FCAT Set

Horizon Educational

Fuel Cell Automative Trainer Set

Data Measurement Interface

https://youtu.be/NKie5zO_ETk

Software Manual

Web application

You do not need to download any external software to begin running tests with your FCAT, as it can be controlled directly from the online interface.

All operations can be carried out through an internet browser (preferably Firefox or Chrome.)

First, you must connect to the WiFi Network transmitted by the car. The network is called "CREA-TT02-xxxx" with the x's corresponding to your car's serial number. The password is "tt02CREA". Once you have connected to the network, type in the WiFi's IP address into your address bar to load the software interface: 192.168.240.1

If your testing bench is connected via Ethernet, you network will provide you with a second IP address displayed at the top of your WiFi menu. Instructions for installing a static IP address are available later in this manual.

Once you are connected, you should see the software's main menu. You do not need to have a high screen resolution to access the interface. The size of the browser window will adjust automatically, allowing you to work with other software simultaneously. You can also run the software on a smartphone or tablet.
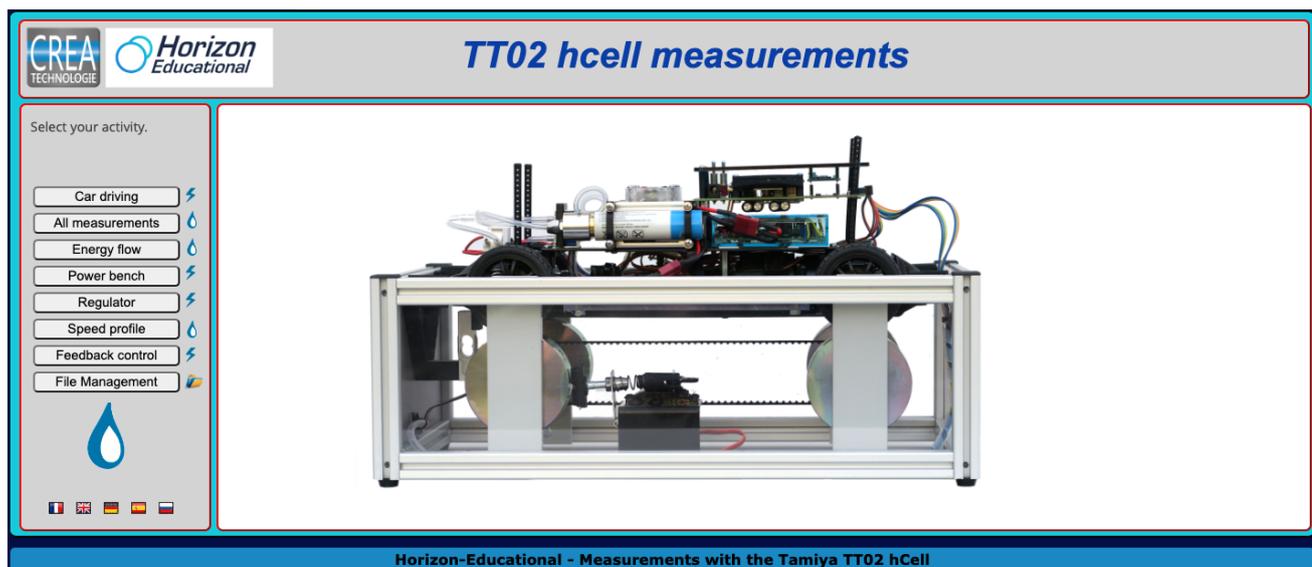
Main menu

The menu on the left allows you to launch several different actions:

- Remote-controlled operation and readouts from the tachometer
- Operation and read out of chosen measurements
- A mode dedicated to the demonstration of energy flows
- Power bench measurements according to velocity
- Operation with speed limitations
- Measurements based on custom profiles
- Assessment of the implementation of a control
- Management of stored measurement files

Some modes power the car with the hydrogen power supply (hCell), while others power the car exclusively on electric power. All functions powered by the hCell can also be run on an electric power supply as well.
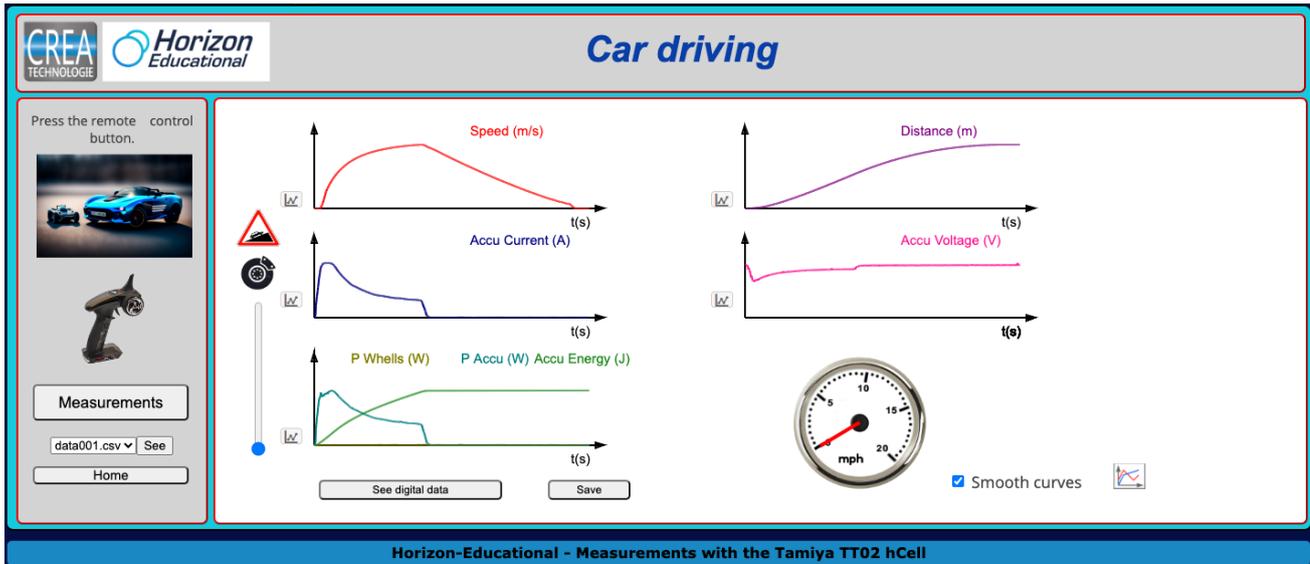
The small logo to the right of each menu item indicates the type of power supply used.
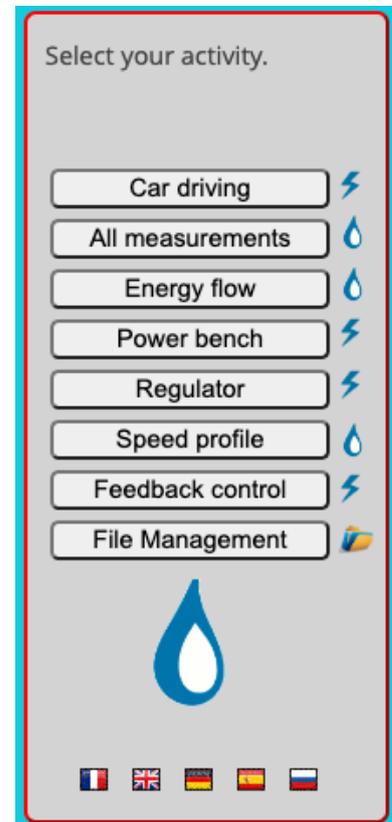
Car driving

After switching the car and remote control on, press START to recording measurements.

Measurements will stop recording automatically when the car stops. They can also be stopped by pressing the STOP button.

In this mode, the car can only be controlled by remote control.

Next to each measurement is a small icon which allows you to zoom into the corresponding graph.
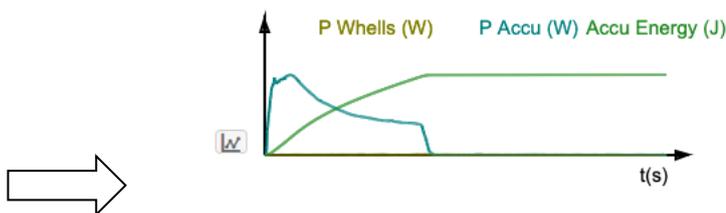
On the bottom-right of the interface is a check box which allows you to smooth the curves of your measurements. To display the raw curves, simply uncheck this box. The icon next to this checkbox allows you to see both smooth and raw curves simultaneously.
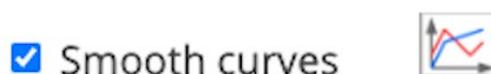
In contrast to the previous mode, all data points are now displayed on a singular graph. You can manually select which measurements you would like to display by selecting or unselecting each corresponding checkbox.

In this mode, the car can either be controlled with the remote control, or with the horizontal slider.

The vertical slider next to the graph enables you to apply brake force, simulating a slope.
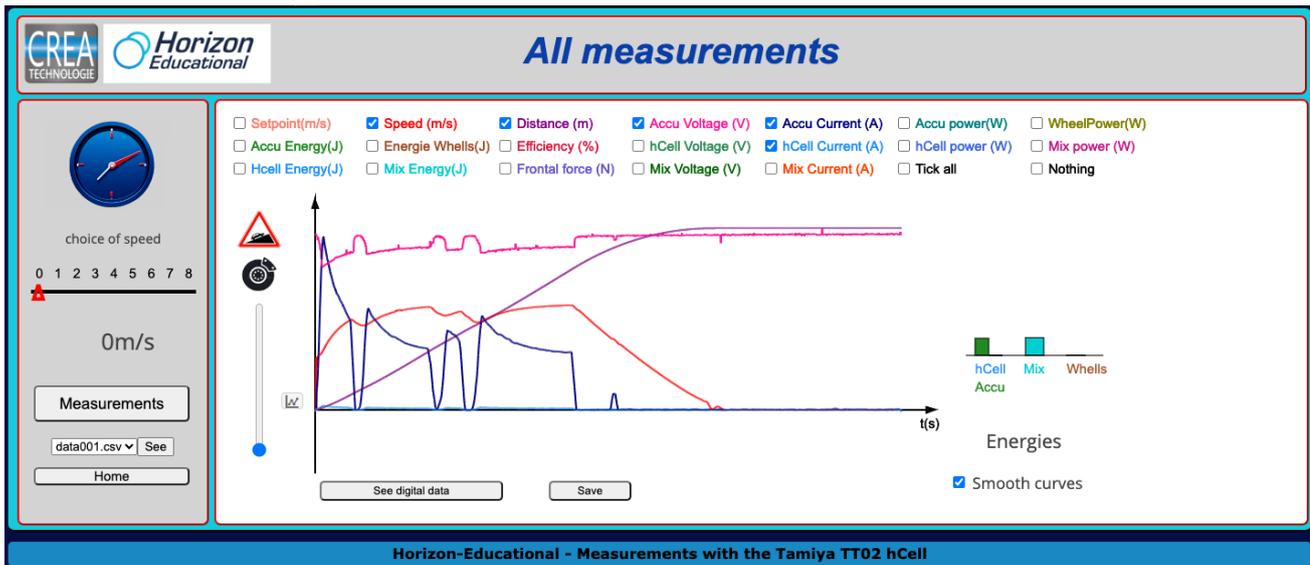
The measurements selected from the main menu can also be zoomed in on.
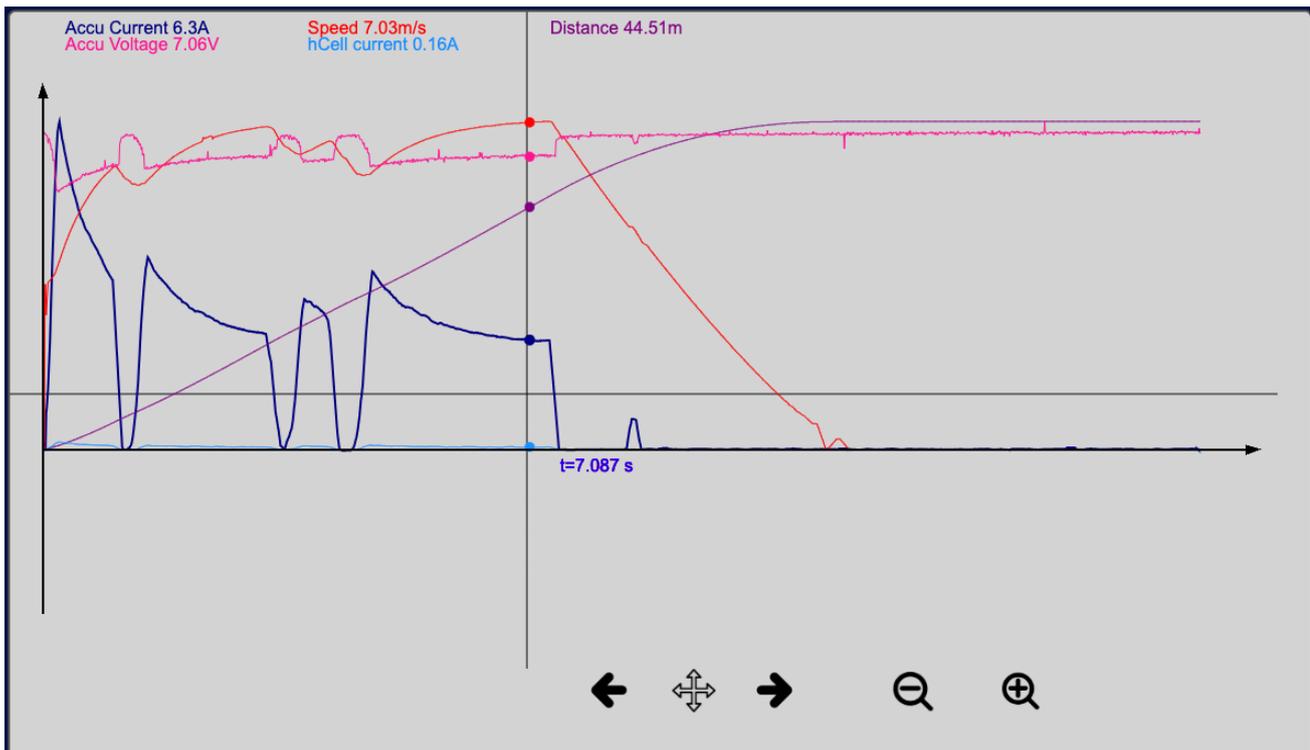
Energy flow

This mode is similar to the previous one, but the display has been optimized to track power and energy and create a clear visualization of the energy transfer between the battery, the hydrogen cell and the engine.
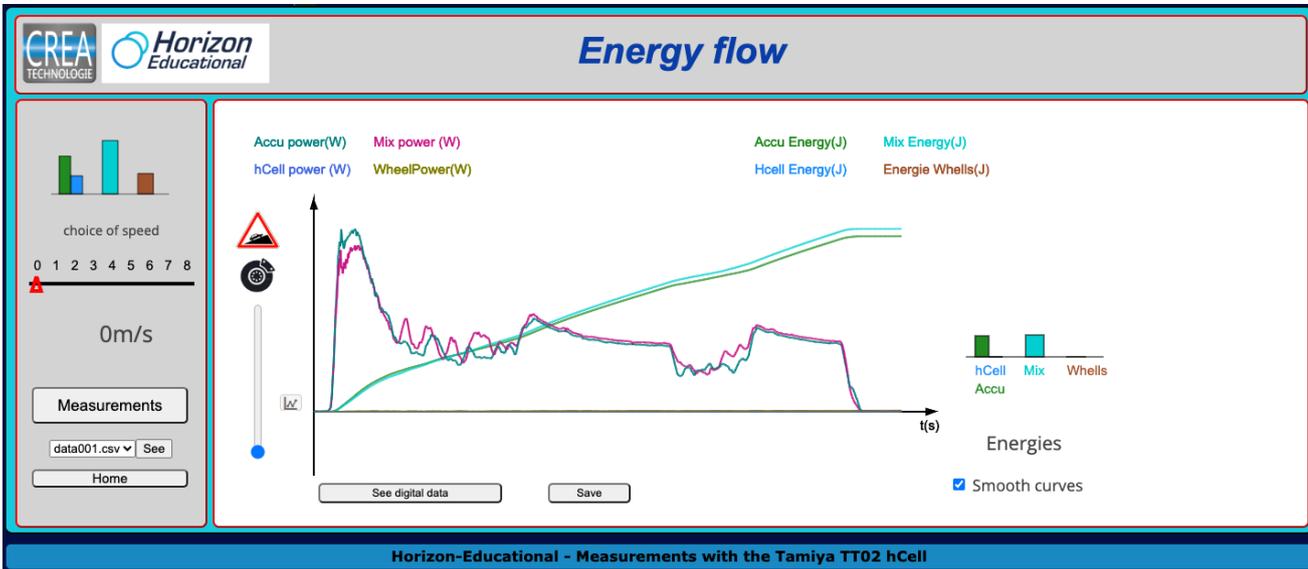

It is important to note that four units of power and energy are recorded each time

- The power and energy entering or leaving the battery
- The power and energy leaving the hydrogen cell
- The power and energy of the combined battery and hydrogen cell
- The power and energy available to the wheels

A small histogram displays the changes in energy in real-time, particularly the charge of the battery.

- In green, the energy generated by the battery since the car was started (this value can become negative if the battery receives more energy from the hydrogen cell than it supplies to the system)

- In blue, the energy generated by the hydrogen cell

- In turquoise, the combined energy output from the energy manager.

- In brown, the mechanical energy on the wheels
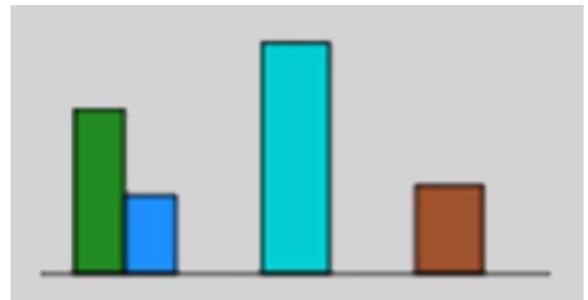
Power bench

In this mode, the bench acts as an automotive test bed – it will perform an automatic start cycle at full power.

The velocity, distance, current, voltage, power and energy are recorded as a function over time, as in the other modes.

The difference is the reading of the values of torque and power on the wheels as well as the output, which are displayed according to speed and not time.

This makes it possible to differentiate between the behavior of an electric motor and a thermal motor, by comparing it with the appearance of the manufacturer's curves.
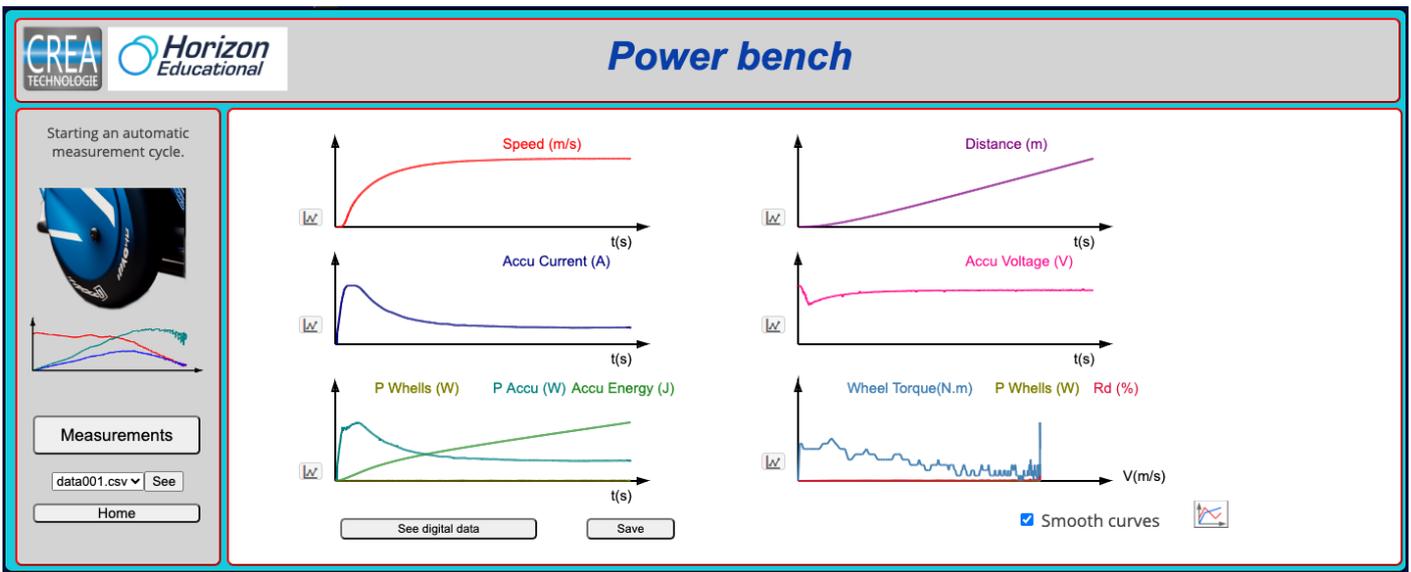
To analyze the performance of an engine or a vehicle, it is more interesting to observe the quantities as a function of the speed. This last graph gives us three values depending on the speed, the torque on the wheels, the power on the wheels, and the efficiency.

These three quantities make it easy to compare different vehicle configurations.
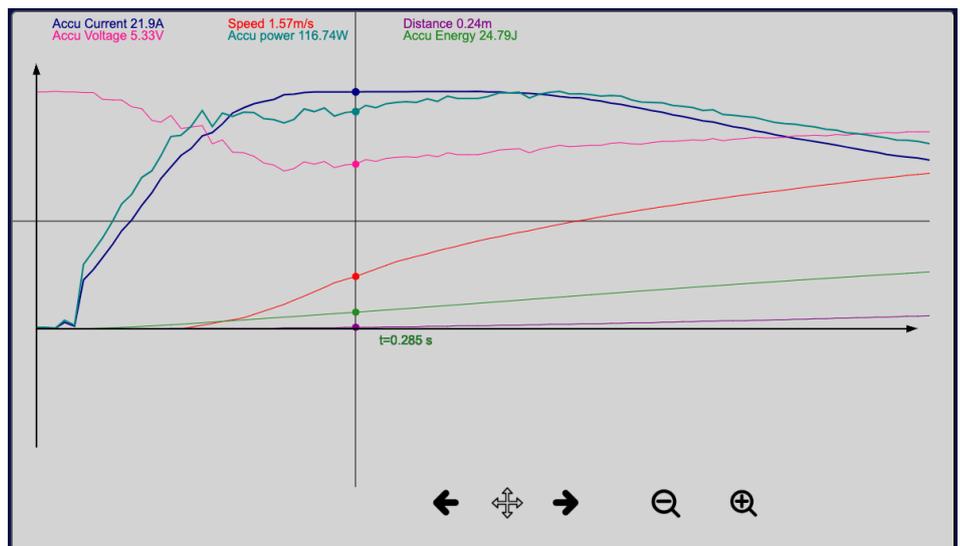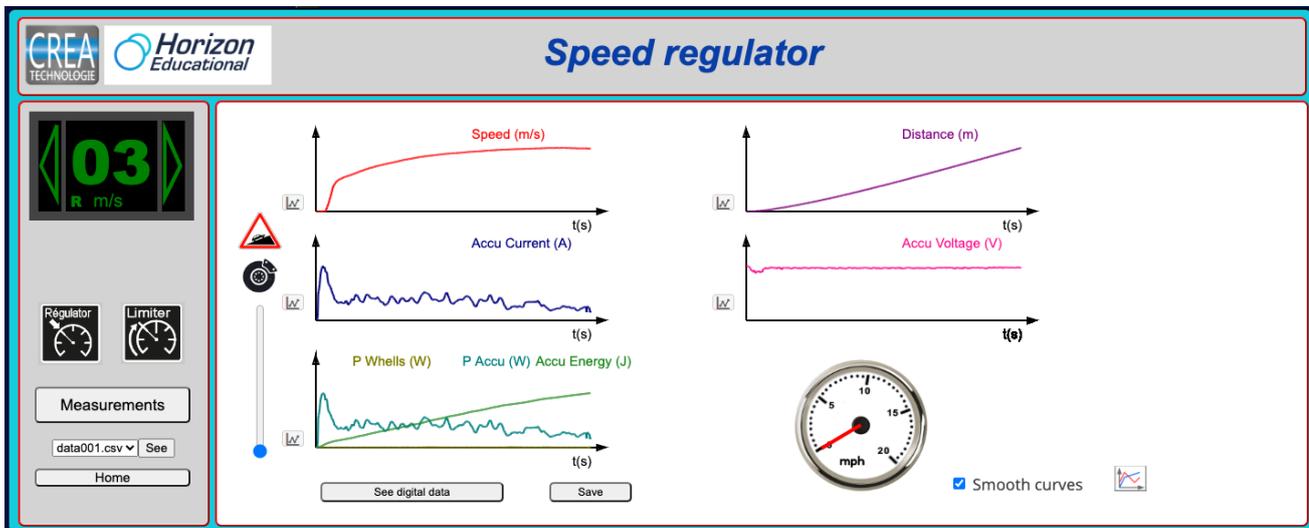
This mode allows you to apply a speed limiter or cruise control like on a real vehicle.

You can adjust the set speed with the digital display, where you can also toggle between the regulator and limier mode – the letter "R" or "L" indicating which mode you have selected.

When a set speed is chosen:

- In cruise control mode, the car drives at the requested speed (it is interesting here to apply a braking force to simulate a slope)

- In speed limiter mode, you must use the remote control to control the car, and you will find that you cannot exceed your set speed limit

Speed profile

This feature allows you to define a speed reference profile as a function of time to perform identical measurements under different conditions, or to compare types of driving.

A speed profile is a sequence of time and speed values as in the example given, where the speed and time in each row is separated by a semicolon.

0;0

0.5;1

1;2

2;0

```
Choose file profil.CSV

Delete this message
and for each line
indicate here the
time in seconds and
the target speed in
m/s

0;0
0.5;1
1;2
2;0
```

You can enter a custom profile directly into the dialogue box or load a CSV file from your device. Your custom profile should begin at time 0 and should ideally end at a speed of 0 in order to stop the car at the end.

To select a CSV profile from your device, select the browse button, then load the file into the software's memory.

Choose file profil.CSV   Choose file   **Load Profile**

When the profile has been created correctly, you will be able to validate it and see a corresponding setpoint graph.

```
Choose file profil.CSV

0;0
1;1
2;1
3;1
4;2
5;2
6;2.5
7;2.5
8;2.5
9;3
10;4
15;5
16;5

validate profile
```
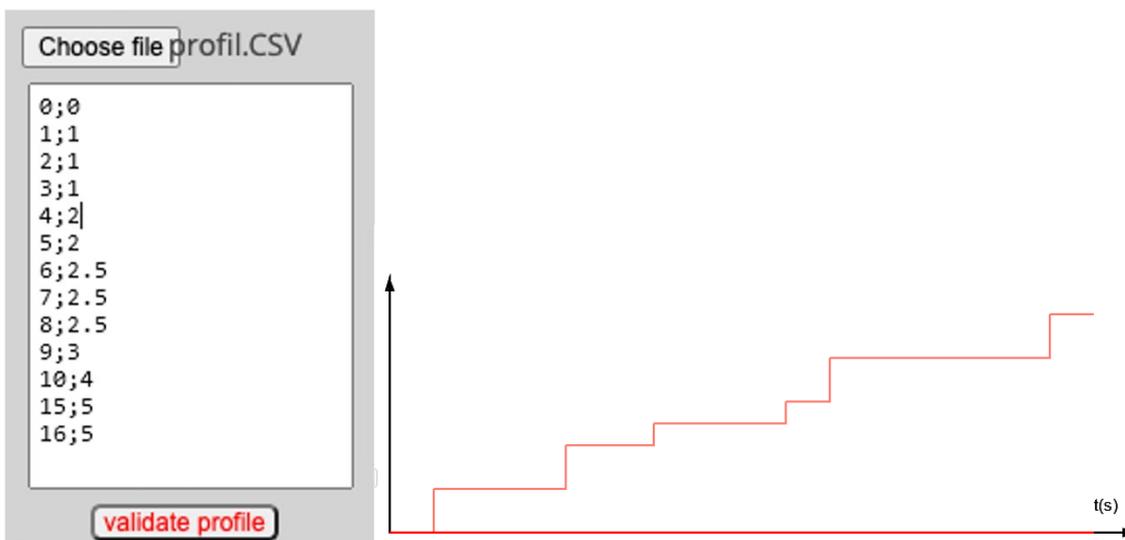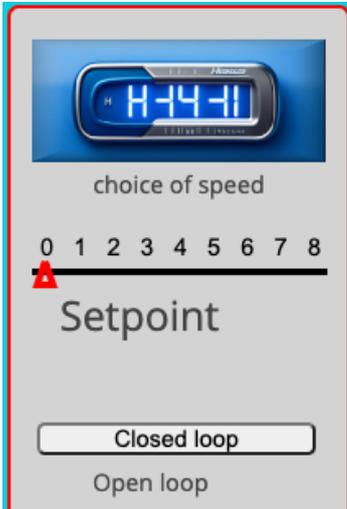
You can then begin recording measurements with this custom profile as a guide.

Feedback control

This mode allows you to carry out a more in-depth analysis of the servocontrols with speed regulation.

You can use the slider to select a speed, which the vehicle must follow.

In an open loop operation, the selected speed is sent to the motor, but no speed control is performed. The system will therefore be very sensitive to disturbances, especially to braking.
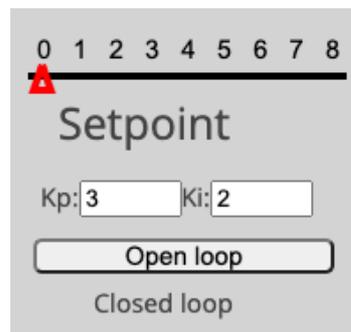

In a closed-loop operation with the installation of proportional and/or integral-type correctors, a speed measurement with a feedback loop will allow the speed error to be corrected and the setpoint to be followed as closely as possible, despite any disturbances.
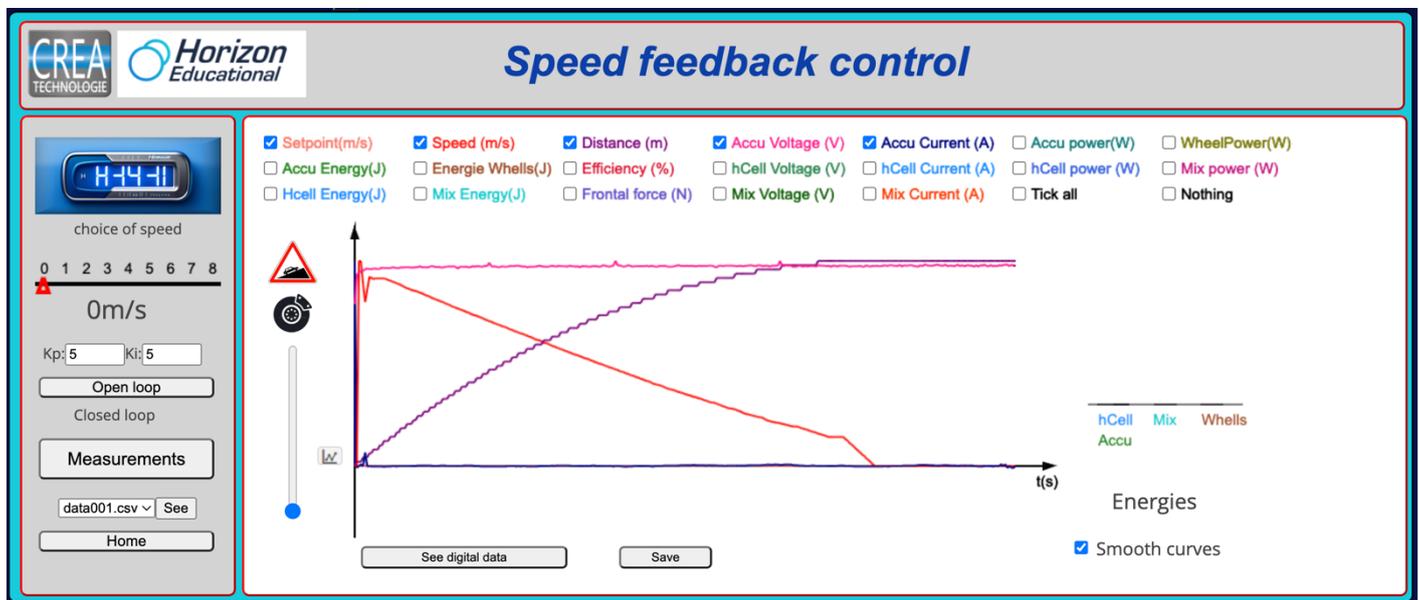
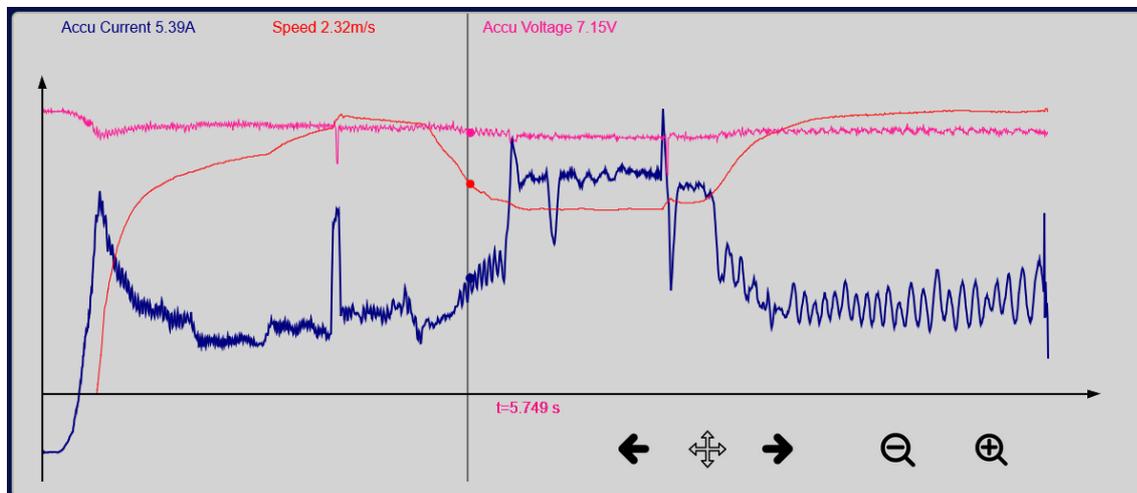

Here we see the regulation with the action of braking

Overview of data measurements

An overview of your measurements will be displayed on the main screen of each mode. The small icon on the left of each graph allows you to zoom in and see more detail.
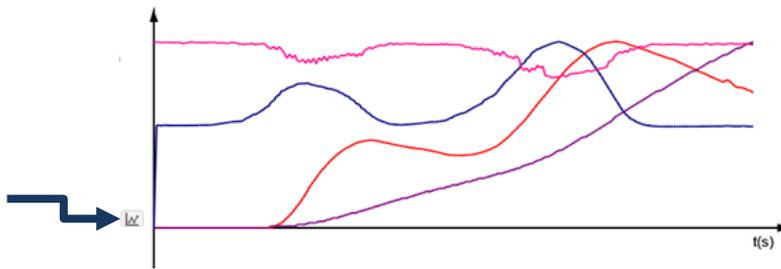
Curves as a function of time

The zoom function allows you to analyze the data for each measurement more precisely

The time value displayed in the center of the screen corresponds to where your cursor is placed. The colored values at the top of the screen indicate the currently selected value for each measurement.

The magnifying glass and the arrows allow you to analyze the measurements in more detail.

Curves as a function of speed

Certain measurements are displayed according to speed instead of time, particularly in the case of power bench measurements.
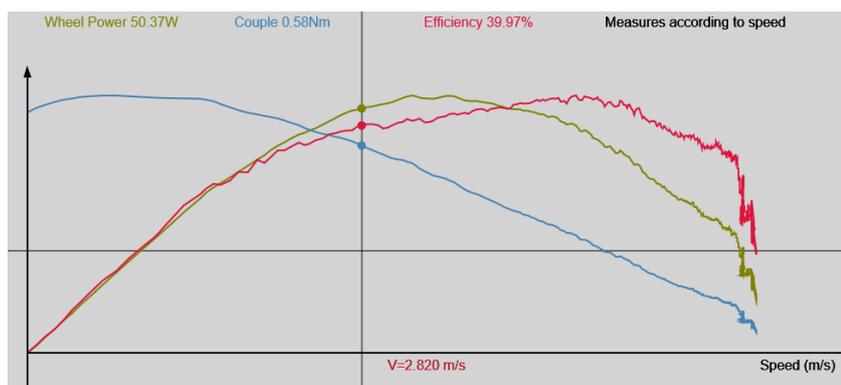
File management

Every time you save a measurement, a data.csv file will be created.

These files can be accessed and organized through the software's built-in file management system.

Numerical data

Every measurement will be recorded and accessible as a data file saved in a CSV format.
Each distinct variable is marked by a different color.

Measurements; sliderControl

time (ms)	set speed (m/s)	speed (m/s)	distance (m)	Accu Voltage (V)	Accu current (A)	hCell Voltage (V)	hCell current (A)	Mixed voltage (V)	Mixed current (A)	Force (N)	Wheel torque (N.m)
0	0,60	0,00	0,00	7,85	20,92	0,00	0,00	0,00	0,00	0,00	0,000
4	0,60	0,00	0,00	7,80	20,77	0,00	0,00	0,00	0,00	0,00	0,000
8	0,60	0,00	0,00	7,81	20,92	0,00	0,00	0,00	0,00	0,00	0,000
11	0,60	0,00	0,00	7,81	20,82	0,00	0,00	0,00	0,00	0,00	0,000
15	0,60	0,00	0,00	7,81	20,87	0,00	0,00	0,00	0,00	0,00	0,000
19	0,60	0,00	0,00	7,81	20,83	0,00	0,00	0,00	0,00	0,00	0,000
23	0,60	0,00	0,00	7,80	20,82	0,00	0,00	0,00	0,00	0,00	0,000
27	0,60	0,00	0,00	7,81	20,82	0,00	0,00	0,00	0,00	0,05	0,002
30	0,60	0,00	0,00	7,80	20,81	0,00	0,00	0,00	0,00	0,08	0,003
34	0,60	0,00	0,00	7,80	20,81	0,00	0,00	0,00	0,00	0,10	0,003
38	0,60	0,00	0,00	7,81	20,81	0,00	0,00	0,00	0,00	0,12	0,004
42	0,60	0,00	0,00	7,81	20,81	0,00	0,00	0,00	0,00	0,13	0,004
46	0,60	0,00	0,00	7,80	20,81	0,00	0,00	0,00	0,00	0,13	0,004
49	0,60	0,00	0,00	7,81	20,80	0,00	0,00	0,00	0,00	0,14	0,005
53	0,60	0,00	0,00	7,81	20,80	0,00	0,00	0,00	0,00	0,14	0,005
57	0,60	0,00	0,00	7,80	20,80	0,00	0,00	0,00	0,00	0,14	0,005
61	0,60	0,00	0,00	7,80	20,80	0,00	0,00	0,00	0,00	0,15	0,005
65	0,60	0,00	0,00	7,81	20,80	0,00	0,00	0,00	0,00	0,15	0,005
69	0,60	0,00	0,00	7,81	20,80	0,00	0,00	0,00	0,00	0,15	0,005
72	0,60	0,00	0,00	7,80	20,80	0,00	0,00	0,00	0,00	0,15	0,005
76	0,60	0,00	0,00	7,80	20,80	0,00	0,00	0,00	0,00	0,15	0,005
80	0,60	0,00	0,00	7,81	20,80	0,00	0,00	0,00	0,00	0,15	0,005
84	0,60	0,00	0,00	7,80	20,80	0,00	0,00	0,00	0,00	0,10	0,003
88	0,60	0,00	0,00	7,81	20,79	0,00	0,00	0,00	0,00	0,06	0,002

The icon at the top of the page allows you to download these files, which you can then import into a spreadsheet.

	A	B	C	D	E	F	G	H	I	J	K	L
1	time (ms)	set speed (m/s)	speed (m/s)	Distance (m)	Current (A)	Voltage (V)	Force (N)	Pabsorbed (W)	PAvail(W)	Torque (N.m)	Yield (%)	Energy (J)
2	1	0	0	0	0	7,29	-0,05	0	0	-0,002	0	0
3	5	0	0	0	0,05	7,27	0	0,36	0	0	0	0
4	10	0	0	0	0	7,27	0	0	0	0	0	0
5	14	0	0	0	0	7,27	0	0	0	0	0	0
6	18	0	0	0	0	7,27	0	0	0	0	0	0
7	22	0	0	0	0,39	7,25	0	2,83	0	0	0	0,01
8	28	0	0	0	0,54	7,25	0	3,92	0	0	0	0,04
9	32	0	0	0	0,44	7,25	0,14	3,19	0	0,005	0	0,05
10	36	0	0	0	6,45	7,06	0,24	45,54	0	0,008	0	0,23
11	41	0	0	0	12,36	7,13	8,07	88,13	0	0,262	0	0,67

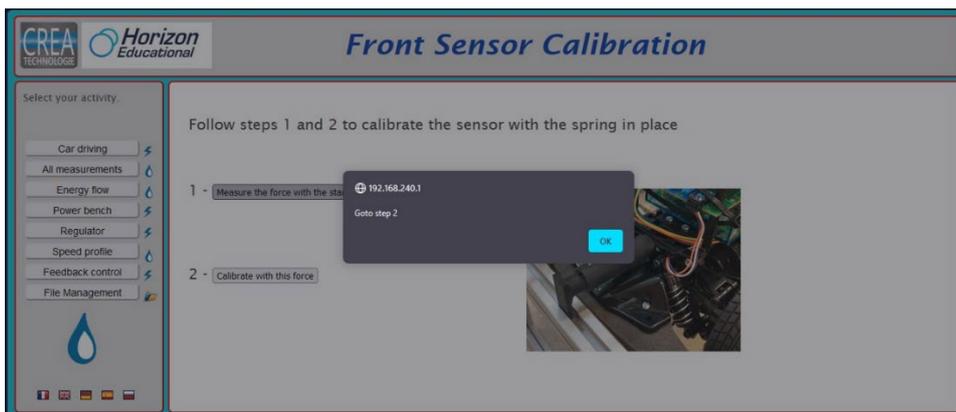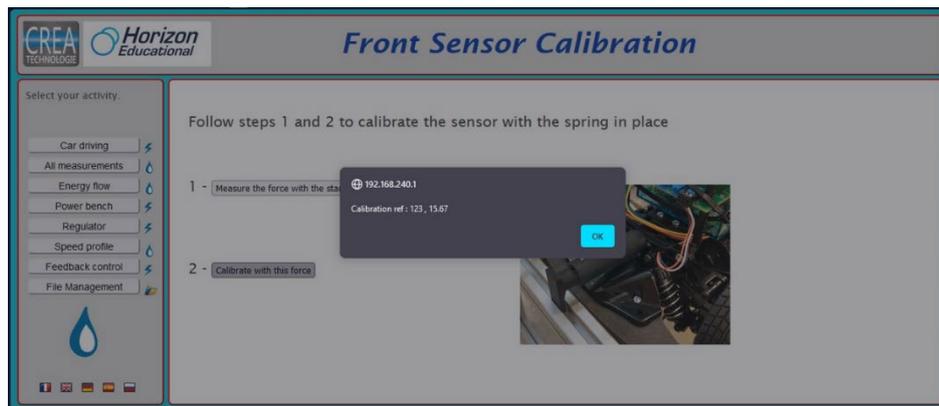You can then continue to plot data points and create additional graphs as needed.
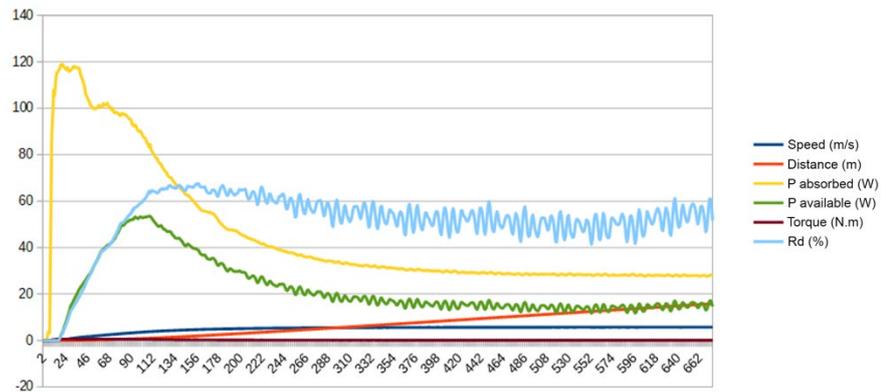
Force Calibration

Once the car has started (see QUICK START GUIDE) you can access the calibration page at the following link : 192.168.240.1/mesures.php ?typeMesure=etalonForces
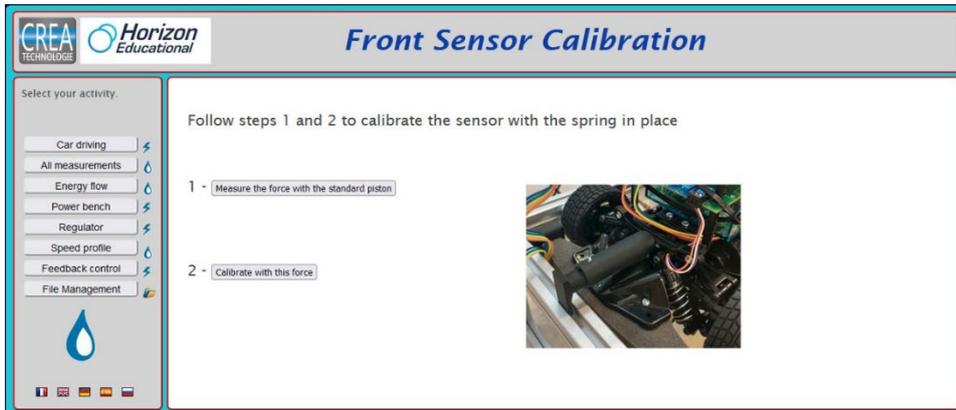
You can now insert the calibration piston included with your package, and use the "measure force" command:

You can then use the second command to calibrate.

Once you've removed the piston, the system is ready for operation.

Please note that calibration should not be performed regularly and should only be conducted by the teacher. If the piston is installed at the wrong time, measurements may be recorded incorrectly.

Fixed IP Configuration

Your testing bench is also Ethernet enabled and can be connected with an RJ45 cable with a fixed IP address. Your network administrator will define this IP address. This allows you to connect to the testing bench from every device on the network without using WiFi. Otherwise, the DHCP server will choose an address, which can vary.

http://192.168.240.1/BANC/ipconfig.php

WIFI IP Address (IP : 192.168.240.1)

IP Ethernet Configuration - (IP : 192.168.0.70) **IP config**
config interface 'wan'
option ifname 'eth0'
option proto 'dhcp'
option metric '10'

config interface 'wan1'
option ifname 'eth1'
option proto 'dhcp'
option metric '10'

New Ethernet configuration

Fixed IP address: 192.168.0.12

Mask : 255.255.255.0

Bridge : 192.168.0.1

Broadcast : 192.168.0.0

DNS : 80.87.169.12

FIXED IP   DYNAMIC IP (DHCP)   REBOOT

To switch to a fixed IP, input the network information provided to you by your network administrator. The validate the change, select "FIX IP". To return to a dynamic IP, select "Dynamic IP (DHCP).

You must restart (reboot) the system whenever you change between a fixed and dynamic IP address.