point 3 measurements are performed. From these measurements the measurement that has the largest deviation to the average is discarded and the recorded data point is the average of the two remaining measurements. In the case of 3 of 5, two measurements are discarded and the average is calculated over the remaining 3. This type of noise reduction is intended for environment where frequent noise is introduced through an external discontinuous source. Since 3 or 5 measurements are performed instead of 1 the time for each measurement is increased too.

3.3 Control via TCP/IP

The CAPmeter server exposes a Telnet Server that can be connected to over TCP/IP. This allows controlling the software from other programs (e.g. Labview or Matlab). All measurement data is automatically sent to any client connected via TCP/IP. The settings for the interfaces must still be set within the CAPmeter software. There is no way to adjust the settings via TCP/IP.

Following commands are recognized when received via TCP/IP:

S<Enter>   Start the measurement

X<Enter>   Stop the measurement

?<Enter>   Send all measurement settings