
COACHLAB II⁺ INTERFACE 006

USER'S GUIDE



CENTRE FOR MICROCOMPUTER APPLICATIONS

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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...

CoachLab II⁺ 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. 1.5, December 2014

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I. INTRODUCTION

CoachLab II⁺ is a multifunctional interface for computerized measurement and control. It is an on-line interface with real-time display of the measured data on the computer screen.

CoachLab II⁺ is provided with its own micro-controller and *FLASH* memory (see 'Embedded system'). *FLASH* memory allows easy updating of the internal operating system software (firmware).

CoachLab II⁺ is connected to the computer via the USB port and powered via a mains adapter (included). The interface can sample up to 6 sensors simultaneously, in sampling rates as high as 100,000 samples per second (when measuring on one channel). A wide variety of sensors is available for connection to CoachLab II⁺.

Embedded system

Operating systems such as Microsoft Windows have the disadvantage that "real-time" measurements can be interrupted at any time for very short periods by other tasks the operating system has to perform (multitasking). This is especially a problem with high sample frequencies. This can be solved by controlling the processes by a separate micro-controller and to store the data in the interface's memory. This technology is used in CoachLab II⁺, so it has its own processor and memory.

When the software sends a measurement command to CoachLab II⁺, it carries the measurement out independently, and stores the data in its local memory. The data are sent to the computer via the USB port. If this process is interrupted by other tasks of the operating system, the data are not lost; they only appear with a little delay on the screen.

Reading guide for this manual

Chapter II provides all basic information about CoachLab II⁺ and its components.

Chapter III describes the use of CoachLab II⁺ with the computer and the Coach software.

Chapter IV provides detailed technical specifications of CoachLab II⁺.

Chapter V read in case of problems.

Appendix 1 describes the sensors, which can be used with CoachLab II⁺.

Appendix 2 lists measurement and control commands of CoachLab II⁺.

II. GETTING ACQUAINTED

In this chapter you can learn basic operations of CoachLab II⁺ like providing power and connecting sensors and actuators.

1. CoachLab II⁺ components

The CoachLab II⁺ package contains the following items:

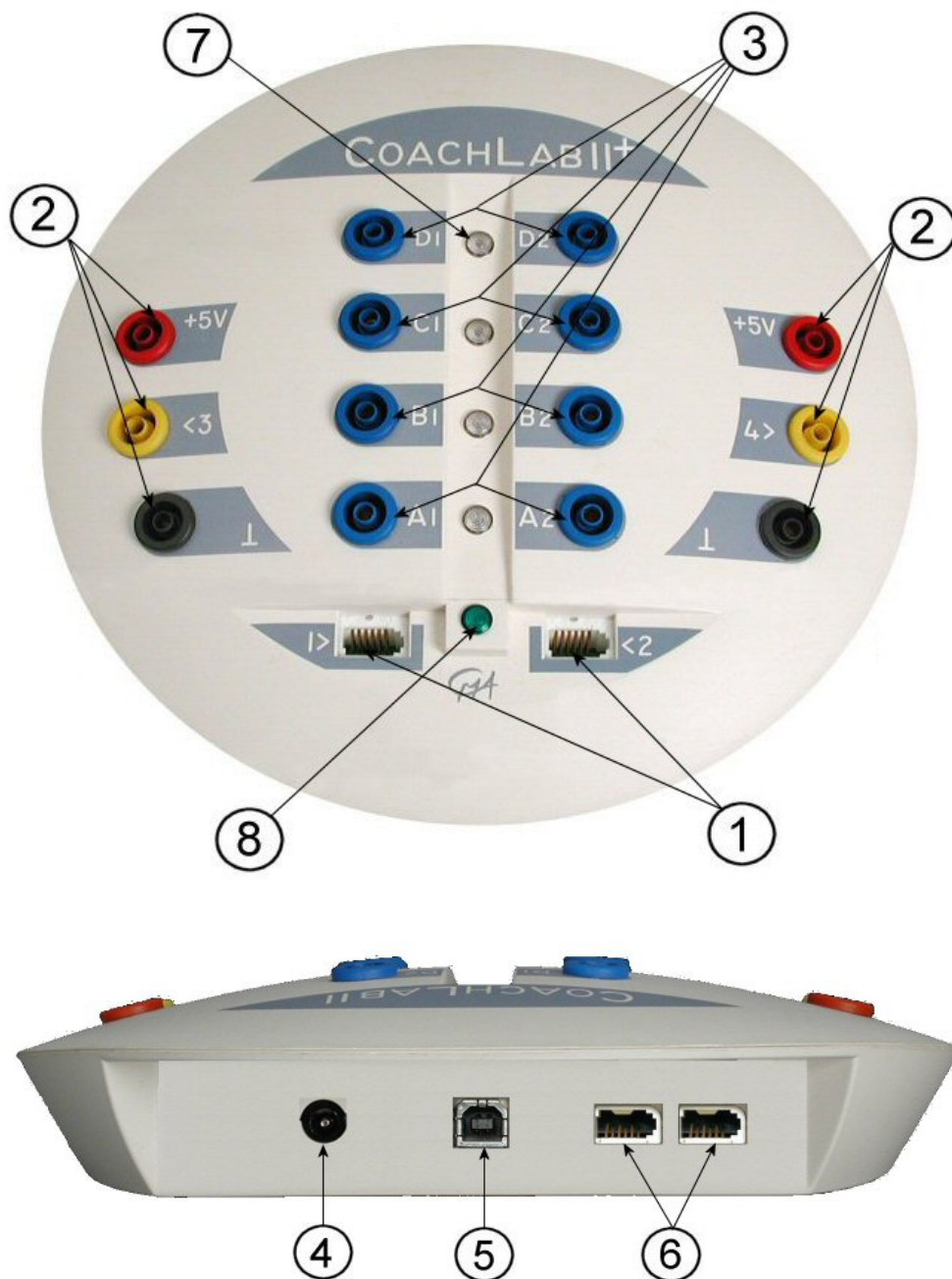
- CoachLab II⁺ interface
- Power supply
- USB cable
- User's Manual (English).



Items of the CoachLab II⁺ package

CoachLab II⁺ is provided with (see below):

- 1) Two analog inputs (1 and 2) to connect sensors with BT connectors.
- 2) Two analog inputs (3 and 4) to connect sensors with 4-mm plugs.
- 3) Four output channels A-D to control various actuators.
- 4) A bus for the external mains adapter.
- 5) A bus for USB connection.
- 6) Two digital inputs (input 5 and 6) to connect ultrasonic or digital sensors.
- 7) Four red/orange/green LEDs showing the status of each of the digital output channels.
- 8) A green LED which lights up when CoachLab II⁺ is properly powered.



2. CoachLab II⁺ operating system

CoachLab II⁺ is equipped with internal operating system (firmware). The firmware is stored in FLASH memory, which allows easy updating of the CoachLab II⁺ operating system with the most recent version.

As new functionality becomes available, you can download the software from the CMA website to your computer and update your CoachLab II⁺. Firmware updates are included with the Coach software. Check the CMA website (<http://www.cma-science.nl>) for updates.

3. Computer and software requirements

To use CoachLab II⁺ with the computer you need Coach 6 version 6.32 (or higher) running on a Pentium 4 computer (or better) with Win 8/Win 7/Vista/XP system software with at least 512 MB RAM and an unused USB port.

4. Attaching CoachLab II⁺ to the computer

CoachLab's USB connection bus is located at its rear side.

- Plug the square end of the USB cable into the USB bus on CoachLab II⁺.
- Plug the other end of the USB cable into the USB port on the computer.

Coach automatically detects the USB connection for CoachLab II⁺. It is not necessary to specify any hardware settings.

5. Providing power to CoachLab II⁺

CoachLab II⁺ is powered by an external power supply.

- Plug the round plug of the 12 V power supply into the bus (4) on the rear side of CoachLab II⁺.
- Plug the power adapter into the outlet.
- The green LED (8) lights up indicating that the interface is powered properly and a test program starts. During the test all LEDs successively light up.

Warning: Use **only** the included 12 V power supply otherwise CoachLab II⁺ can be damaged.

6. Resetting CoachLab II⁺¹

Rarely it may happen that the communication between CoachLab II⁺ and the computer is lost. If this is the case reset CoachLab II⁺. This can be done in two ways (via 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 CoachLab II⁺ can not be

¹ For more detailed problem descriptions see Chapter V 'Troubleshooting'.

initialized then:

- If the interface is connected properly to the computer (i.e. it did work before), reset the interface by disconnecting and reconnecting the plug of the external mains adapter.
 - Press *Retry* in Coach.
2. When the communication with the interface is lost while working in a Coach activity/result then:
- Right click the CoachLab II⁺ screen panel.
 - Select the option *Reset Hardware*. This option is only available if the CoachLab II⁺ panel is available in Coach.

7. Connecting sensors

Analog and digital sensors can be connected to inputs of CoachLab II⁺. All analog inputs can be used simultaneously and have two measurement ranges: 0 .. 5V and -10 .. 10 V can be converted into counters².

7.1. Analog sensors

Analog sensors can be connected to the analog inputs of CoachLab II⁺. Two kinds of inputs are available:

- two inputs (input 1 and 2) for sensors with BT (British Telecom)-style plugs with a right-hand connector³;
- two inputs (input 3 and 4) for sensors with 4-mm plugs (old style CMA sensors).

Adapters are available to convert:

- a BT input to three 4-mm plugs (CMA art. nr 0520)
- three 4-mm plugs to a BT connector (CMA art. nr 0519).



CMA Adapters 0520 (left) and 0519 (right)

² CoachLab II+ has the capability to convert an analog signal to a counter, a 1-bit digital meter, a frequency meter or a time-interval meter. In the conversion process, the analog signal is monitored at a high frequency (10 kHz) to determine when it crosses a predefined threshold in a given direction.

³ All CMA sensors purchased after January 2001 are provided with British Telecom plugs and can be connected directly to BT inputs.

7.2. Converted sensors

With the CMA CoachLab II⁺, it is possible to convert an analog sensor to function as a counter, a 1-bit digital meter, a frequency meter or a time-interval meter.

Such converted sensors can be very useful as pulse source for Event-based measurements. For a converted sensor, the input signal is internally monitored at 10 kHz, which puts a limit on the maximum frequency (5 kHz) or count rate (5000 counts/s). All converted sensors make use of a threshold and a direction in which the threshold signal value is passed.

Sensors, which generate pulses, such as the Geiger-Müller Ionizing Radiation Sensor (CMA art. nr 0666i) or the Smart Pulley (CMA art. nr. 0662i), can be directly connected to these inputs.

CoachLab II⁺ has the possibility to adjust 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. In the Coach 6 software converted sensors are indicated by a purple icon.

7.3. Digital sensors

Two inputs for digital sensors (input 5 and 6) are located at the rear side of CoachLab II⁺. Two digital sensors or two Ultrasonic Motion Detectors can be connected to these inputs. The digital channels accept British Telecom-style plugs with a left-hand connector. Notice that analog and digital sensors are "keyed" differently, preventing them from being connected to the wrong port.

8. Connecting actuators

CoachLab II⁺ has four output channels indicated A - D to control various actuators.⁴ Each of the output channels is provided with a push-pull channel driver, which can be set in four controllable states.⁵ The output LED indicates the states of the output channel by means of different colors: Green, Orange, Red, Off.

The maximum output current of each channel is 0.6 A. The total output current of all channels together is maximally 1.2 A. For instance, it is possible to drive two bi-directional motors of 0.5 A each.

The output channels can be set to 16 different power levels. Power is reduced by

⁴ CMA offers different actuators for example Actuator set with simple actuators like lamps, motor and buzzer (Art. nr 062) and more advanced actuators like step-motor burette (Art. nr 061). With the Switch Module (Art. nr 063), 230V-devices can be controlled.

⁵ A 'push- pull' output channel is a two-wired output. Each wire can be switched to one of the poles of the power supply (+ 12V and Ground). This way, one can choose the direction of the current through the actuator and results in four controllable states per output.

switching the 12 V on and off at a rate of 625 Hz.⁶

E.g. at level 1, an output channel is switched on for 1/16th of the cycle time and switched off for the remaining cycle time. The cycle is repeated with the mentioned frequency of 625 Hz. This is called PWM - Pulse Width Modulation.

9. Sensor recognition

CoachLab II⁺ automatically identifies sensors when they are connected to its BT inputs (analog inputs 1 and 2, digital inputs 5 and 6). CoachLab II⁺ recognizes *Intelligent* and *Auto-id* sensors⁷.

- An *Intelligent sensor* has a memory chip with information about the sensor. Through a simple protocol (I²C) the sensor communicates with CoachLab II⁺ and transfers its data (name, 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 CoachLab II⁺ then CoachLab II⁺ automatically detects the sensor. When CoachLab II⁺ recognizes the connected sensor as an *Intelligent* sensor or *Auto-id* sensor then the Coach program displays calibrated signal values measured by the sensor. Users can overrule this setting by selecting another sensor from the Coach Sensor Library.

When an *Intelligent* sensor or *Auto-id* sensor is physically disconnected from CoachLab II⁺ then the Coach program stops to display signal values measured by the detected sensors.

III. USING COACHLAB II⁺ WITH THE COMPUTER

To use CoachLab II⁺ with the computer you need a computer with the Coach software (see also 3. *Computer and software requirements*, page 8).⁸ During the measurements CoachLab II⁺ stays connected to the computer (via a USB port). 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 software.

⁶ The maximum power level for an actuator can be adjusted by the Coach software.

⁷ A complete list of intelligent sensors can be found in Appendix 1.

⁸ As it is possible to develop your own software to control CoachLab II⁺ (for example in LabVIEW or Java) the description of the command list and the data formats for CoachLab II⁺ are available on request from CMA.

1. Working with Coach

Extensive information on working with Coach can be found in the Coach User Manual *Guide to Coach* and in the on-line Coach Help System.

1.1. Installation of the CoachLab II⁺ driver

If Coach 6.32 (or newer) is not yet installed on your computer, first install or update the Coach software. Do NOT connect the CoachLab II⁺ hardware before the installation of the software is finished. For more information see the installation manual of Coach. When CoachLab II⁺ is connected for the first time, restarting Windows may be necessary (only the first time).

1.2. Automatic sensor detection for activities with CoachLab II⁺

CoachLab II⁺ automatically identifies sensors when they are connected to CoachLab II⁺ BT inputs (analog inputs 1 and 2, digital inputs 5 and 6).

In Coach Activities with CoachLab II⁺, two kinds of sensor icons are used: *normal* and *detected*. Normal sensor icons (green) can be selected from the Coach Sensor library and placed on the sensor palette or on one of the inputs of the CoachLab II⁺ panel by the user. Detected sensor icons (orange) are used for sensors automatically recognized by CoachLab II⁺. These sensor icons exist only on the CoachLab II⁺ 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 below).



When a sensor is physically connected to one of the BT inputs of CoachLab II⁺ then, depending on the current settings on the CoachLab II⁺ screen panel, Coach acts as follows (usually within few seconds):

1. **there is no sensor icon on this Panel input** - then the sensor icon corresponding to the sensor detected by CoachLab II⁺ appears on that Panel

position;

2. **there is a normal sensor icon on this Panel input** - then nothing happens, the normal sensor icon remains on the screen panel.

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

1. **there is a detected sensor icon on this Panel input** - then the detected sensor icon disappears from the Panel;
2. **there is a normal sensor icon on this Panel input** - then the normal sensor icon remains on the Panel without any change. CoachLab II⁺ follows the Coach calibrations.

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

2. Computer measurements with CoachLab II⁺ and Coach

After installation of Coach, exemplary Activities for the CoachLab II⁺ interface are available and are described in the *Coach Workbook*.

2.1. Tutorial: temperature measurements with CoachLab II⁺ and Coach

Guided by this step-by-step tutorial you can perform your first temperature measurements with CoachLab II⁺. Before you start make sure that the Coach software is installed on your computer.

On-line temperature measurement

In this experiment you are going to investigate temperature variations of water in a beaker. During this measurement CoachLab II⁺ 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 CoachLab II⁺ screen panel.

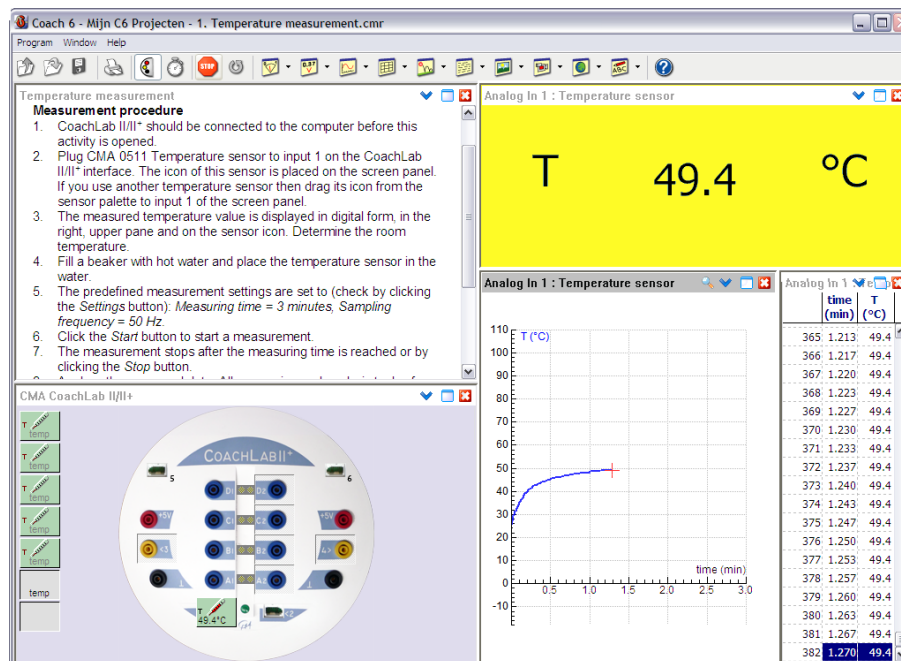


Materials

1. CoachLab II⁺
2. Computer with the Coach program
3. CMA Temperature sensor (art. nr 0511)
4. 250-ml beaker and 100 ml hot water

Measurement procedure

1. Connect CoachLab II⁺ to the computer.
2. Start Coach. Open the project *Measurement CL II - 1. Tutorial* and select the activity *On-line temperature measurement*.
3. Plug the CMA Temperature sensor (0511) into input 1 on CoachLab II⁺.
4. The temperature sensor icon is already placed on the CoachLab II⁺ screen panel. If you use another temperature sensor then drag its icon from the sensor palette to input 1 of the CoachLab II⁺ screen panel.
5. The measured temperature value is displayed in digital form in the Value window and on the sensor icon. Determine the room temperature.
6. Fill a beaker with hot water and place the temperature sensor in the water.
7. The predefined measurement settings are (check by clicking the *Measurement settings* button): measuring time = 3 minutes, sampling frequency = 50 per second. Click the green button to start the measurement.
8. The measurement stops after the measuring time is reached or by clicking the red stop button.
9. 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).



Manually-triggered temperature measurement

The Coach project *Measurement CL II - 1. Tutorial* consists of another tutorial activity: *2. Manually-triggered measurement on-line*. Perform this activity to learn how to do manually-triggered measurement with CoachLab II⁺ and Coach. The text included in the activity will guide you step-by-step through the measurement.

IV. TECHNICAL SPECIFICATIONS OF COACHLAB II⁺

1. Connection to the computer

CoachLab II⁺ is connected to the PC using a standard USB cable.

2. Power supply

CoachLab II⁺ is powered by a 12V DC, 1.25A switched mains adapter with a 2.1 mm DC-plug. Polarity: inside positive (+), outside negative (-).

Warning: Only use the included 12 V power supply otherwise CoachLab II⁺ can be damaged.

3. Analog to Digital Conversion

CoachLab II⁺ uses a 12-bit ADC. The 12-bit resolution results in a voltage resolution of 1.22 mV for the 0-5V range, and 4.9 mV for the -10 to +10V range.

The maximum sample rate depends on the number of used channels and the way the channels are used. The following table gives an overview:

Number of inputs used	Maximum sample rate
One analog input	100 kHz ⁹
Two analog inputs	50 kHz ^{Error! Bookmark not defined.}
Three analog inputs	3.3 kHz
Four analog inputs	2.5 kHz
One or two converted sensors (counter, frequency, period)	2.5 kHz (signal sampled at 10 kHz) ¹⁰
One motion detector (+ other inputs)	100 Hz
Two motion detectors (+ other inputs)	50 Hz

4. Memory

CoachLab II⁺ is equipped with Flash (non-volatile) memory, which contains the internal operating system (firmware). Flash memory can be rewritten to update

⁹ In order to facilitate large measurements that contain more than 32k samples (up to 500,000 samples), the interface is able to measure in “continuous mode”. In this case the number of samples is larger than the internal memory of the interface can hold, so the data must be transferred to the computer fast enough in order for the internal memory buffer not to get overwritten by newer data. The maximum sample rate is now limited by the speed of the data transfer from the CoachLab II+ to the computer. This mode can be used when a sample rate of 2.5 kHz (or lower) is chosen by the user. For higher sample rates, the maximum number of samples is limited by the internal memory of the interface and depends on the number of sensors that is used simultaneously (they share the same memory buffer).

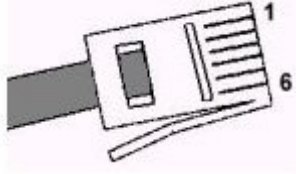
¹⁰ The signal of the sensor(s) are internally sampled at a frequency of 10 kHz, resulting in an absolute max. signal frequency of 5 kHz. The max. sample frequency of the *converted* signal in Coach is 2.5 kHz.

the firmware. For buffering of sampled data, CoachLab II⁺ is equipped with 64 kB of RAM memory which can contain maximal 32k samples. But in Coach it is possible to use the buffer in a cyclic way, resulting in measurement runs of up to 500,000 points (Coach' limit).

5. Inputs

5.1. BT 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	Note: 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 connecting 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).
	 Right-hand connector	
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 signal	Analog data	Analog data
Input range	-10 to +10 V	0 to +5 V
Resolution (12 bit)	4.9 mV	1.2 mV
Input impedance	100 kΩ	100 kΩ

¹ V_{res} - 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 CoachLab II⁺ and intelligent sensors.

5.2. 4-mm inputs

Inputs 3 and 4 connect analog sensors with 4-mm plugs with the following connectors:

4-mm lead	Analog input 3 and 4
Red	+5 V DC sensor supply voltage
Yellow	V _{in}
Black	Ground (common for all inputs)

	V _{in}
Inputs	Input 3, Input 4
Input signal	Analog data
Input range	-10 to +10 V or 0 to +5 V (software controlled)
Resolution (12 bit)	4.9 mV (-10 to +10V range) or 1.2 mV (0 to +5V range)
Input impedance	100 k Ω

Note: The 4-mm inputs allow direct measurement of any voltage between -10 and +10 V or between 0 and +5 V (depending on software settings).

For connecting sensors with BT plugs to input 3 and 4 CMA adapter art. nr 0520 has to be used. In this adapter the pins 1 and 6 of the BT plug are connected to each other and both signals 0 to +5 V and -10 to +10 V can be measured (without extra settings).

5.3. Analog inputs as event-source (converted signal)

All analog inputs can be selected to function as a counter, a 1-bit digital meter, a frequency meter or a time-interval meter. The analog signals are sampled each 100 μ s and evaluated if below or above the specified threshold. Hence the requirement for the analog input signal is that this signal is above the threshold for at least 100 μ s and also below the threshold for at least 100 μ s. This implies a maximum pulse or event frequency of 5 kHz, in case the signal is perfectly symmetrical. If noise is present in the input signal or the signal is not symmetrical, the maximum pulse frequency will be lower.

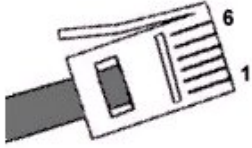
In case of event-based measurements, time stamps of the measurement points are also available from the CoachLab II⁺ memory (time resolution = 0.1 ms). If used as a counter, because of the above mentioned signal requirements, the maximum count-rate is 5000 counts per second (for symmetrical signals).

The maximum sample frequency of a *converted* signal is 2.5 kHz. Note that the maximum frequency of the signal itself may be higher (up to 5 kHz).

5.4. Digital inputs

The digital input ports labeled 5 and 6 are used for connection of digital sensors (for example ultrasonic motion detectors) with a left-hand BT connector. The digital

channel can also be used for connection of an up/down counter (e.g. a bi-directional pulley). The left-hand BT connector has the following pin-out configuration:

Pin	Sonic Input 5 and 6
	 Left-hand connector
1	Echo (input) ¹ / I/O ³
2	Init (output) ² / I/O ³
3	Auto - ID / I/O ³
4	+5 V DC
5	Ground
6	I/O ³

¹ Echo - Ultrasonic motion detector input, TTL signal

² Init - Distance initialization signal, TTL signal

³ I/O: these 4 pins can be configured for digital input or output

6. Outputs

The outputs are used for connecting actuators with 4-mm wires. The output channels are provided with push-pull drivers. The outputs can deliver current up to 0.6 A per channel (continuously). Maximum current for all output channels together is 1.2 A (continuously). There are 16 power levels available. Power is reduced by switching the 12 V on and off periodically at a rate of 625 Hz.

Note: To minimize the risk of damaging by overloading, the outputs of CoachLab II⁺ do not have any power when no actuator icon is placed on the screen panel in the Coach software.

7. Indicator LED's

The green LED indicates that CoachLab II⁺ is properly being powered by the mains. The Red/Orange/Green LEDs indicate the 4 states of the output channels.

8. Dimensions

Size: Ø approx. 21 cm, height: approx. 3.5 cm;

Weight: approx. 400 g

9. Warranty

CoachLab II⁺ is guaranteed completely for product quality during 12 months after the date of purchase. Any damage caused by operation contrary to the prescriptions in this manual is excluded from this guarantee.

V. TROUBLESHOOTING

Problem which appears when working with the Coach software	Solution
Coach is not able to communicate with the connected CoachLab II⁺ interface on opening a Coach activity or result. This is the case when: 1. there is no interface connected to the computer; 2. the activity/result is developed for another interface than CoachLab II⁺; 3. the communication between interface and computer is lost. A dialog box tells you that 'Coach cannot initialize Panel CoachLab II⁺'.	1. Connect CoachLab II⁺ to the computer. 2. Click the button 'Select other' and select CMA CoachLab II⁺ from the list. Note: If the activity author did not define 'Alternative panels' then this button does not appear. In this case click 'Ignore' and switch the panel in the activity (see the Coach help keyword 'Select other Panel'). 3. Reset CoachLab II⁺ by briefly disconnecting it from the mains and reconnecting it. The test cycle will run (the LEDs will flash). Open the activity/result again. Note: If CoachLab II⁺ is not detected by Coach at all, check whether it is connected with the original delivered cable and mains adapter (12V).
Coach is not able to communicate with CoachLab II⁺ in an Activity (you can see that the values on the Sensor icons do not change at all for a longer period of time. Normally, these values always fluctuate a little bit due to noise.)	• Right click the screen Panel and select the option 'Reset Hardware'. • You may combine this with resetting CoachLab II⁺ (see point 3 described above).
The measurement values displayed on the Sensor icon or in a Window are not realistic.	You have probably used a Sensor icon, which does not correspond to the actual sensor connected to CoachLab II⁺. • Check the ToolTip with the description of the Sensor icon, or look up the sensor information in the CMA Hardware help. • Replace the Sensor icon.
When measuring, the values do not appear on the screen in real time, but after the measurement run is finished.	1. The measurement frequency is too high. If you want to receive the values in real time set the Measurement frequency to a lower value. 2. The measurement is carried out in Quick mode, i.e. the screen is not updated during the run. This happens among others when you start a measurement with the shortcut <Ctrl>+<F9>. When the Activity stays running in Quick mode (also after starting the measurement with the Start button). Quick mode has to be turned off in the Activity options in Author mode.

APPENDIX 1. SENSORS WHICH CAN BE USED WITH COACHLAB II⁺

CoachLab II⁺ allows the use of sensors, which produce an output voltage in the ranges 0 .. 5V or -10 .. 10V. CMA sensors with BT plugs can be directly connected to the inputs 1 and 2 of CoachLab II⁺. Older CMA sensors with 4-mm plugs can be connected directly to the inputs 3 and 4 of CoachLab II⁺.

Vernier sensors with BT connectors can be directly connected to the inputs 1 and 2 of CoachLab II⁺. Older Vernier sensors and sensors of other brands such as Pasco or Fourier Systems can be connected with a proper adapter (e.g. from DIN plug to BT plug).

An actual list of sensors offered by CMA can be found on the CMA website at www.cma-science.nl.

APPENDIX 2. MEASUREMENT AND CONTROL WITH COACHLAB II⁺

1. Measurement methods

The following measurement techniques are implemented in CoachLab II⁺:

Single reading

A direct sample (data point) from a given channel is collected.

Time-based measurements

Data from each connected channel (analog and/or digital) are collected at a regular time interval. The sampling frequency and total measurement time can be selected.

One of the channels can serve as a trigger channel. The pre-trigger time, trigger level and trigger direction can be predefined.

For measurements with selected pre-trigger time before it is checked or the signal fulfils the trigger conditions the measured data are stored in the pre-trigger buffer. Because of this the data collected during the pre-trigger time are always available.

Event-based measurements

Before an event-based measurement can be performed a counter, or a converted analog sensor (counter, frequency, 1-bit digital, or period) must be assigned to an analog or a digital input. Data from all connected channels are collected each time an external event is registered by the counter. Next to the sensor values also time stamps are recorded (with a resolution of 100 μ s).

The measurement process stops after a specified number of events.

Start-stop measurement

By using the event-based mode it is possible to perform time measurements for example when a falling object passes across two light gates.

Response-time measurement

This method is used for measurements with ultrasonic motion detectors. The distance between an object and a motion detector is determined in the following way. CoachLab II⁺ initiates a measurement by sending a trigger pulse to an ultrasonic motion detector. At the same moment the 16-bits timer of the micro-controller is reset and the ultrasound detector sends an ultrasonic pulse. When the sensor detects the pulse reflected from an object the time is recorded. Based on the time and the speed of sound in air the distance between the detector and the object is determined. The resolution of the measured time is 1.33 μ s. This corresponds to a resolution of 0.23 mm in the determination of the distance.

Counting 'events' / 'pulses'

In this method a counter is incremented by one unit when an event is registered at an analog or a digital channel. The counting range is 0 - 65535.

Up/down counter

There are sensors (e.g. a bi-directional pulley) that generate a counting signal on two different pins of the connector. One of the signals is used to increase the counter, the other one to decrease the counter. CoachLab II⁺ is able to handle the signals from these kind of sensors. The interface is also able to handle signals where the counting direction (up or down) depends on the value of a second pin (e.g. 0 is count up, 1 is count down). The counting range lies between -32768 and 32767.

2. Control commands

Analog or digital actuators can be controlled through the outputs of CoachLab II⁺. For this purpose the following commands are implemented:

SetOutputs On/Off

All outputs are set in the specified state at the same time

SetBit(s)

One or more outputs (specified by the parameter **s**) are set to 'High' at the same time.

ResetBit(s)

One or more outputs (specified by the parameter **s**) are reset to 'Low' at the same time.

GetOutputs

Returns the actual state of the outputs.

SetPowerLevel

Sets the power level of an output to one of the 16 available levels. The power is reduced by switching the 12 V on an output channel on and off at a rate of 625 Hz for certain part of the time period (ranging from 1/16 to 16/16 period). This is called PWM - Pulse Width Modulation.

OnFor (one-shot)

An output can be switched on for a given time interval. Time resolution is 0.8 ms. Maximum time is 52 s.

Flash

An output can be periodically switched on or off. Maximum period time is 13 s.

When two outputs, which are adjusted to the same power level, are combined as one analog channel, it is possible to control for example a DC motor, which turns in two directions.

3. Measurement and control at the same time

All control commands can be executed while a measurement is running for sampling frequencies up to 10 kHz.

Note:

It is possible to develop own software (for example in LabVIEW or Java) to control CoachLab II⁺. For this reason the description of command list and the data formats for CoachLab II⁺ are available on request from CMA.

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. 14/12/2014

