
€LAB INTERFACE 008

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) for the latest version of this manual and updates of Coach software products.

Aan onze Nederlandse gebruikers...

€Lab wordt standaard uitgeleverd met Engelse handleiding.

U kunt de laatste versie van de Nederlandse handleiding en de nieuwste update van Coach downloaden van de CMA-website (www.cma-science.nl).

€LAB User's Guide ver. 4.0, December 2014

Author: Ewa Kedzierska

© CMA, Amsterdam, 2014

TABLE OF CONTENTS

I. GETTING ACQUAINTED	4
1. Introduction	4
2. €LAB components	4
3. €LAB operating system	4
4. Computer and software requirements	5
5. Attaching €LAB to the computer	5
6. Troubleshooting tips	5
7. Connecting sensors	5
7.1. Analog sensors	5
7.2. Automatic sensor recognition	6
7.3. Counters.....	6
II. USING €LAB WITH THE COMPUTER	7
1. Working with Coach 6	7
2. Automatic sensor detection for Coach Activities with €LAB	7
3. Example of a measurement with €LAB and Coach	8
III. TECHNICAL SPECIFICATIONS OF €LAB	9
1. Connection to the computer	10
2. Power Supply	10
3. Analog to Digital Conversion	10
4. Memory	10
5. Inputs-	11
6. Sensors which can be used with €LAB	11
6.1. Maximum power requirements.....	11
6.2. USB-power quality.....	12

I. GETTING ACQUAINTED

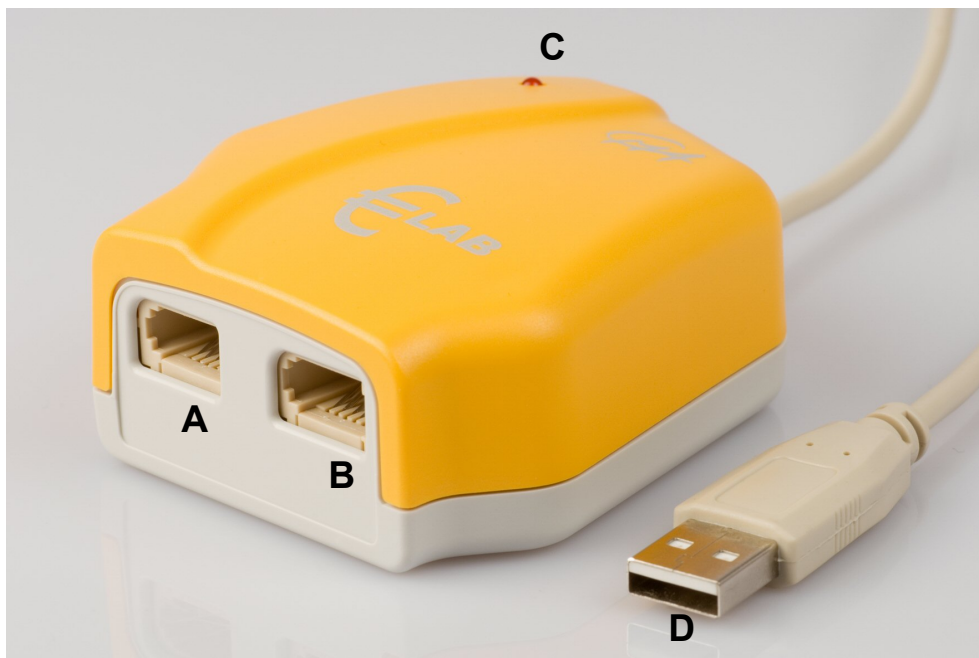
1. Introduction

The CMA €LAB is a simple USB lab interface which can be used to introduce students to measurements with the computer. The interface has two analog inputs to connect sensors with BT plugs. A large number of sensors is available for €LAB and can be used for measuring different physical quantities. It is connected directly to the computer through a USB-port and no extra power supply is needed. To use €LAB, you need the Coach 6 Lite or Coach 6 software running on your computer.

2. €LAB components

€LAB is provided with:

- A. Analog BT input 1
- B. Analog BT input 2
- C. LED indicating interface initialization
- D. USB cable.



€LAB contains an embedded processor and built-in memory, enabling measurements at high sample rates (up to 40 000 measurements per second) with accurate timing, independent of the host computer. The FLASH memory allows easy upgrade of the internal system software.

3. €LAB operating system

€LAB is equipped with an internal operating software (firmware), which is stored in its FLASH memory. The firmware update can be performed manually by using CMA


Firmware Update program or automatically via Coach 6 and Coach 6 Lite. Coach recognizes automatically when a connected €LAB needs to be updated and offers direct update.

4. Computer and software requirements

To use €LAB with the computer you need Coach 6 Lite (free) or Coach 6 (licensed) version 6.2 or higher running on a Pentium III computer with Windows with at least 192 MB RAM (recommended 256 MB) and unused USB port. Both programs can be downloaded via CMA website at www.cma-science.nl.

5. Attaching €LAB to the computer

To connect €LAB to your computer simply plug its USB-plug into a free USB-port of the computer. The LED of the interface will switch on for a short period of time. This means that the interface initializes. Windows might show a notice that a new USB-device is found. After €LAB is detected and you have Coach 6 Lite installed on your computer then Coach 6 Lite will start automatically and the €LAB project will open.

Automatic detection of €LAB can be switched off by right clicking the Coach 6 icon  in the taskbar and selecting *Stop*.

6. Troubleshooting tips

It may happen that the communication between €LAB and the computer is lost. If this happens you have to reset €LAB. This can be done in two ways (in the Coach software):

1. When there is no communication on opening of a Coach Activity/Results and the program displays the message that the panel €LAB can not be initialized then unplug the interface and plug it in again after a few seconds or plug it into another USB-port of your computer. Press *Retry* in Coach.
2. When the communication with the interface is lost while working in a Coach Activity/Result then:
 - Right click the €LAB screen panel.
 - Select the *Reset Hardware* option. This option is only available if the €LAB panel is active in Coach.

7. Connecting sensors

7.1. Analog sensors

A wide range of sensors can be connected to €LAB. Most CMA, Vernier and TI sensors are recognized by the interface.

Both €LAB inputs have two measurement ranges: 0 .. 5 V and -10 ... 10 V and can be used simultaneously. Please note that due to USB-power limitations some sensors

will not work properly, for details see '*III. 6. Sensors which can be used with €LAB*'.

7.2. Automatic sensor recognition

€LAB automatically identifies most CMA sensors when they are connected to €LAB inputs. €LAB recognizes Intelligent and Auto-id sensors.

- An *Intelligent sensor* has a memory chip with information about the sensor. Through a simple protocol (I²C) the sensor communicates with €LAB and transfers its data (name, quantity, unit and calibration) to the interface and the Coach program.
- An *Auto-id sensor* is equipped with a specific sensor resistor, which allows automatic identification of the sensor and using proper sensor data from the Coach Sensor Library.

When a sensor is physically plugged into an input of €LAB then €LAB automatically detects the sensor. When €LAB recognizes the connected sensor as an Intelligent sensor or Auto-id sensor then the Coach program displays calibrated signal values measured by the sensor. User can overrule this setting by selecting another sensor from the Coach Sensor Library.

When €LAB recognizes the connected sensor as another type of sensor then the *Unknown sensor* voltage icon appears and displays signal voltage values measured by the sensor. To calibrate the measured signal the user has to select manually the proper sensor from the Coach Sensor Library. (See also '*II. 2. Automatic sensor detection for Coach Activities with €LAB*').

7.3. Counters

One input at a time of the €LABAB interface can be used as a counter input. If sensors, which generate pulses, such as the Geiger-Müller radiation sensor (CMA art. nr. 0661) or the Photogate with Pulley attachment (CMA art. nr. 0662i), are connected to these inputs, pulse counting is automatically performed.

€LAB has the possibility to adjust (via Coach software sensor settings) the counter threshold. If a counter signal crosses this threshold in the predefined direction, the counter is incremented by one.

Sometimes it is useful to count signal changes of an analog sensor as pulses, e.g. to measure how often the screen is refreshed (using a light sensor as counter) or to measure the rate with which your heart beats (using a heart beat sensor as a counter). With €LAB it is possible, via Coach software sensor settings, to define analog sensors as counters. If the analog signal of such a sensor crosses a specified value (threshold) in a predefined direction, the counter is incremented by one. (For detailed information consult Guide to Coach 6 Lite or Guide to Coach 6 manuals which can be downloaded at CMA website).

II. USING €LAB WITH THE COMPUTER

To use €LAB with the computer you need a PC computer with the Coach 6 Lite or the Coach 6 program (see '1. 4. Computer and software requirements').

During the measurements €LAB stays connected to the computer. Sampled data are transferred in real time to the computer. The course of the measurement can be followed directly on the computer screen in the Coach program.

1. Working with Coach 6

When you work with Coach 6 Lite (6.2 or higher) you can start the program by automatic interface recognition. Plug your €LAB into the USB port, after the interface is detected Coach 6 Lite will start and the €LAB project will open.

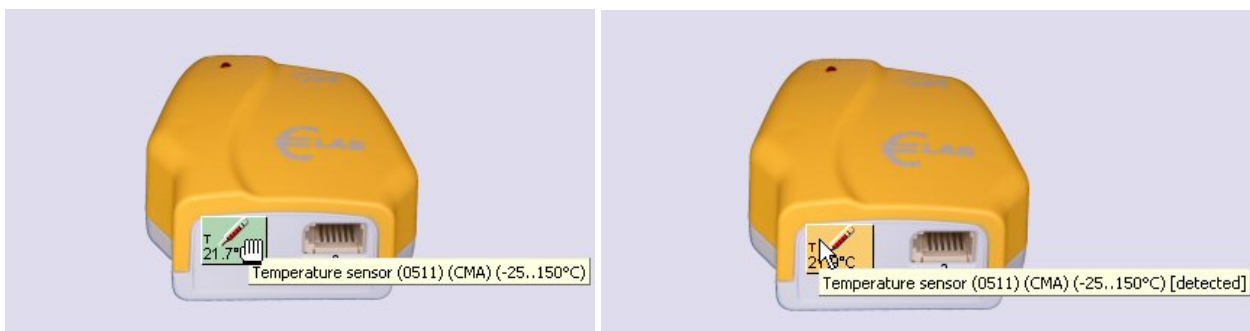
When you work with Coach 6 (6.2 or higher) then you have to open Coach via Windows Start menu or via double-clicking a Coach Activity file (*.cma), a Coach Result file (*.cmr) or a Windows shortcut to such file.

Coach 6 Lite and Coach 6 offers a set of elementary Exploring Science Activities for €LAB and its temperature, light and sound sensors. These are ready-to-go Activities in which students solve the given problems by taking measurements with sensors. The Own LAB Activity, included in the Coach project Own LAB, allows students to setup and perform their own experiments with any supported sensors.

Extensive information on working with Coach 6 Lite and Coach 6 programs can be found respectively in the *Guide to Coach 6 Lite* and *Guide to Coach 6* manuals, and in the on-line Coach Help System.

2. Automatic sensor detection for Coach Activities with €LAB

In Coach Activities with €LAB, two kinds of sensor icons can be used: *normal (green)* and *detected (orange)*. Normal sensor icons can be selected from the Coach Sensor library and placed on the sensor palette or on the €LAB screen panel by the user. Detected sensor icons are used for sensors automatically recognized by €LAB. These sensor icons exist only on the €LAB screen panel and cannot be moved by the user. When the mouse cursor is placed above a detected sensor icon then the tool tip hints that it is a [detected sensor] appears (see the figure).



When a sensor is physically connected to one of the inputs of €LAB then, depending

on the current settings on the €LAB screen panel, Coach acts as follows (usually within few seconds):

1. ***if there is no sensor icon on this Panel input*** - then the sensor icon corresponding to the sensor detected by €LAB appears on that Panel position. For *Intelligent* and *Auto-id* sensors calibrated signal values measured by the sensor are displayed on its icon, for another type of sensors signal voltage values measured by the sensor are displayed on its icon.
2. ***if there is already a normal sensor icon on this Panel input*** - then nothing happens, the normal sensor icon remains on the screen panel and calibrated signal values measured by the sensor are displayed on the icon.

When a sensor is physically disconnected from one of the inputs of €LAB then, depending on the current settings on the €LAB screen panel, Coach acts as follows (usually within few seconds):

1. ***if there is a detected sensor icon on this Panel input*** - then the detected sensor icon disappears from the Panel;
2. ***if there is a normal sensor icon on this Panel input*** - then the normal sensor icon remains on the Panel without any change, however the measured values are not displayed on the sensor icon anymore.

When the user tries to replace a detected sensor icon by dragging a normal sensor icon on it then the question *Replace the currently connected sensor?* appears on the computer screen. Clicking *Yes* replaces the detected sensor icon by the normal sensor icon.

3. Example of a measurement with €LAB and Coach

Guided by this step-by-step tutorial you can perform your first temperature measurements with €LAB. Before you start make sure that the Coach 6.2 Lite software is installed on your computer.

In this experiment you are going to investigate temperature variations of water in a beaker. During this measurement €LAB collects temperature data and the measured data are displayed on the screen in a graph, a table and as a digital value. The measured value is also displayed on the sensor icon on the €LAB screen panel.

Materials

1. €LAB
2. PC computer with the Coach 6.2 Lite installed
3. CMA Temperature sensor (art. nr 0511)
4. 250 mL beaker and 100 mL hot water

Measurement procedure

1. Connect €LAB to the computer.
2. After €LAB is detected Coach 6 Lite will start automatically and the €LAB

- project will open.
3. Open the project *Own LAB* and select the activity *Own LAB*.
 4. Plug the CMA Temperature sensor (CMA art. Nr 0511) into input 1 of €LAB.
 5. €LAB detects the temperature sensor and its icon appears on the €LAB screen panel. You can overrule these settings by dragging a sensor icon from the sensor palette to input 1 of the €LAB screen panel.
 6. Right click the icon and select *Display as Diagram*. Place the diagram in one of the empty panes.
 7. Right click the icon and select *Display as Table*. Place the table in one of the empty panes.
 8. Right click the icon and select *Display as Value*. Place the value in one of the empty panes.
 9. Determine the room temperature.
 10. Fill a beaker with hot water and place the temperature sensor in the water.
 11. Click the *Measurement settings* ⌚ button and set the measuring time to 3 minutes, and measurement frequency to 50 per second.
 12. Click the green *Start* ▶ button to start a measurement.
 13. The measurement stops after the measuring time is reached or by clicking the red *Stop* ⏹ button.
 14. Analyze the measured data. All processing and analysis tools of Coach are available from the Diagram and Table Tool menus (right click the diagram/table window or click its *Menu* button).

The screenshot shows the Coach 6 Lite software interface. The main window displays the current temperature reading: **71.9 °C**. Below this, there is a data table for the temperature sensor (CH1) with the following data:

time (s)	T (°C)
2065	72.0
2066	72.0
2067	71.9
2068	71.9
2069	72.0
2070	71.9

Below the table, there is a graph showing the temperature (T in °C) versus time (s). The graph shows a curve that starts at approximately 50°C and rises to 71.9°C. The x-axis ranges from 0 to 30 seconds, and the y-axis ranges from -20 to 140°C.

The interface also includes a 'EuroLab' window showing a virtual representation of the temperature sensor and a 'Coach 6 Lite - Life old - Own Lab test.cma' window with a menu bar (Program, Window, Help) and a toolbar with various icons.

III. TECHNICAL SPECIFICATIONS OF €LAB

1. Connection to the computer

€LAB is connected to the PC via a USB-port (compatibility USB 1.0, USB 1.1 and USB 2.0, Max. transfer rate 64 kB/s).

2. Power Supply

€LAB is powered from the USB power supply. Because of this the quality of the 5V power supply for the sensors depends on the quality of the USB-power supply and may differ from one computer to another.

5V sensor power supply	4.35 .. 5.25V (quality dependent on host computer hardware)
Maximum current	At least 40 mA is available for sensor power. Up to 440 mA is normally available, but dependent on host computer hardware and other USB-devices connected to the host computer. Power consumption with no sensors connected is max. 60 mA.

3. Analog to Digital Conversion

€LAB uses a 12-bit ADC. The 12-bit resolution results in a voltage resolution of 1.2 mV for the 0 .. 5 V range, and 5 mV for the -10 .. 10 V range.

The maximum sample rate depends on the number of used channels and the way the channels are used. In *normal mode*, the interface can take one sample every 100 µs. This means that one channel can be sampled at 10 kHz and two channels can be sampled at 5 kHz. Sample intervals can be chosen in units of 100 µs, so possible rates are: 10 kHz, 5 kHz, 3.3 kHz, 2.5 kHz, 2.0 kHz, 1.67 kHz etc.

In *fast mode*, the interface takes one sample every 25 µs (sample rate: 40 kHz). During fast mode only one sensor/actuator can be connected.

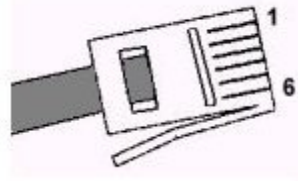
Counter operation is possible for one channel at a time. The channel is monitored every 200 µs to determine if the signal has passed the set threshold value (up or down). This means that the minimum width of a pulse that must be counted is 200 µs. The maximum frequency of a signal to be counted is 2.5 kHz in case of a symmetric signal. Counter operation is not available in fast mode.

4. Memory

€LAB is equipped with Flash (non-volatile) memory, which contains the internal operating system (firmware). Flash memory can be rewritten to update the firmware. For buffering of sampled data, €LAB is equipped with 32 kB of RAM memory which can contain maximal 16,000 samples.

5. Sensor inputs

Inputs 1 and 2 are used for analog sensors with right-hand BT connectors with the following pin-outs:

Pin	Analog Input 1 and 2	<p>Note:</p> <p>The BT plug has two signal pins Vin (pin 1) and Vin-low (pin 6). The input range of pin 1 is -10V to +10V, and pin 6 is 0 to +5V. In the Coach software it is possible to select the range i.e. select the pin of which signal will be taken (see the Coach help keyword 'Input range'). Standard range is 0 to +5 V (pin 6). For connected sensors with 4-mm plugs via adapter art. nr 0519 the standard range 0 to +5 V (pin 6) should be selected. (In this adapter there is no connection between the yellow lead and pin 1).</p>
	 <p>Right-hand connector</p>	
1	Vin	
2	Ground	
3	Vres ¹ /I2C ³ data	
4	Auto-ID ² /I2C ³ clock	
5	+5 V DC	
6	Vin-low	

	Vin	Vin-low
Inputs	Input 1, Input 2	Input 1, Input 2
Input range	-10 to +10 V	0 to +5 V
Resolution (12 bit)	5 mV	1.2 mV
Accuracy	≤ 1 %	≤ 1 %
Input impedance	100 kΩ	100 kΩ

¹ Vres - Output reference voltage (pull-up resistor 15 kΩ) for resistance measurements.

² Auto ID (pull-up resistor 10 kΩ) - Auto ID sensor detection input. The BT inputs have the possibility for automatic sensor recognition.

³ For (I²C) communication between €LAB and intelligent sensors.

6. Sensors which can be used with €LAB

In principle, all sensors from CMA, Vernier and TI can work with €LAB, but for a few sensors the accuracy might be degraded due to the quality of the USB power supply (see details below). Note that this does not depend on the €LAB interface, but on the host computer USB implementation and thus may differ from one computer to another.

6.1. Maximum power requirements

For some sensors complications can arise with the sensor power supply. Computer USB-ports are guaranteed to supply at least 100 mA per USB-port (most computers will supply up to 500 mA without problems). Because the interface uses maximum 60 mA, at least 40 mA is available to the sensors. CMA sensors, which continuously

draw more than 40 mA are CO₂ Sensor 0660i and CO₂ Sensor 0661i. For most computers this will not cause any problems, but some computers may not provide enough power. If this problem occurs a powered USB-hub can be used.

Some sensors draw more than 40 mA for a very short time after plug-in (inrush current). In most cases this will not cause any problems, but with some sensors a reset of the interface will occur due to a voltage decrease or temporarily shut-off of the USB power supply. After the interface has reset, the sensor and interface will again function normally. The Coach software will automatically re-establish the connection to the interface. If this happens, you may notice a delay of a number of seconds and the LED on the €LAB interface will switch on for a short time when the interface resets. The CMA sensors that are likely to cause a reset of the interface are Blood Pressure Sensor 0377i, Colorimeter 03581, Force sensors 0663i, Ion Specific Sensors 039x, ORP Sensor 0313i and Spirometer 0378i.

Please note that this depends on the USB-power supply and may differ from one computer to another: on some computers a reset will not occur when one of the sensors from the list below is connected, on some computers a reset may also occur when other sensors are connected.

6.2. USB-power quality

Computer USB-ports are only guaranteed to have the 5 V supply between 4.35 V and 5.25 V, so the power supply does not always provide exactly 5 V. Because the power supply for the sensors is directly derived from the USB power supply, the sensor power supply quality will be comparable to the USB power supply quality.

Normally, if the 5 V power supply is not exactly 5 V but a bit lower or higher, it will only influence the maximum measurement range of connected sensors. For example, if the 5 V supply is a bit lower than 5 V, a Force Sensor that can normally measure forces up to 60 N will then only measure forces up to e.g. 57 N.

Although the maximum values of the range will be affected, for most sensors, measurements that are not at the maximum of the range will not be affected: the output of most sensors is not dependent on the exact value of the 5 V supply in the normal measurement range and the calibrations will not be affected.

For some sensors this does not hold true and the output of these sensors **IS** affected by the exact value of the 5 V power supply. These sensors will seem to function normally, but the accuracy of these sensors may be degraded and/or possible noise on the USB power supply can be propagated to the sensor output. These are the following CMA sensors: Angle Sensor 013i, Charge Sensor 0361i, Colorimeter 03581, Conductivity Sensor 0382, Dissolved Oxygen Sensor 0376, Gas Pressure Sensor 0341 (only a very small influence), Heart Rate Sensor 027i (needs to readjust after a sudden fluctuation in the power supply, but is not sensitive to the exact value of the power supply, Magnetic Field Sensor 024 and Relative Humidity Sensor 0381.

Warranty:

The €LAB 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 €LAB 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. 10/12/2014