
MoLAB DATA-LOGGER ML01

USER'S GUIDE



CENTRE FOR MICROCOMPUTER APPLICATIONS

<http://www.cma-science.nl>

For our international customers...

Check the CMA International website (www.cma-science.nl/english/downloads) for the latest version of this manual and updates of Coach 6 CE and Coach 6 software products.

Aan onze Nederlandse gebruikers...

MoLab wordt standaard uitgeleverd met Engelse handleiding.

U kunt de laatste versie van de Nederlandse handleiding en de nieuwste update van Coach 6 CE en Coach 6 downloaden van de CMA-website (www.cma-science.nl), rubriek 'Ondersteuning'.

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I. INTRODUCTION

MoLab data-logger ML01 is a mobile graphic data acquisition system. It is a handheld Windows CE device equipped with its own processor and memory. Its touch screen provides color display and easy control.

CMA sensors of the ML type can be connected to the four MoLab sensor inputs. Temperature, voltage and light sensors are included. An internal sound sensor is built-in. The Coach 6 CE program, preinstalled on MoLab, offers tools for data collection and data analysis and provides possibilities to create student activities filled with texts and images.

MoLab is a versatile device, which can be used standalone as well as connected to a PC computer, in the field or in the classroom.

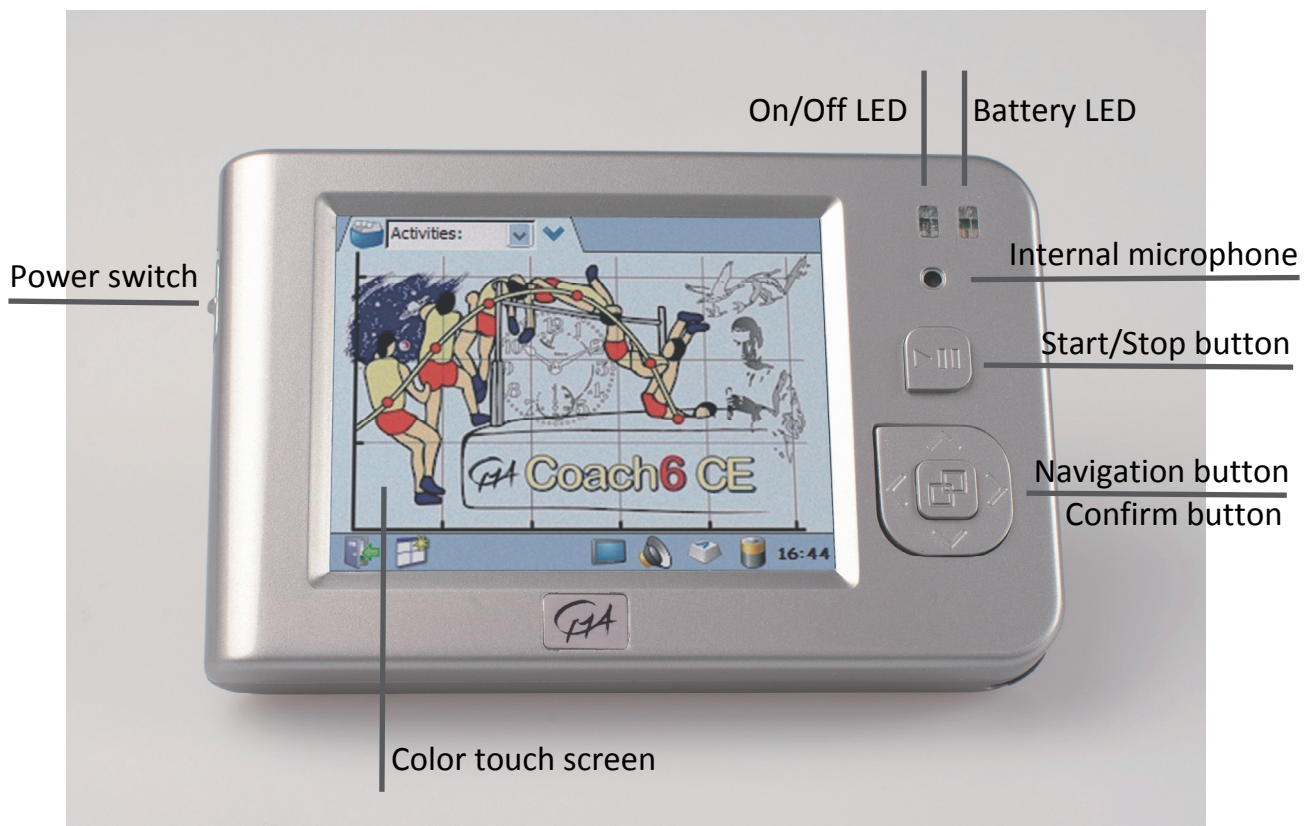
II. ITEMS INCLUDED WITH MoLAB

The MoLab package contains the following items:

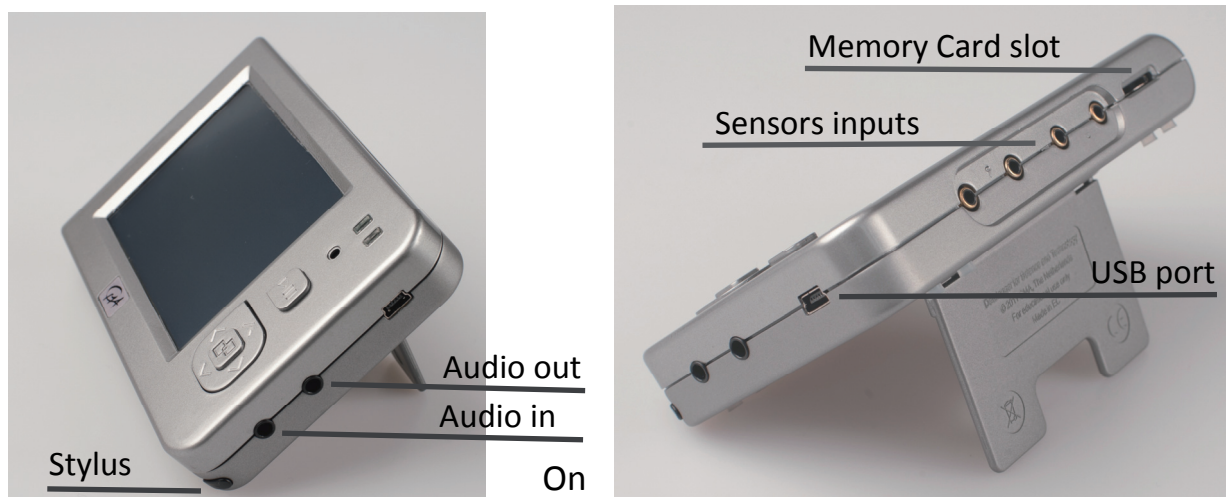
- MoLab data-logger ML01
- Power adapter
- USB cable
- Sensor cables with 5-pin mini jack plugs
- Spare stylus
- Protective rubber cover
- ML11s Temperature sensor (-40 .. 125 °C)
- ML14s Light sensor (1 .. 65,535 lx)
- ML17f Voltage sensor (-15 .. 15 V)
- User's Guide.



III. THE MOLAB DATA-LOGGER



MoLab is controlled by the touch screen, the Start/Stop button, the Navigation button and the Confirm button. The power on/off switch is located on the left side. Two LEDs indicate the power status (left) and the status of the battery (right). Below the LEDs the internal, built-in microphone is located.



the right side of MoLab a mini USB port is located. This port is used for connection to the PC or for recharging the internal battery. Audio Out (for headphones or speaker) and Audio In (for external microphone) ports are located below. The Stylus, needed to control the touch screen, is stored in the slot below the Audio ports.

The top edge of MoLab has four sensor inputs for ML sensors and a Micro SD memory card slot for memory extension. At the backside there is a battery compartment for the lithium-ion rechargeable internal battery (supplied with MoLab).

IV. POWERING

MoLab is powered by an internal rechargeable battery (Li-Poly 3.7 V, 2300 mAh) located in the backside compartment. The battery is charged when MoLab is connected to the computer via a USB port, or when it is powered by the provided AC power adapter. The right LED indicates the state of charging. It lights up when the battery is charged; it is red when the battery is low and changes to green when the battery is fully charged. The actual status of the battery can be checked in Windows CE or in Coach 6 CE. Notice that the battery can be recharged after partial discharge without losing its capacity.

The battery life will depend on the sensors used but typically you can expect to use MoLab up to a few hours without recharging it. To save power turn the screen off when you do not need it (via  Power Properties). The MoLab screen will go blank after a selected time interval of no use (no screen taps, no button press), but MoLab continues its working. To activate the screen again simply touch it or tap it.

Notes:

- *When the USB port does not provide the standard power, MoLab will not be charged or charging will be slower.*
 - *MoLab can be used while the battery is being charged by the power adapter.*
 - *On most computers USB ports do not provide enough power for simultaneous operating of MoLab and charging its battery. Using double USB connections significantly improves charging speed.*
-

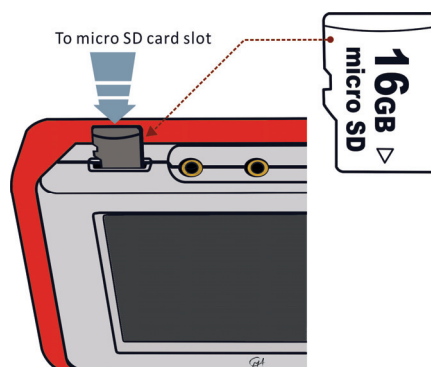
V. WINDOWS CE OPERATING SYSTEM

MoLab is a Windows CE device. Windows CE Explorer can be used to manage files on MoLab.

With Windows CE Services software such as Microsoft ActiveSync or Windows Mobile Device Center, files can be transferred, backed up, added, removed and copied between MoLab and the host PC. To establish communication between MoLab and the PC, you must first install Microsoft ActiveSync (Windows XP and earlier versions of Windows) or Windows Mobile Device Center (Windows Vista and Windows 7) on the host PC. Both programs are freely available on the Microsoft website (www.microsoft.com).

VI. USING MEMORY CARD

For memory extension a micro SD memory card can be used. After inserting such a card in the MoLab's card slot, the Storage Card folder will appear in the Windows CE folder *My Device*. You can store your files in a similar way as in other Windows CE folders.



VII. CONNECTING SENSORS

CMA sensors of the ML sensor line can be connected to inputs of MoLab. Four sensor cables with 5-pins mini jack plugs are provided to connect such sensors to MoLab. Three sensors are delivered with MoLab:

- ML11s Temperature sensor (- 40 .. 125 °C),
- ML14s Light sensor (1 .. 65,535 lx), and
- ML17f Voltage sensor (-15 .. 15 V).

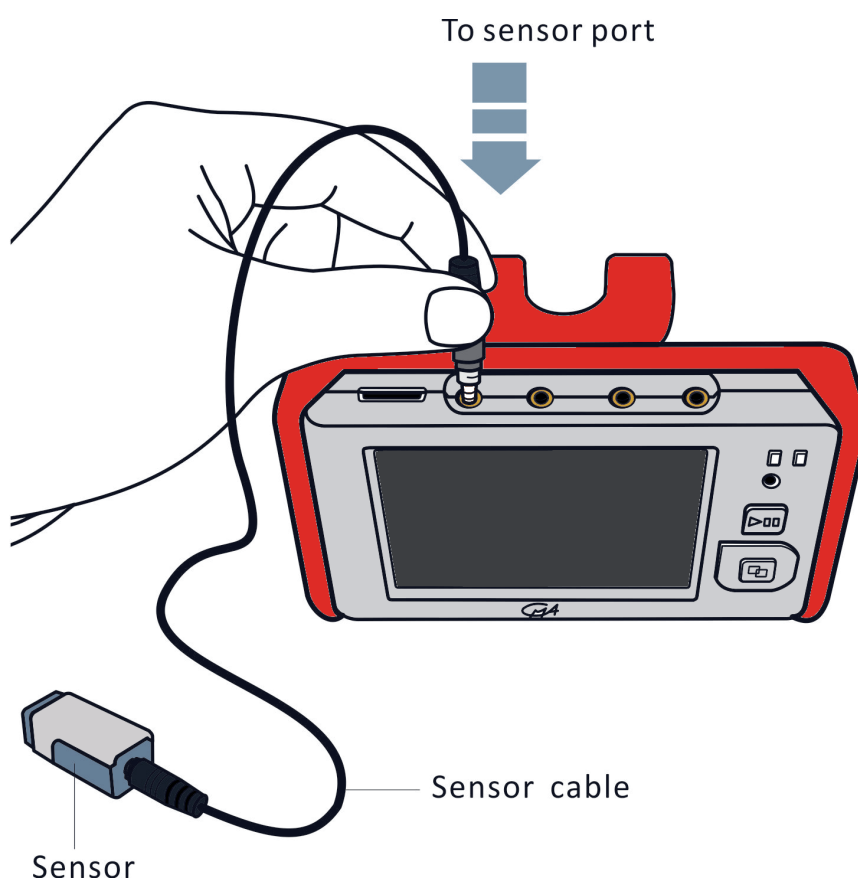
Other ML sensors are available separately. For the complete list see the CMA website (www.cma-science.nl).

Additionally, MoLab is equipped with the internal, built-in sound sensor, which is supported by Coach 6 CE.

To connect a sensor:

- Plug the connector of a provided sensor cable into a sensor.
- Connect the other end of the sensor cable to a sensor input of MoLab.

Maximal 4 sensors can be used simultaneously.



Connecting a sensor to MoLab.

VIII. USING MOLAB AS A STANDALONE DEVICE – WORKING WITH COACH 6 CE

When working with MoLab as a standalone device MoLab is controlled by its touch screen, buttons, and the Coach 6 CE program running on MoLab.

After turning MoLab on, it briefly displays the opening image and starts the Coach 6 CE program. The Main Coach Screen appears on the MoLab screen. Coach 6 CE can also be started via double-tapping the Coach 6 icon on the MoLab desktop.

In this chapter you find a short description how to work with the Coach 6 CE program. Detailed information about the use and features of Coach 6 CE can be found in the **Guide to Coach 6 CE** available on the CMA website (www.cma-science.nl).



The opening image of MoLab.

1. Main Screen

The Main Screen is the first screen that appears after starting Coach 6 CE and it displays the Coach 6 CE title image.

The main Toolbar offers:

- A drop-down list for direct opening of Coach Activities and Result files stored on MoLab.
- A menu icon  – for the tool menu with options to open a new or existing activity.
- Info on the Coach 6 CE version.



The Main Screen of Coach 6 CE.

Across the bottom bar of the Main Screen the following icons are displayed:

Icon	Tap an icon to:
	Exit Coach 6 CE
	Open a New Coach Result
	Open the utility program to calibrate the screen

	Open the Volume and Sounds properties
	Display/hide the on-screen keyboard
	Open the Power Properties
16.10	Open the Date/Time Properties

2. Coach Activities and Results

Coach 6 CE works with Coach Activities (*.cma files) and Coach Results (*.cmr files). Coach Activities are Coach documents created in the Author mode in the Coach 6 PC program. Student users can open such Activities in Coach 6 CE but cannot overwrite them. Instead student users save the results of their work in Coach Results.

Coach Activities and Results can be stored in the MoLab user memory (DataFlash) or on a user memory card, and opened in the Coach 6 CE program.

The CMA Coach Projects folder, located in *DataFlash* > *CoachCE* folder, is a default folder for storing exemplary CMA Coach Activities. This folder can be opened directly via the menu option **Open CMA Project** available in the Main and Activity Screen menus.

To open an existing Activity (*.cma file) or Result (*.cmr file)

- Select the desired Activity or Result file from the drop-down list.
- or
- Tap the **Menu** icon and select **Open**. The **Open an Activity** dialog opens. This is a standard Windows CE dialog, which lists folders and Coach Activities  and Results  in the selected location.
 - Browse and select the desired Activity or Result file.
 - Click **OK**.

To create a new Result (*.cmr file)

- Tap the **Menu** icon and select **New** or select **New (Sound only)** if your new result is created for data collection with the internal, built-in sound sensor.
- or
- Tap the **Open a New Result** icon  located in the bottom bar.

After opening an Activity or Result, the MoLab Toolbar changes. Each MoLab activity has six Screens, indicated by the following icons:

 Activity,  Sensors,  Diagram,  Table,  Text,  Image.

Tapping an icon in the Toolbar displays the respective Screen. Each Screen has its own Toolbar, which displays (from left to right):

- Screen icon – which indicates the currently selected Screen.
- A drop-down list – which lists all items available in the selected Screen, e.g. a list of activities, a list of sensors, a list of diagrams, etc.
- A menu icon  – which opens the tool menu with options specific for the selected Screen.

On the bottom of each Screen extra icons for measurement are available:

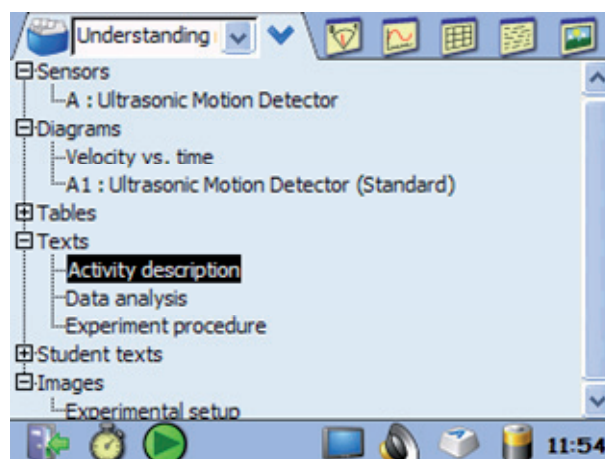
Icon	Tap an icon to:
	Open the Measurement Settings dialog
	Start the measurement
	Start the manual measurement
	Stop the measurement

3. Activity Screen

The Activity Screen gives, in the form of a tree, an overview of all items available in the opened Activity/Result. Each tree branch corresponds to one of the MoLab Screens with exception of Text Screen, which is split into two branches Texts and Student Texts.

If there are no items available under a branch then this branch is not shown in the tree. By clicking the '+' sign a branch can be expanded to show all available items. By clicking the '-' sign a branch can be closed again.

By double-tapping an item listed under a branch this item is directly displayed. For example double-tapping a diagram 'A1: Temperature sensor (Standard)' opens the Diagram Screen and displays the 'A1: Temperature sensor (Standard)' diagram.



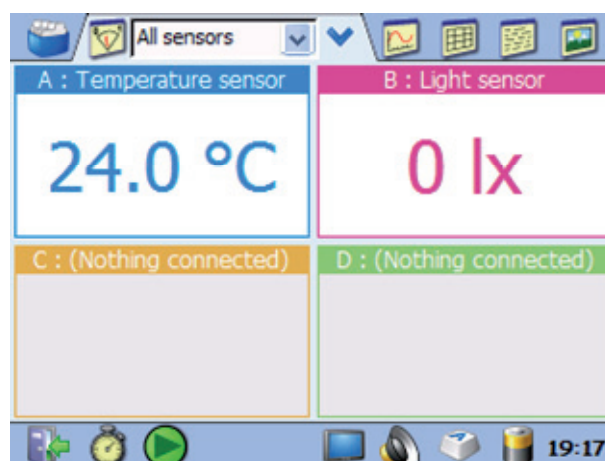
The Activity Screen.

ACTIVITY SCREEN TOOL MENU

- **New** - to create a new Result.
- **New (Sound only)** - to create a new Result with the internal sound sensor.
- **New (Photogate timing)** - to create a new Result for timing measurements with a photogate. In this activity only the Photogate ML54f connected to input A of MoLab can be used.
- **Open ...** - to open an Activity/Result (*.cma/*.cmr file).
- **Close** - to close an opened Activity/Result.
- **Activity Options** - to set the Activity options.
- **Save ...** - to save a Result (as *.cmr file).
- **Save as ...** - to name and save a Result (as *.cmr file).
- **Delete ...** - to delete an opened Activity/Result (*.cma/*.cmr file).

4. Sensors Screen

MoLab automatically detects connected ML sensors and loads the sensors information. Live data measured by the detected sensors are displayed on the Sensors Screen. By default the Sensors Screen is divided into four quadrants. When a sensor is connected to a sensor input (A, B, C or D) then its corresponding quadrant displays the sensor name (e.g. A: Temperature sensor) and its current readings (some sensors have more than one sensor built-in then more values are shown per sensor input). These live displayed data are not stored in MoLab's memory. When there is no sensor connected to a sensor input the respective sensor quadrant displays the message (Nothing connected). In some cases for example when using a photogate in counting or timing mode it is only possible to display live data after a measured has been started.



The Sensors Screen.

To maximize a sensor quadrant:

- Double-tap the desired sensor quadrant.
- Or
- Select the desired sensor quadrant via the drop-down list.

SENSORS SCREEN TOOL MENUS

The displayed Sensors Screen tool menu is context sensitive. When tapping the menu icon  or long touching a sensor quadrant with (Nothing connected) the short menu appears:

- **Sensor Settings...** – to open a dialog to define sensor settings.
- **Measurement Settings** – to open a dialog to define a measurement type and its specific settings.

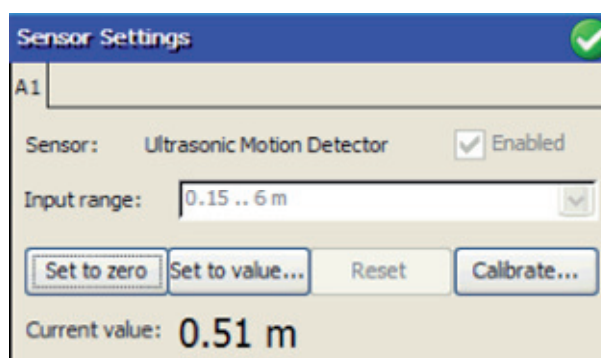
When long touching a sensor quadrant displaying the sensor readings the long menu appears:

- **Sensor Settings...** – to open a dialog to define sensor settings.
- **User Calibration...** - to open the User Calibration dialog, appears only if applicable for the detected sensor.
- **Set to Zero** – to set the actual measured value to zero, appears only if applicable for the detected sensor.
- **Set to Value** - to set the actual measured by the sensor value to another value, appears only if applicable for the detected sensor.
- **Reset Calibration** – to reset the user sensor calibration.
- **Measurement Settings** – to open the Measurement Settings dialog to define the measurement type and its specific settings.

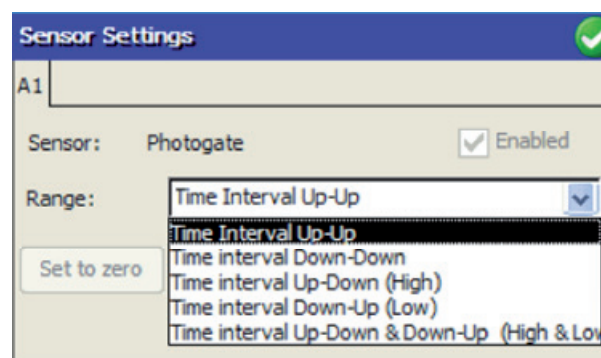
The **Sensor Settings** dialog displays sensor information regarding detected sensors. Each detected sensor and sub-sensor has its own tab. Tap a sensor tab e.g. **A1** to display its sensor information. Some sensors have more measurement ranges available. Tap a drop-down list to choose another range.

Use the **Set to zero** or **Set to value** button to shift the sensor factory calibration. Use the **Calibrate** button to create a simple, 2- or 3-point user calibration. This button is active only for sensors, which have the possibility to store a user calibration. Use the **Reset** button to reset the user calibration to the sensor factory calibration.

The Sensor Settings dialog is slightly different for 'Photogate timing' Activity/Result. Here only the Photogate ML54f connected to input A of MoLab



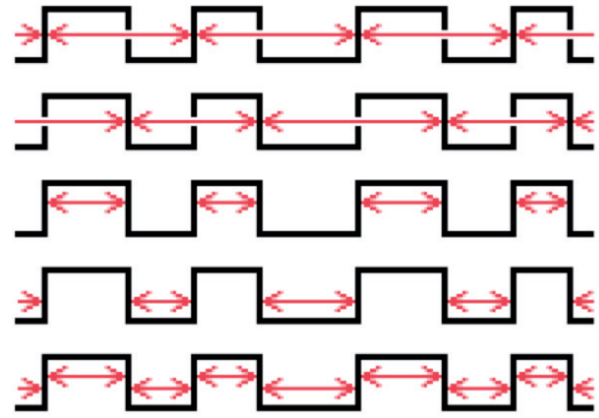
The Sensor Settings dialog.



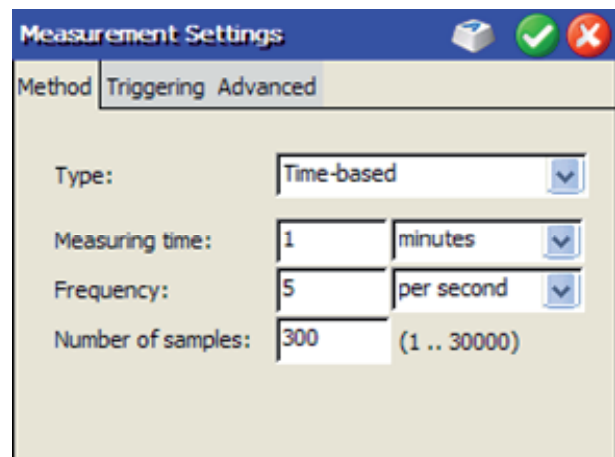
The Sensor Settings dialog for 'Photogate timing' Activity/Result.

can be used. Tap a drop-down list to choose one of the a time interval measurements. Five types of time interval measurements are available in Coach:

1. Time Interval Up-Up (default)
2. Time interval Down- Down
3. Time interval Up – Down (High)
4. Time interval Down – Up (Low)
5. Time interval Up – Down & Down- Up, (High & Low)



In the **Measurement Settings** dialog specify how MoLab has to measure. Select the measurement type (time-based or manual) and set the measurement settings (measuring time and frequency). If you want to start your measurement automatically enable triggering and define trigger conditions in the Triggering tab. In the Advanced tab it is possible to repeat the measurement process a number of times.

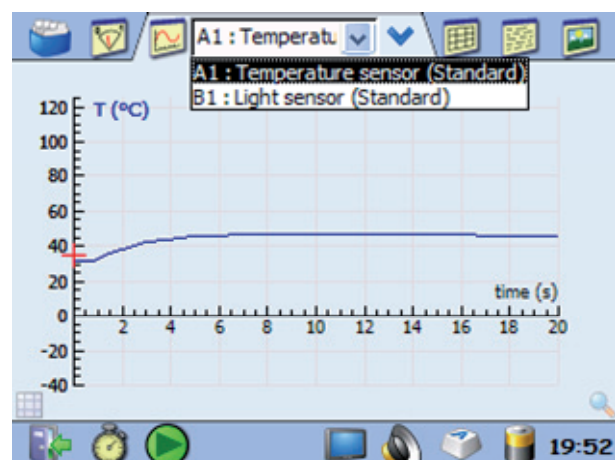


The Measurement Settings dialog.

5. Diagram Screen

The Diagram Screen is used to display measured or calculated data in diagrams.

A standard diagram, the sensor quantity against the clock (time), is created automatically after the sensor has been detected. Changing of any diagram style options, such as removing the grid or changing the diagram color, removes the suffix '(Standard)' from the diagram's name. Diagram changes, such as defining a new column, make it a 'User-defined' diagram. All available diagrams are listed in the drop-down list. The Diagram Screen displays the currently selected diagram.



The Diagram Screen.

DIAGRAM SCREEN TOOL MENU

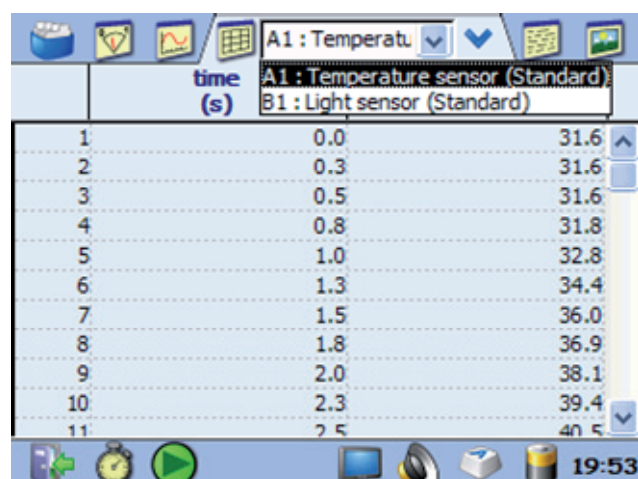
- **Zoom to Fit** (*only for a diagram with data*) - to optimally zoom in the graph.
- **Zoom Out** (*only when in zoomed state*) - to return to the previous zoom state.
- **Scan** (*only for a diagram with data*) - to read co-ordinates of points in the graph. When sketch is started the additional option appears in the tool menu:
 - **Stop Scan** - to stop the scan.
- **Erase all Values** (*only for a diagram with data*) - to remove all data from the activity.
- **Sketch** - to draw a prediction graph or a graph, which can be converted to real data. When sketch is started the additional options appear in the tool menu:
 - **Erase Sketch** - to remove the sketch, and
 - **Convert Sketch to Table** - to convert the sketch to real data.
- **New Diagram** - to create a new diagram.
- **Edit Diagram** - to edit the displayed diagram.
- **Diagram Style** - to change the display settings of the diagram.
- **Process/Analyze** - to select data processing and analysis tools.
- **Copy column** (*only for a diagram with data*) - to keep previous run(s) active.

The **Grid** icon  located in the lower, left screen corner allows switching the grid on/off. The **Zoom to fit** icon  located in the lower, right screen corner, allows re-scaling the horizontal and vertical axes to optimally display all graphs. Tap the **Zoom-out** icon  until you return to the original scale.

On starting a measurement a graph is drawn. When starting a new measurement, the existing data is overwritten by the new data, without warning.

6. Table Screen

The Table Screen is used to display measured or calculated data numerically in tables. Tables are synchronized with diagrams and share a number of settings (among which their name): irrespective where these settings are changed, they are reflected both in the diagram and the table. The standard table is the table corresponding to the standard diagram. All available tables are listed in the drop-down list.



	time (s)	A1 : Temperature sensor (Standard)	B1 : Light sensor (Standard)
1	0.0	31.6	
2	0.3	31.6	
3	0.5	31.6	
4	0.8	31.8	
5	1.0	32.8	
6	1.3	34.4	
7	1.5	36.0	
8	1.8	36.9	
9	2.0	38.1	
10	2.3	39.4	
11	2.5	40.5	

The Table Screen.

On starting a measurement a table is filled with values. When starting a new measurement run, the existing data is overwritten by the new data.

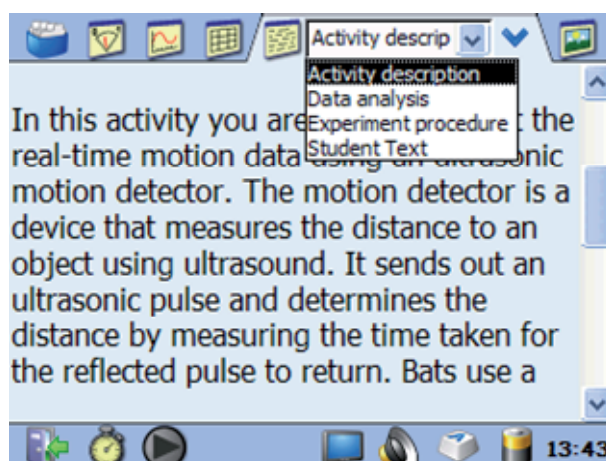
TABLE SCREEN TOOL MENU

- **Erase all Values** (*only for a table with data*) - to remove all data from the activity.
- **New Table...** - to create a new table.
- **Edit Table ...** - to edit the displayed table.
- **Process/Analyze** - to select data processing and analysis tools.
- **Rows** - to add, delete and sort table rows.
- **Edit** - to edit table cells.
- **Copy column** (*only for a table with data*) - to keep previous measurement run(s) active.

7. Text Screen

The Text Screen is used to display text and local html texts embedded in the Activity. Texts describing an activity, experiment procedure, data analysis etc. can be prepared by Authors in Coach 6. Student users cannot edit these texts. Student users can write and edit only Student Texts.

All available texts are listed in the drop-down list. The Screen displays the currently selected text. By default an empty Student Text is included in a new Result, allowing direct typing of student notes.



The Text Screen.

TEXT SCREEN TOOL MENU

- **New** - to add a new Student Text.
- **Edit Title** - to edit the title of the selected Text.
- **Open file** - to open a text file.
- **Cut** - to cut a piece of text.
- **Copy** - to copy a piece of text.
- **Paste** - to paste a piece of text.
- **Undo** - to undo last action.
- **Text size** - to select the font size of Texts. The selected font size will be used for all Texts.

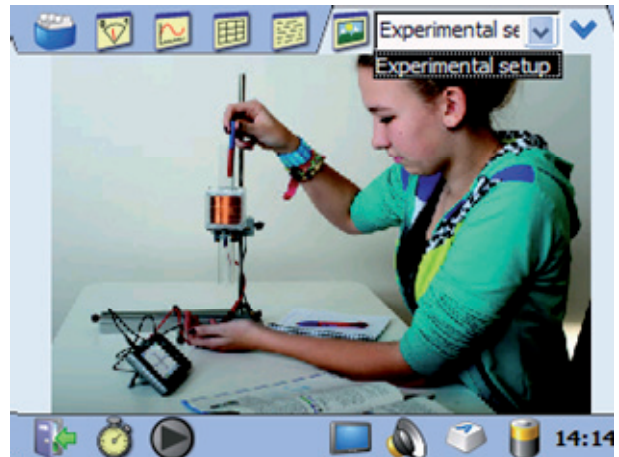
To type text in the Text Screen

- Tap the Keyboard icon , located in the bottom bar, to display the extended on-screen keyboard.
- Tap a blue text screen.
- Tap letters on the on-screen keyboard to write your text.

8. Image Screen

The Image Screen is used to display photos and images. The following file formats are supported in Coach 6 CE: bmp, gif, jpg, and png.

The Image Screen displays the currently selected image. Other available images can be selected for display via the drop-down list. By default there is no image in a new Result; the Image Screen is empty.



The Image Screen.

IMAGE SCREEN TOOL MENU

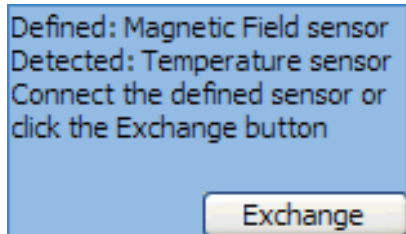
- **New** - to add a new image.
- **Edit Title ...** - to edit the title of the selected Image.
- **25%** - to display the image in 25% of its original size
- **50%** - to display the image in 50% of its original size.
- **75%** - to display the image in 75% of its original size.
- **100%** - to display the image in its original size.
- **Fit** - to display the image fitted to the screen.

9. Collecting data with Coach 6 CE

To collect data with MoLab as a standalone device:

- Turn MoLab on.
- Wait until the Coach 6 CE starts and its Main Screen appears.
- Ensure MoLab has sufficient battery power or is connected to its power supply.
- Connect the desired ML sensor(s) to the sensor input(s) on MoLab.
- Create a new Coach Result:
 - Tap the Menu icon  and select:
 - **New**, or
 - **New (Sound only)** - when you want to use the internal Sound sensor, or
 - **New (Photogate timing)** - when you want to use the Photogate ML54f and perform timing experiments.
 - A new Result opens. MoLab automatically detects the connected sensor(s) and lists detected sensors, their standard diagrams and tables in the Activity screen.

Or

- Open an existing Coach Activity/Result:
 - Select the desired Activity/Result from the drop-down list of Activities and Results or tap the Menu icon , select **Open** and browse to select the desired Activity/Result.
 - The Activity/Result opens. MoLab automatically detects the connected sensor(s). If the detected sensor is different from the sensor defined in the activity then the defined sensor is listed under the activity tree in red. Its sensor quadrant displays information about the defined sensor and the detected sensor. Connect the sensor defined in the Activity or change the defined sensor into the detected sensor by tapping the **Exchange** button.
- 
- Tap the Sensors Screen icon  to display the Sensors Screen and check the live readings of the connected sensors.
 - You are ready to start your measurement. The measurement is executed according to the given measurement settings. Tap the **Measurement Settings** icon  to check these settings: measurement type, measuring time, sampling frequency and number of collected samples. If needed change the default settings.
 - Tap the green **Start** icon  or press the MoLab **<Start/Stop>** button to start data collection.
 - In most cases, Coach directly starts the measurement.
 - If triggering is enabled then the measurement is started automatically when

the trigger conditions are met.

- When the type of measurement is set to **Manual** then the green **Manual Start** icon  appears in the bottom bar. Tap this icon to collect a single measurement. When a keyboard input is specified then the value of one or more quantities have to be typed in.
- The measurement stops when the specified measurement time (time-based) or specified number of samples (manual) has been reached. If you want to interrupt the measurements process, click the red **Stop** icon  or press the MoLab **<Start/Stop>** button again.
- Save your result file via the Activity Screen menu option **Save** or **Save As....**

WARNING! Please notice that when starting a new measurement, by tapping the green Start button or pressing the MoLab **<Start/Stop>** button, existing data is overwritten by the new data without any warning. To avoid losing any data save your experiment results first.

Note:

- *To avoid loss of data, for instance in case of empty battery, the Coach CE will save intermediate results during measurements longer than 10 minutes. Saving of the Result file, which includes all texts and images, will be done each minute (in case of new data). The last saved file can be found in CoachProjects /DataRecovery/last_result.cmr*
-

10. Processing and analyzing data

The data collected in measurements can be processed and analyzed with the help of advanced tools. These tools are available under the option **Process/Analyze** in the menu of Diagram and Table Screens.

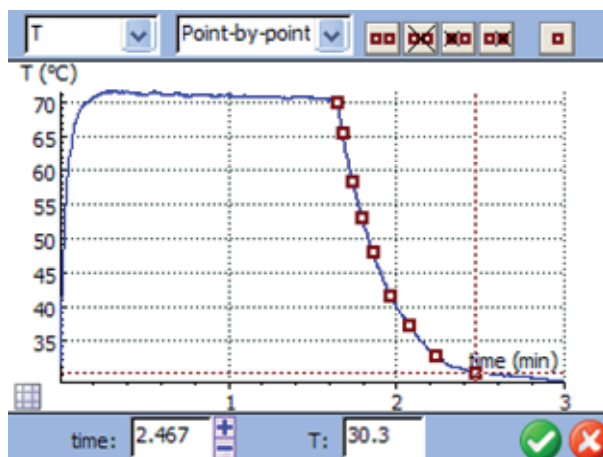
The Process/Analyze options work all in a similar way. After selecting an option an extensive dialog that includes the diagram is shown. Above and below the diagram the specific parameters can be specified. The drop-down list in the left upper corner appears in all dialogs. This list is used to switch between vertical quantities (graphs) if the diagram contains several quantities. All processing and analysis tools are detailed described in the **Guide to Coach 6 CE**.

10.1. Select/Remove Data

With the **Select/Remove Data** tool either a range of data or single points can be selected for removal or retention.

To select/remove data

- Select **Process/Analyze > Select /Remove Data**.
- In the top left drop-down list select the quantity for which you want to make a selection.
- In the next drop-down list select the selection method.
- For the **Range** method: select the range by dragging the boundary lines, or type in the boundary values in the **Begin** and **End** fields.
- For the **Point-by-point** method: select points by tapping a point in the graph or by using small icons:  select all,  deselect all,  select even,  select odd. The last icon  select/deselect a point can be used instead of tapping a point in the graph after selecting the desired point with the **<Navigation>** button.
- Tap  to confirm or  to close the dialog without changes.
- In the next dialog select **Keep selected** or **Delete selected** and confirm with .



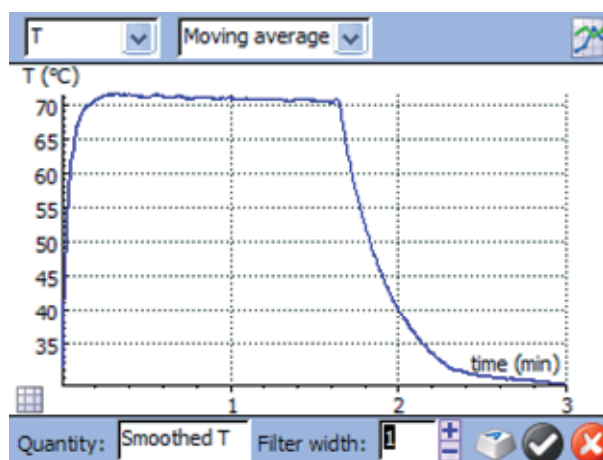
The Select/Remove data dialog.

10.2. Smooth

The **Smooth** tool is used to create a smooth curve that fits a rough or limited set of measured points. The smoothed graph may consist of (much) more points than the original data set and can successively be processed.

To execute smoothing

- Select **Process/Analyze > Smooth**.
- In the top left drop-down list select the graph you want to smooth.
- In the next drop-down list select the smooth method.
- Specify the smoothing parameters:
 - For **Moving average** enter the desired **Filter width**.
 - For **Spline** leave the automatically calculated **Smoothing factor** or tap the  icon and type in the desired value.
- If desired, change the name of the **Quantity**.



The Smooth dialog.

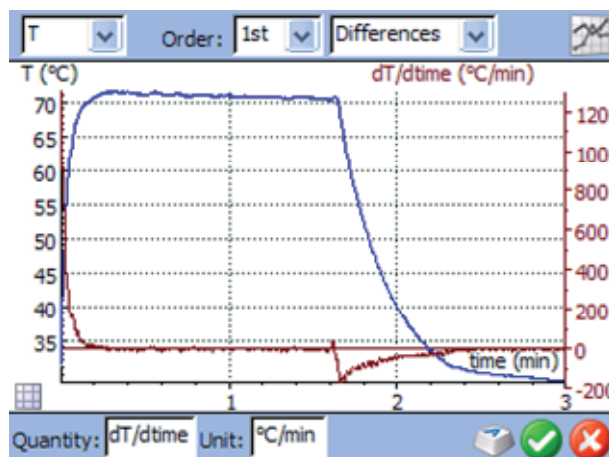
- Tap  (top right screen corner) to create the smoothed graph. If you are not satisfied with the result, change parameter settings and tap the  icon again.
- Tap  to confirm or  to close the dialog without changes.
- Choose between **Add graph**, **Replace graph**, **New diagram** or **Replace data** and confirm with .

10.3. Derivative

The **Derivative** tool is used to produce the graph of the first or the second derivative of the original quantity.

To calculate a derivative graph

- Select **Process/Analyze > Derivative**.
- In the top left drop-down list select the graph of which you want to calculate the derivative.
- In the next drop-down list select the derivative order.
- In the third drop-down list select a method of calculating the graph of the derivative (**Differences** or **Smooth**).
- When desired, edit the **Quantity** and **Unit**.
- Tap  to calculate the derivative graph.
- Tap  to confirm or  to close the dialog without changes.
- Select either **Add graph** or **New diagram** and confirm with .



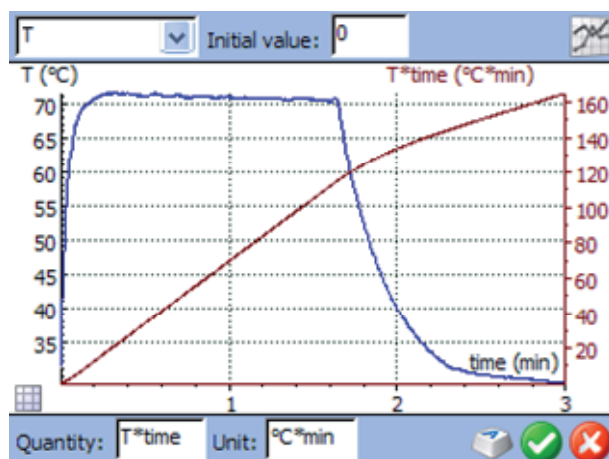
The Derivative dialog.

10.4. Integral

The **Integral** tool is used to calculate the function (the primitive function) whose derivative is equal to the displayed graph. Such an integral function can be determined for a constant of integration.

To calculate an integral graph

- Select **Process/Analyze > Integral**.
- In the top left drop-down list select the graph of which you want to calculate the integral.



The Integral dialog.

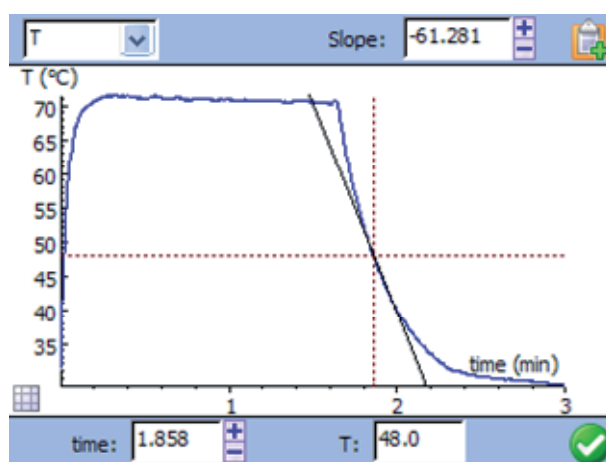
- In the **Initial value** field type in the constant of integration. This is the value assigned to the quantity along the vertical axis for $x=0$.
- When desired, change the name of the **Quantity** and/or **Unit**.
- Tap  to calculate the integral graph.
- Tap  to confirm or  to close the dialog without changes.
- Select either **Add graph** or **New diagram** and tap  to confirm.

10.5. Slope

The **Slope** tool is used to manually determine the slope of the tangent at any point of a displayed graph.

To determine a slope

- Select **Process/Analyze > Slope**.
- In the top left drop-down list select the graph in which you want to determine a slope.
- The diagram in the dialog is in scan mode. The co-ordinates of the scanned point, indicated by the dark red cross-hairs, are displayed in the fields below the graph.
- Tap the point in which you want to determine the slope. A line appears in the diagram.
- Use the stylus and rotate the line until it is positioned correctly along the graph. The only way to determine the slope is by vision; Coach does not indicate which slope is 'correct'.
- Read the value of the slope in the **Slope** field. You can copy the value of the slope to the clipboard by tapping .
- Click  to close the dialog.



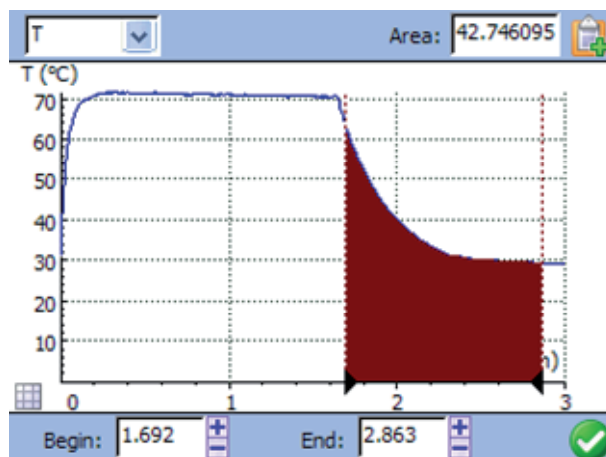
The Slope dialog.

10.6. Area

The **Area** tool is used to determine an area between a displayed graph, the horizontal axis and two boundary lines.

To determine an area

- Select **Process/Analyze > Area**.
- In the top left drop-down list select the graph from which you want to determine an area.
- The diagram shows two boundary lines between which the area is calculated. Use the stylus and drag the boundary lines to the required position, or type the x-values for the boundary lines in the **Begin** and **End** fields.
- Read the area displayed in the **Area** field. You can copy the value of the slope to the clipboard by tapping .
- Click  to close the dialog.



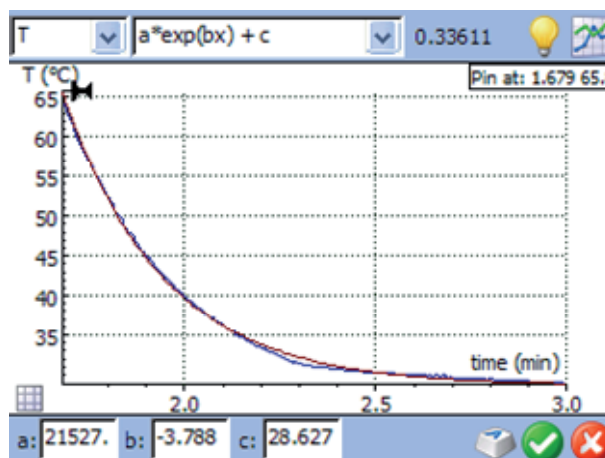
The Area dialog.

10.7. Function Fit

The **Function fit** tool is a procedure to approximate the data in the graph with a standard mathematical function. You can choose from a number of function types. The coefficients of the fit function are determined using a least-squares method. Fitting can be done manually or automatically.

To determine a function fit

- Select **Process/Analyze > Function Fit**.
- In the top left upper drop-down list select the graph that you want to fit.
- In the next drop-down list select the function type that will be used.
- Tap , Coach automatically estimates the best initial parameter values of the fit function. In some cases this is already the optimal fit.
- Tap , Coach automatically refines the suggested fit to find the best function fit.
- Tap  to confirm.
- Select **Add graph** or **Replace graph**.



The Function Fit dialog.

When you choose to replace the graph, the original data will be lost unless you saved the result prior to the fit procedure.

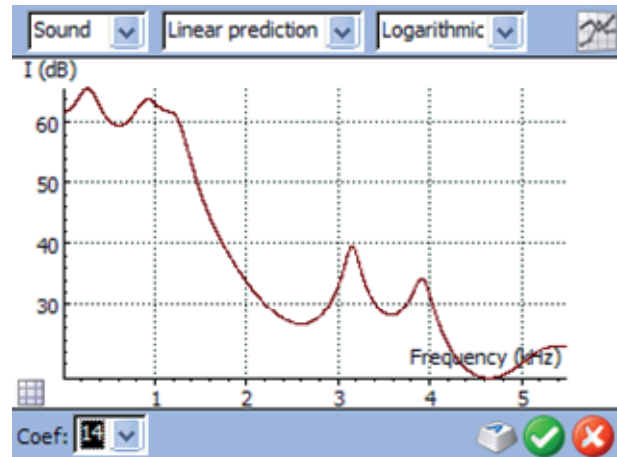
- Tap  to confirm or  to close the dialog without changes.

10.8. Signal Analysis

The **Signal Analysis** tool is used to find the frequency spectrum of the original graph.

To determine a frequency spectrum

- Select **Process/Analyze > Signal Analysis**.
- In the top left drop-down list select the graph of which you want to calculate the frequency spectrum.
- In the next drop-down list select the method: **Fourier transform, Linear prediction, R-ESPRIT or Prony**.
- In the third drop-down list select **Linear** or **Logarithmic** for the intensity scale along the y-axis.
- Specify signal parameters:
 - **Linear Prediction:** enter the number of coefficients. This number determines the maximum number of peaks (formants), which will be found in the spectrum.
 - **R-ESPRIT:** enter the number of frequencies and the snapshot dimension. This number determines the model used in the analysis and the maximum number of peaks in the spectrum. The snapshot dimension is determined automatically, or entered manually after tapping the  icon.
 - **Prony:** enter the number of frequencies.
- Tap  to display the frequency spectrum of the graph.
- Tap  to confirm.
- Tap  again to confirm creating a **New diagram** or  to close the dialog. For Prony and R-ESPRIT method you can also display the graph of the approximation found by the selected method by checking the **Add approximation to original diagram** option.



The Signal Analysis dialog.

10.9. Statistics

The **Statistics** tool displays statistical information about the diagram/table as a whole or about a selection of data in the table.

To display statistics

- For whole data: select **Process/Analyze > Statistics**.
For a selection of data: with the stylus drag a selection in a table and then select **Process/Analyze > Statistics**.
- You can copy the statistics information to the clipboard by tapping .
- Click  to close the dialog.



	time ms	Sound %
Number:	1103	1103
Max:	99.95	14.11
Min:	0.00	4.05
Average:	49.98	9.51
Sum:	55124.99	10492.72
Sum sq:	3674999.24	105919.04
s(n):	28.88	2.35
s(n-1):	28.89	2.35

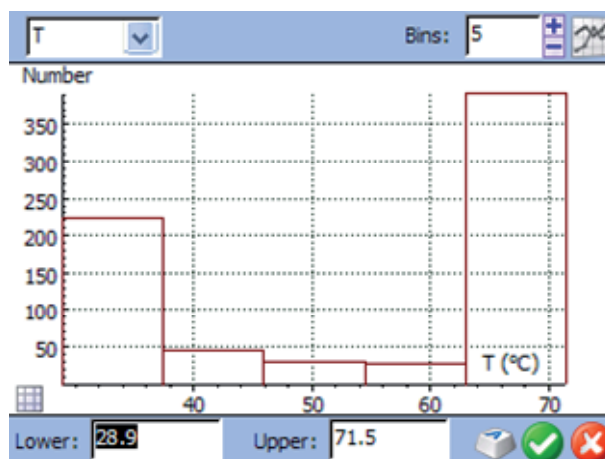
The Statistics dialog.

10.10. Histogram

The histogram option is used to create the histogram bar diagram. The range of the variable (column) is divided into equal size bins for which the frequency of occurrence is calculated. The height of the diagram bar is equal to the frequency of occurrence within the bin.

To determine a histogram

- Select **Process/Analyze > Histogram**.
- In the top left drop-down list select the column for which you want to create the histogram.
- Specify the **Lower** and **Upper boundary** values.
- Type the number of bins (default 5).
- Tap  to create a histogram. If you are not satisfied with the result, change parameter settings and tap  again.
- Tap  to confirm your histogram or  to close the dialog without changes.
- Tap  again to create a **New diagram** or  to return to the Histogram dialog.



The Histogram dialog.

IX. Using MoLab with a PC computer

MoLab can be used with a Windows computer for:

- transferring files between the computer and MoLab,
- using MoLab as a lab interface connected to the computer and controlled by the Coach 6 program running on it.

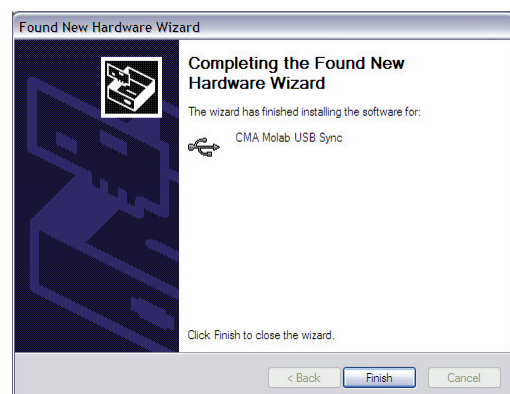
For both MoLab has to be connected to the PC via the USB cable, and its driver and Windows CE Services software have to be installed on the computer.

1. Installing the MoLab driver¹

1.1. Windows XP and earlier versions of Windows

Prior to connecting MoLab to your Windows XP computer, you need to install the Windows XP driver for MoLab.

- Download the XP driver for MoLab from the CMA website (<http://www.cma-science.nl/english>). The driver can be found under *Support > Interfaces > MoLab data-logger*².
- Unzip this file to a temporary folder on your hard disk. Right click the file `wceusbsh.inf` and select 'Install'.
- In the first dialog of Found New Hardware Wizard select 'Yes, this time only'. Click 'Next' to continue.
- In the second dialog of Found New Hardware Wizard select 'Install the software automatically (Recommended)'. Click 'Next' to continue.
- The Wizard searches and installs the CMA MoLab USB Sync driver. When the warning about missing Windows Logo testing appears click 'Continue Anyway'.
- Click 'Finish' when the driver installation has finished.



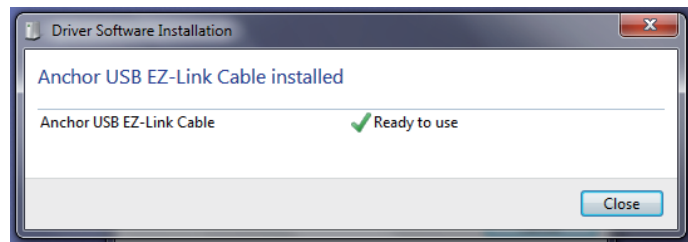
1.2. Windows Vista and Windows 7

- Turn MoLab on and connect it to the computer via the USB cable. The additional USB connector can be connected to the second USB port for extra power supply.

¹ Administrator rights needed.

² If you have Coach 6.4 or Coach 6.4 Lite already installed on your computer you can find this driver in the Program Files (x86)\CMA\Coach6\Common\MoLabDriverXP folder.

- When MoLab is connected to the computer for the first time Windows 7 automatically detects it as Generic USB Serial Device and starts installing the device driver software.
- After MoLab driver software installation is successfully finished Anchor USB EZ-Link Cable is installed and ready to use.



2. Installing Windows CE Services software

To establish communication between MoLab and the Windows computer, you must first install Microsoft ActiveSync (Windows XP and earlier versions of Windows) or Windows Mobile Device Center (Windows Vista and Windows 7) on the host PC. Both programs are freely available on the Microsoft website (www.microsoft.com).

2.1. Windows XP and earlier versions of Windows

- Download and install Windows ActiveSync³.
- Turn MoLab on and connect it to the computer via the USB cable. The additional USB connector can be connected to the second USB port for extra power supply.
- Start ActiveSync. The program will automatically make a connection with MoLab.

2.2. Windows Vista and Windows 7

- After MoLab driver software installation is successfully finished Windows automatically downloads and starts installation of Windows Mobile Device Center. Notice that your computer has to be connected to Internet.
- After installation of the Mobile Device Center is completed the program starts automatically.
- After detection of MoLab by Windows, Mobile Device Center displays the message '!! Connected'. For proper working select 'Connect without setting up your device'.

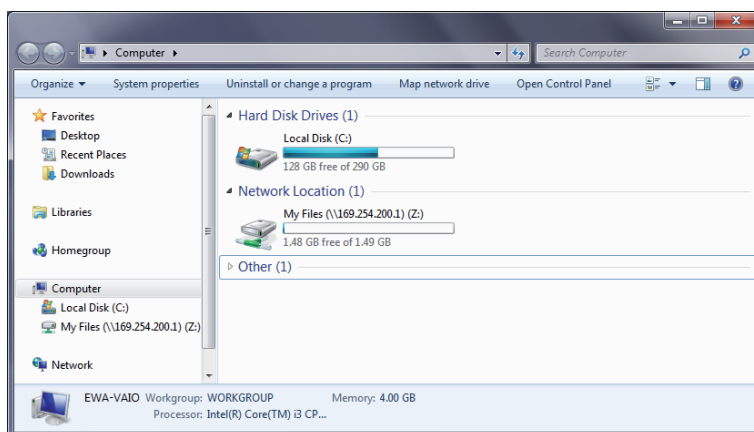


3. Transferring files between MoLab and a computer

³ <http://www.microsoft.com/download/en/details.aspx?id=15>

After making connection to MoLab you can browse the content of MoLab in Windows ActiveSync/Mobile Device Center, or in Windows Explorer where MoLab is available as CMA_MoLab.

Each time MoLab is turned on and connected to the computer via the USB cable, MoLab is detected as CMA_MoLab and Windows ActiveSync or Mobile Device Center starts automatically. Files can be transferred, backed up, added, removed and copied between MoLab and the host PC.



WARNING! Be careful when deleting files on MoLab. By removing some folders or files MoLab may not work properly anymore.

4. Using MoLab for data collection with the Coach 6 PC program

In this mode MoLab is connected to a PC computer via a USB cable and is controlled by the Coach 6 program or by the Coach 6 Lite program running on the PC. During such measurement MoLab stays connected to the PC via a USB port and is controlled by the Coach 6 program⁴ or by the Coach 6 Lite program¹ running on the PC. The collected data is transferred in real-time to the computer. The course of the measurement can be followed directly on the computer screen. When the Coach 6 PC software controls MoLab, then the MoLab screen is inactive and displaying the image shown here. The recorded data are not stored in MoLab's memory and should be saved on the PC in Coach 6.



Detailed information about the use and features of:

- **Coach 6** can be found in the **Guide to Coach 6**, and
- **Coach 6 Lite** can be found in the **Guide to Coach 6 Lite**.

Both guides can be found on the CMA website (www.cma-science.nl/english) under *Downloads*.

⁴ The support for MoLab starts in Coach 6.4 and Coach 6.4 Lite.

4.1. Activities for MoLab

The PC version of the full Coach 6 program offers more features than the Coach 6 CE program does. One of the most important is the Author mode with the possibility of creating Coach Activities and Results for MoLab.⁵ Such Activities (*.cma files) and Results (*.cmr files) can be copied to the MoLab DataFlash user memory or a user memory card and opened in the Coach 6 CE program.

Any features in the Activities and Results not existing in the Coach 6 CE program, such as images embedded in texts, videos, background graphs, diagram annotations, etc., will be ignored and will be not shown on MoLab.

Exemplary Activities, prepared for use by students, are available as well in the Coach 6 CE program as in the Coach 6 and Coach 6 Lite programs.

4.2. Typical measurement procedure in Coach 6

To collect data with MoLab connected to the PC (a typical procedure):

- Turn MoLab on and connect it to the computer via a USB cable.
- Start Coach 6 on the computer.
- Connect an ML sensor(s) to the sensor input(s) on MoLab.
- In Coach 6 open an Activity/Result for MoLab.
- MoLab automatically detects the connected sensor(s) and displays the sensor icons of detected sensors on the MoLab screen panel on the PC.
- The measurement will be executed according to the given measurement settings. Click the **Measurement Settings** icon  in the Coach 6 toolbar to check these settings: measurement type, measuring time, sampling frequency and number of collected samples.
- Follow the instructions in the Activity or directly start the measurement by clicking the green **Start** button .
 - In most cases, Coach automatically starts the measurement.
 - If triggering is enabled then the measurement is started automatically when the trigger conditions are met.
 - When the type of measurement is set to **Manual** then the green **Manual Start** icon  appears in the Toolbar. Click this icon to collect a single measurement. When keyboard input(s) is specified then the value of one or more quantities have to be typed in.
- The measurement is stopped when the specified measurement time (time-based) or specified number of samples (manual) has been reached. If you want to interrupt the measurements process, click the red **Stop** button  or press the **Esc** button.
- Save your result to file via the **File** menu options **Save** or **Save As....**

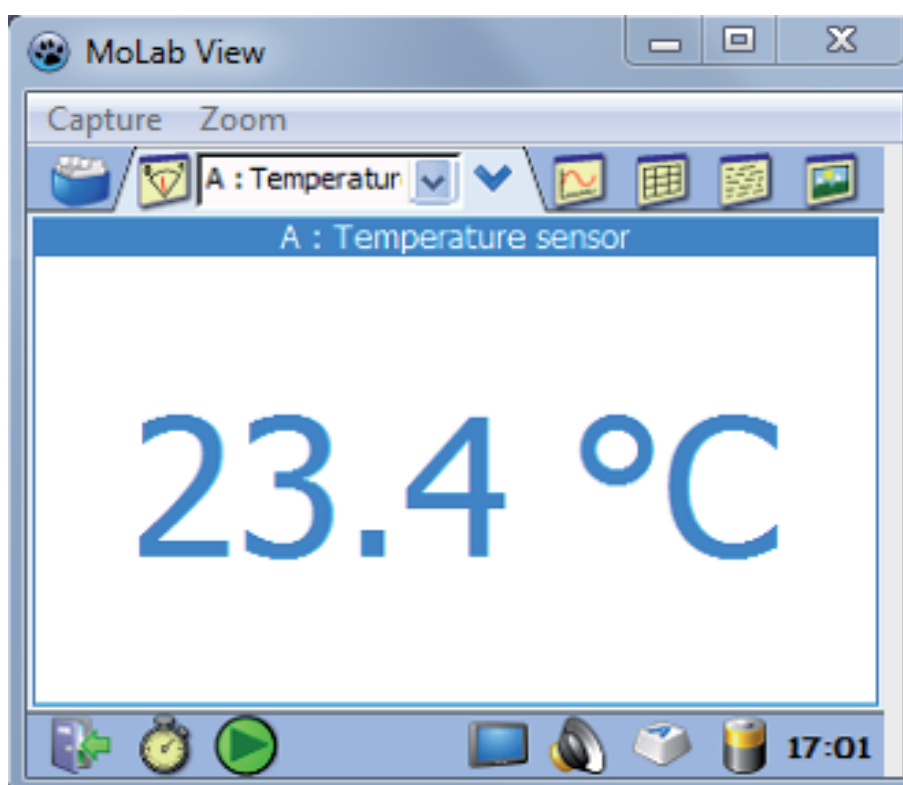
⁵ Only possible in the Author mode in Coach 6.

5. MoLab View

MoLab View is a utility program, which displays the image of the MoLab screen on the computer screen. MoLab View is intended for class instructions on MoLab use or when a projected view of the MoLab screen is required.

For using MoLab View, MoLab has to be:

- connected to the host PC via a USB port,
- Windows CE Services software, Microsoft ActiveSync or Windows Mobile Device Center, has to be installed on the PC⁶, and
- the Coach 6 PC program should be closed.



The MoLab View PC program.

To Start MoLab View

- Click on the Windows **Start** button and select **Programs**.
- Then go to **CMA Coach 6** (or **CMA Coach 6 Lite**) > **Utilities** and select **MoLab View**.
- The program automatically displays the current MoLab screen.

⁶ Notice that in the Mobile Device Center software use the option 'Connect without setting your device'.

MoLab VIEW MENU

CAPTURE MENU

- **Save to file** - to capture the current displayed screen image and save it as a image file (*.bmp and *.png formats).
- **Copy to Clipboard** - to capture the current displayed screen image and store it on the Windows clipboard.
- **Record** - to capture in real-time a series of displayed screens and save it as a video file (*.avi format, different compressions available).
- **Print** - to print the current displayed screen image.

These options are useful for creating teaching materials and tutorial videos.

ZOOM MENU

The **Zoom** menu of MoLab View allows zooming in and zooming out the currently displayed screen.

The Coach 6 CE program running on MoLab can also be controlled in MoLab View using the computer mouse in the same way you would tap the actual MoLab screen using the stylus.

6. MoLab Update

MoLab Update is a PC program to update Coach 6 CE and is available as a separate program or under **Utilities** after installation of Coach 6 or Coach 6 Lite PC software. Software updates of Coach 6 CE, as they are released, will be available at CMA website (www.cma-science.nl/english) under *Downloads*.

X. TECHNICAL SPECIFICATIONS

1. MoLab device

- ✓ Windows CE device
- ✓ On/Off switch
- ✓ 3.5" TFT touch screen, 320 x 240 pixel color display
- ✓ 533 MHz Samsung ARM processor
- ✓ 256 MB memory
- ✓ 64 MB user memory:
 - 32 MB for MoLab Coach 6 CE application (AppFlash)
 - 32 MB for user data (DataFlash)
- ✓ USB mini port for powering and computer connection
- ✓ 4 sensor inputs for ML type of sensors
- ✓ Micro SD memory card slot
- ✓ Audio In/ Audio out ports
- ✓ 3 hardware push buttons
- ✓ Rechargeable battery pack: Li-ion 3.7 V, 2300 mAh (typical)
- ✓ Built-in sound sensor
- ✓ Coach 6 CE software upgradable
- ✓ Windows CE OS upgradable

2. Sensor which can be connected to MoLab

Only ML type of CMA sensors can be connected to MoLab. Three of such sensors are delivered together with MoLab:

- ✓ ML11s Temperature sensor (- 40 .. 125° C),
- ✓ ML14s Light sensor (1 .. 65,535 lux), and
- ✓ ML17f Voltage sensor (-15 .. 15 V).

3. Working conditions and maintenance

For your safety and that of your equipment, follow these rules for handling and cleaning your MoLab and for working more comfortably.

- ✓ Your MoLab is designed to be operated on a desk or hand-held.
- ✓ Your MoLab is not waterproof. Precautions must be taken to ensure that liquid cannot enter the unit.
- ✓ Do not expose your MoLab to extreme heat or cold sources. Do not expose to direct sunlight for extended periods of time. Do not expose it to temperatures higher than 60° C.
- ✓ Operating your MoLab outside the following ranges may affect performance:
 - Temperature: 5° to 40° C.
 - Relative humidity: 0% to 90% (noncondensing)

- ✓ Never force a connector into a port. When connecting a sensor, make sure that the sensor cable connector matches the port, and that you have positioned the connector correctly in relation to the port. Firmly press the sensor cable connector into the sensor port to assure good contact.
- ✓ When cleaning your MoLab, first turn it off and unplug the connected sensors and USB cable. Then clean with a soft, lint-free cloth. Avoid getting moisture in any openings. Do not spray liquid directly on MoLab. Do not use aerosol sprays, solvents, or abrasives that might damage the finish. For cleaning the MoLab Screen you can use a cloth dampened just with water.
- ✓ When replacing the battery, only use a MoLab replacement battery pack supplied by CMA.

4. CMA software for MoLab

- ✓ **Coach 6 CE** – Windows CE program pre-installed on MoLab.
- ✓ **Coach 6 Lite for PC** – PC program to control MoLab with computer, free but limited version.
- ✓ **Coach 6 for PC** – PC program to control MoLab with computer (license needed), includes Author mode to create Activities for MoLab and Data-Video, Modeling and Animations possibilities.
- ✓ **MoLab View** – PC program to display the MoLab screen on a computer screen.

5. Microsoft software for MoLab

The software below is needed to establish communication between MoLab and the host PC. Without it MoLab will not work properly with the computer.

- ✓ **Microsoft ActiveSync** - Windows CE Services software for Windows XP and earlier Windows versions.
- ✓ **Windows Mobile Device Center** - Windows CE Services software for Windows Vista and Windows 7.

This software can be downloaded freely from www.microsoft.com.

Warranty:

The MoLab data-logger ML01 is warranted to be free from defects in materials and workmanship for a period of 12 months from the date of purchase provided that it has been used under normal laboratory conditions. This warranty does not apply if MoLab has been damaged by accident or misuse.

Note: *This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.*

Rev. 11/02/2014

