

Active Control Of Vibration Educational Kit User Manual



Version : 1
Date : 2011-08-11

CAUTION: READ BEFORE OPENING

For safety purposes these instructions must be read before use of this product.

Piezoelectric products are not warranted against mechanical damage resulting from improper use, wherein excessive forces or voltages that are outside specified ranges are applied.

High voltage is present in this product.

Only qualified personnel should work on or around this equipment and only after becoming thoroughly familiar with all warnings, safety notices, and procedures contained herein.

The successful and safe operation of this equipment is dependent on proper handling, installation and operation.

A "qualified person" is one who is familiar with the installation, construction and operation of the equipment and the hazards involved. In addition, he/she has the following qualifications :

- is trained and authorized to energize, de-energize, clean, and ground equipment in accordance with established practices,
- is trained in the proper care and use of protective equipment in accordance with established safety practices.

1. Description of the educational kit.....	4
2. User Manual of APA60SM PIEZO actuATor and CA45 ElectroniC Rack.....	6
3. INSTALLING THE educational kit.....	7
3.1. Connecting the hardware.....	7
3.2. Installing software.....	7
3.2.1. Required equipments.....	7
3.2.2. First time installation.....	8
3.3. Running the Software.....	9
3.3.1. Introduction.....	9
3.3.2. Connection Section.....	10
3.3.3. Parameters section.....	11
3.3.4. Summary.....	13
4. Working modes of the eductionnal kit.....	15
5. Electromagnet Option.....	16
6. Warranty Conditions and exceptions.....	16
7. Inspection upon receipt.....	16
8. After-sale service.....	17
ANNEX 1 : Trouble Shooting Form.....	18

1. DESCRIPTION OF THE EDUCATIONAL KIT MATERIAL

The Educational Kit includes:

- An Amplified Piezo Actuator APA60SM
- A electronic rack including
 - a linear amplifier CA45
 - a signal conditioner SG75
 - a digital PID controller UC45
- An accelerometer
- A mechanical beam
- Cables
- A GUI interface with USB connection making the bridge between the PC and the digital controller UC45.

Figure 1 shows a mounted educational kit:

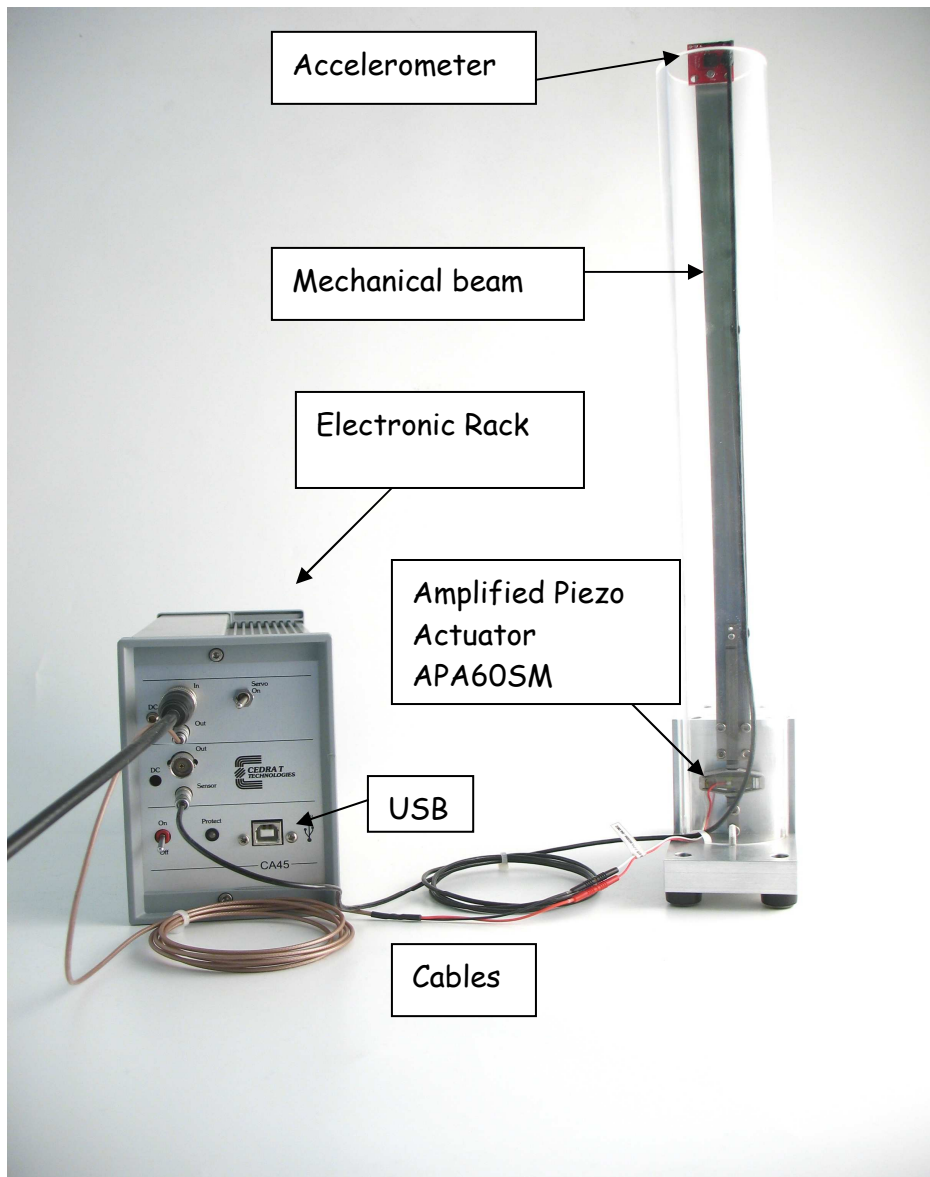


Figure 1: Educational Kit of Cedrat Technologies

Figure 2 shows in detail the connections of the CA45 electronic rack:

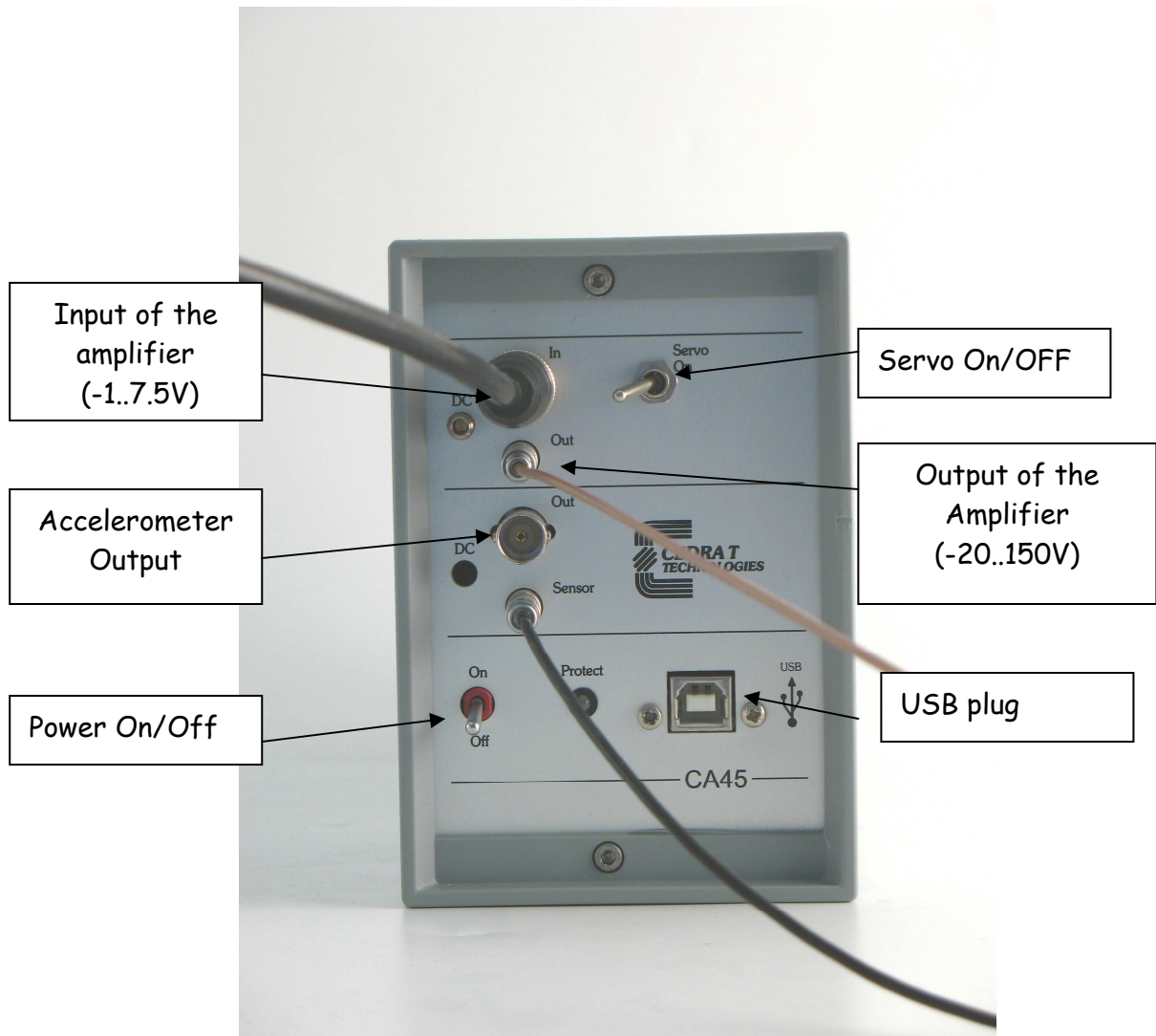


Figure 2: CA45 Electronic rack description

Figure 3 shows the GUI Interface of the controller UC45:

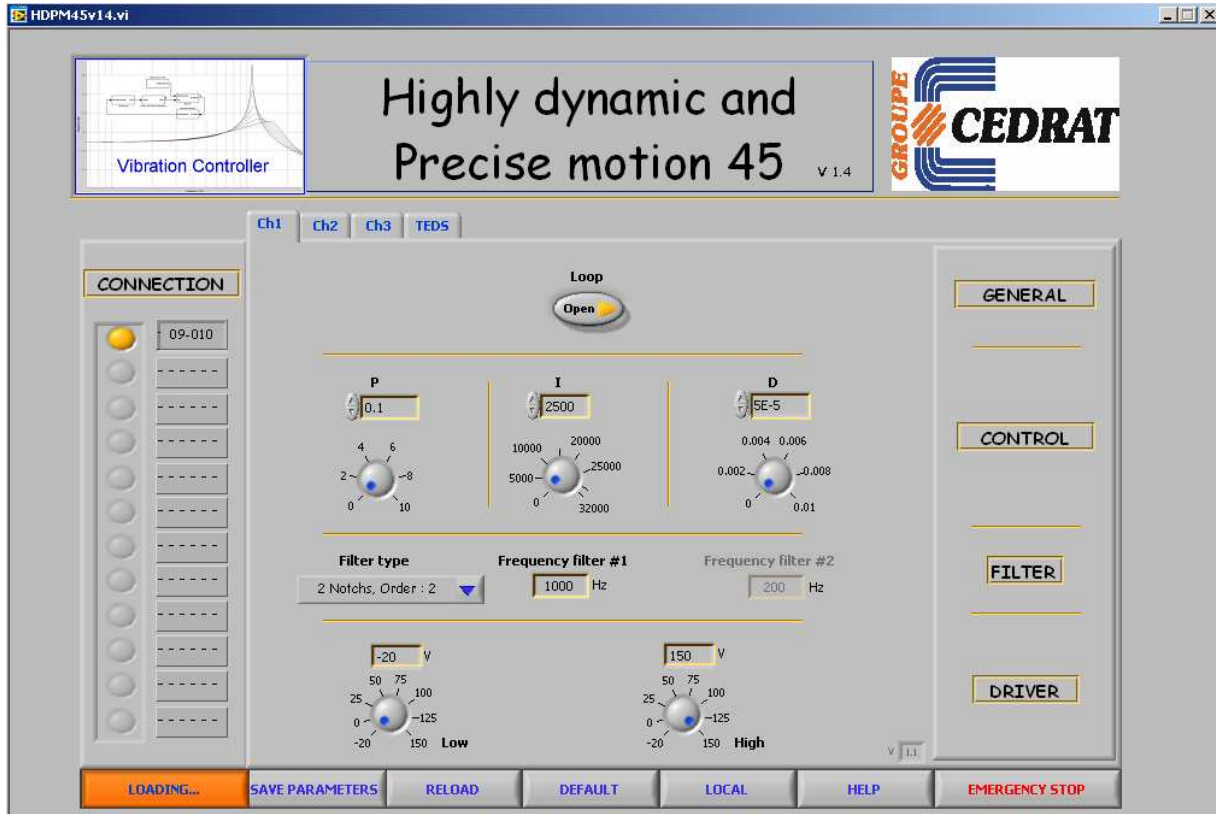


Figure 3: GUI Interface of the controller

The GUI interface enables to dialogue with the PID controller. Several parameters of the controller can be modified. The description of the parameters is given in 3.3.3

2. USER MANUAL OF APA60SM PIEZO ACTUATOR AND CA45 ELECTRONIC RACK

The APA actuator and the CA45 are standard industrial products of Cedrat Technologies. The relative user manuals can be found at: <http://www.cedrat.com/en/mechatronic-products/user-s-manual.html>

3. INSTALLING THE EDUCATIONAL KIT

The educational kit is easy and fast to install.

3.1. CONNECTING THE HARDWARE

Follow the procedure:

1. Connect the CA45 to the grid
2. Switch off the CA45
3. Leave the pin "In" unconnected
4. Plug the brown cable in the pin "Out" and in the actuator.

Respect the colors of the connectors!

5. Plug the dark cable in the pin "Sensor".
6. Connect the USB to the PC. Open the software HDPM45
7. Switch ON the CA45. The front LED is green. The software connects to the controller.
8. Switch "Servo On" into the right position.
9. By shaking the beam manually, you can observe if the system is damped properly



3.2. INSTALLING SOFTWARE

This paragraph describes the different instructions to connect the UC45 microcontroller and to install the software. The operator in the same time must connect the mechanism to the rack following the instruction in the user manual "LA75 - Linear amplifier for piezoelectric actuators - Product and warranty information".



DO NOT CONNECT THE USB DRIVER ON THE PC BEFORE INSTALLING THE SOFTWARE.

3.2.1. Required equipments

You must install the Software on the following Personal Computer configuration:

- Change "," in "." in the regional configuration of your PC if it is not the case. (Settings/ Controls Panel / Regional and language Options / Customize / Decimal symbol).
- Your screen cannot be higher than 1200 per 800 pixels.

The installation is simple:

- A unique CD or a download on Cedrat website (<http://www.cedrat.com/en/mechatronic-products/software-download.html?0>) includes the installation of the drivers to dialogue with the UC45 and the installer for the application software. It contains the autonomous application too.

3.2.2. First time installation

1. The operator has to run the " setup.exe" , following the giving indications.

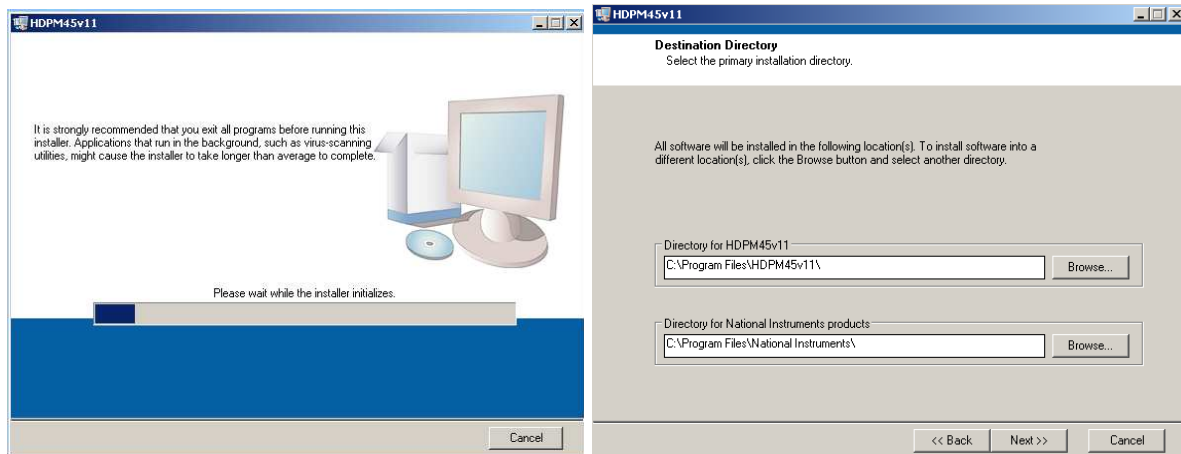


Figure 3-1: Destination directory

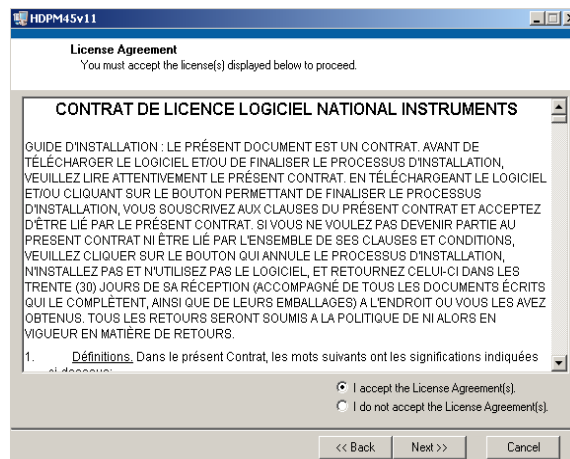


Figure 3-2 : License Agreement.

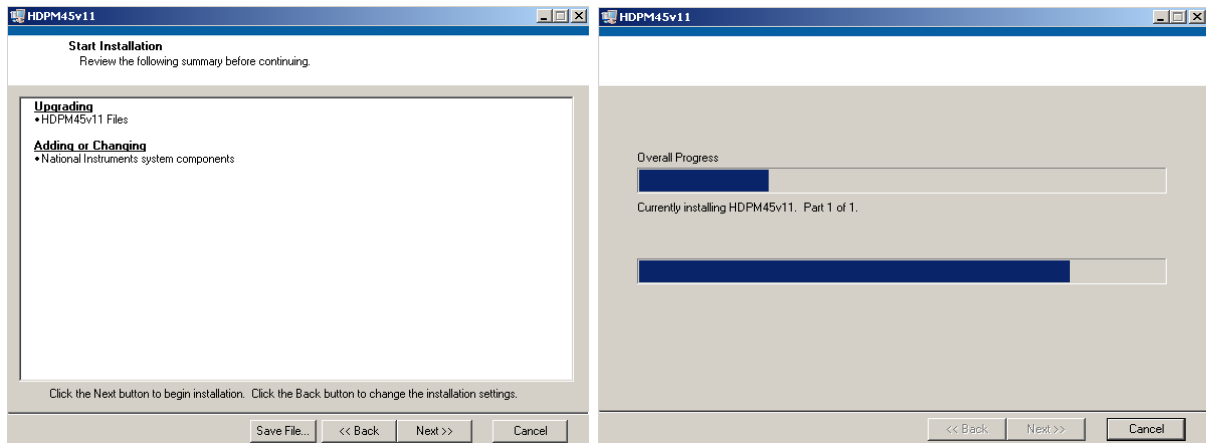


Figure 3-3: Starting Installation.

2. After this installation is finished an other driver will be install automatically, and then **restart** your PC.

3. Connect your PC with the UC45 by USB cable (see **Erreur ! Source du renvoi introuvable.**) and power on the rack.

4. Now the operator can run the software "HDP45_vxx.exe" which is normally on your desktop.

3.3. RUNNING THE SOFTWARE

3.3.1. Introduction

In this paragraph, we describe how to use the "Highly dynamic and precise motion 45" software with a pair piezo actuator/sensor. The software provided with the UC45 permits to command some parameters. At first, the software make a research of the several boards which could be connected. During this first step, a button **LOADING...** appears. **This first step can be 1 or 2 minutes long.**



Figure 3-4 : First step

During a second step, the software will read the parameters on the boards, a button **NO COMMUNICATION** appears. When those two steps are ok, the Human Machine Interface is ready to use, the button **RUNNING** appears. The screen is cut in three areas :

- The first one on the left manages the several boards.

- The second one on the right manages the regulator with some parameters that the operator can change.
- The last one on the bottom of the screen includes several main commands to manage the state of the software.

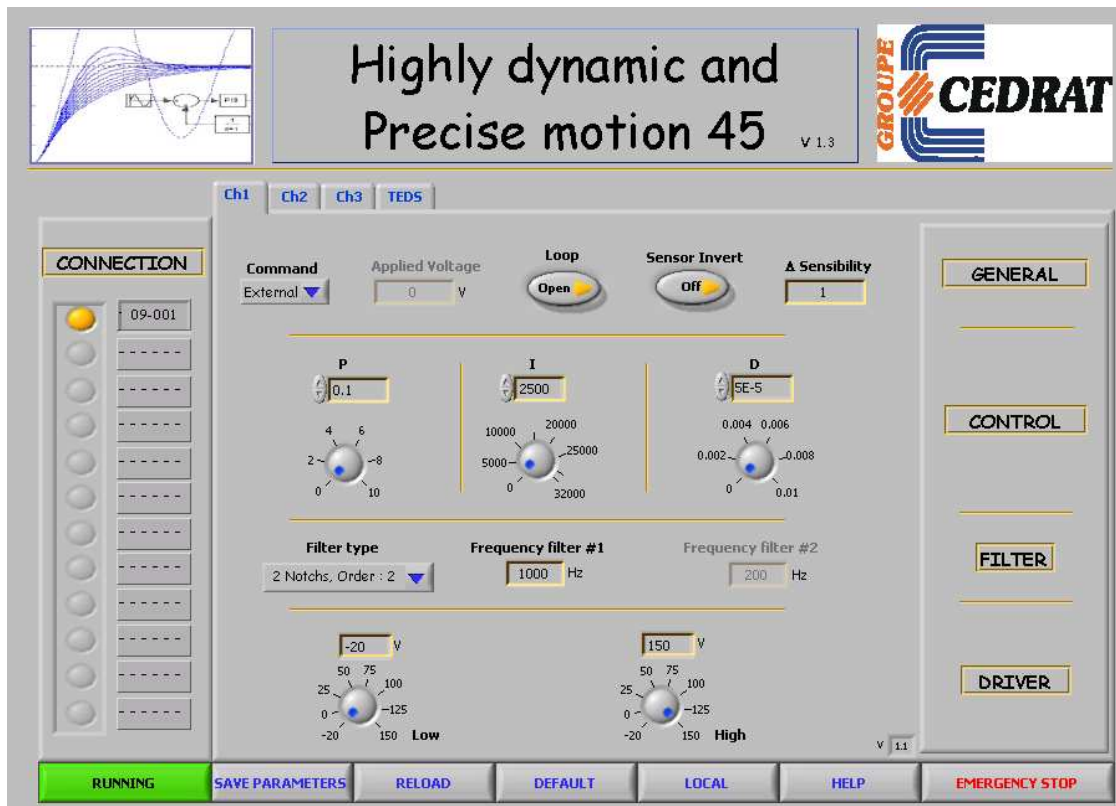


Figure 3-5 : Human Machine Interface description

Each section is named which helps the operator to know what kind of parameter is modified.

3.3.2. Connection Section

On the left side, the screen is composed of twelve possible boards (maximum number). The software search automatically the boards, and the operator can choose the board he wanted to change the parameters:

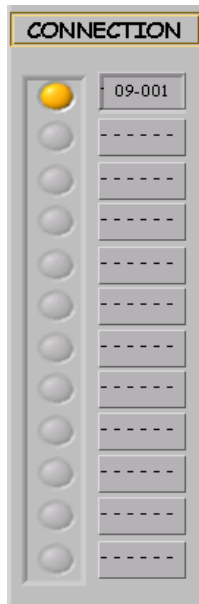


Figure 3-6 : Left section of the HMI : Connection section

Until the connection is not established correctly (button **RUNNING / NO COMMUNICATION** stay in the state **NO COMMUNICATION**), nothing else can be done, excepting **EMERGENCY STOP**.

3.3.3. Parameters section

On the right side, the screen is composed of four sections where the operator could pass different parameters for the numeric PID controller:

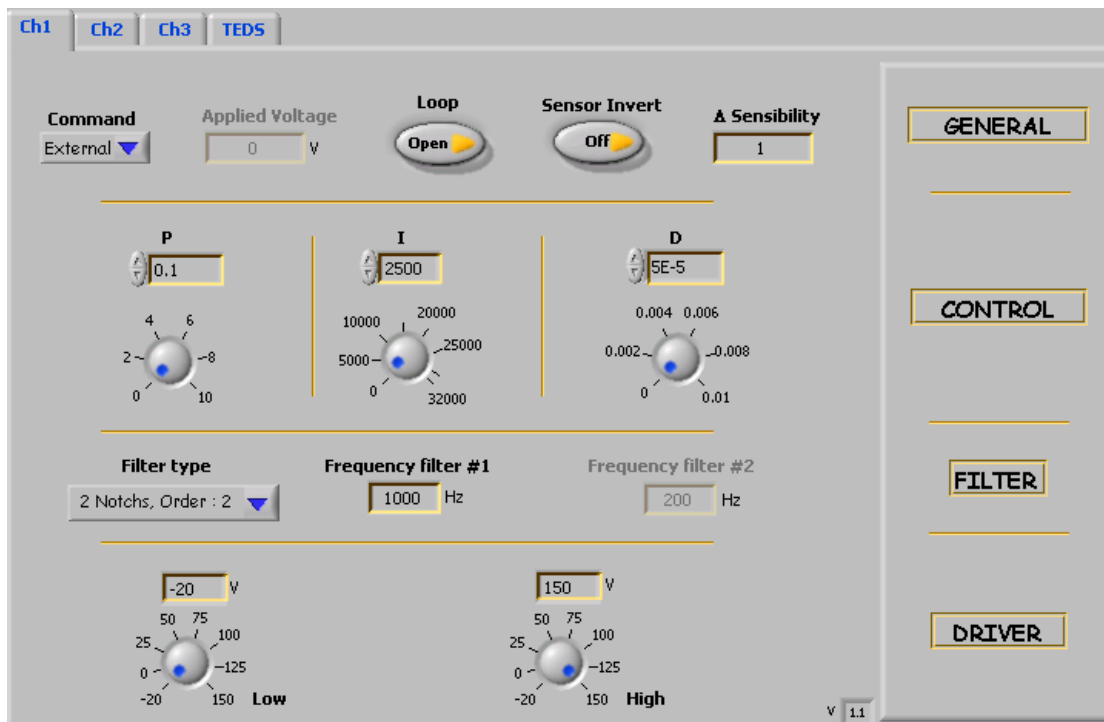


Figure 3-7 : Right section of the HMI: parameter section

GENERAL:

- **Command** is a selector to chose between two possible command to send to the actuator:
 - **Internal:** In this case the command is issued from the **Applied voltage command**. The operator can select the voltage that he would like to send on the actuator between -1 to 7.5 Volts.
 - **External:** In this case the command is issued from the Input BNC connector of the CA45 to command the actuator. This command must be adjusted between -1 to 7.5 Volts.
- **Applied voltage command** is used to send on the actuator directly a static command in Volt between -1 to 7.5V.
- **OL/CL** is a command to close or to open the control loop: OL indicates that the controller works in open loop and CL indicates that the controller works in closed loop (i.e. the regulator is on with the parameters in the control section)
- **Sensor Invert** is used to invert the data's sensor.
- **Δ Sensibility** is used to adjust the sensibility of the data's sensor.

CONTROL:

- **P, I, D** commands adjust the PID parameters as described in the previous paragraphs.
 - The **P** parameter can be adjusted between 0 to 10 by step of 1^{e-5} .
 - The **I** parameter can be adjust between 0 to 32000 by step of 1^{e-5} .
 - The **D** term can be adjusted between 0 to $1e-2$ by step of 1^{e-5} .

The command can be sent by rotating the button or by writing the number independently.

FILTER:

- **Filter type** indicates the kind of filter is inline with the PID regulator:
 - **Low pass, Order: 2** is a filter based on a 2nd order low pass filter. In this case only the **frequency filter #1** can be change.
 - **Notch, Order: 2** is a filter based on a 2nd order stop band filter. In this case only the **frequency filter #1** can be change.
 - **Notch, Order: 4** is a filter based on a 4th order stop band filter. In this case only the **frequency filter #1** can be change.
 - **2 Notches, Order: 2** are two filters based on a 2nd order stop band filter. In this case the **frequency filter #1** and the **frequency filter#2** can be change.
 - **None** indicates that no filter is added with the PID controller.
- **Frequency filter #1, #2** are integers and can be adjust between 50 to 2000 Hz.

DRIVER:

- **Low** indicates the lowest limitation of the voltage output of the driver.
- **High** indicates the highest limitation of the voltage output of the driver.

The limitation can be adjusted between -20 to 150V.

These values are correct if the offset of the driver is adjusted at 0 Volt. To verify place the **command** in the **internal** mode (section **General**) and check the value of the driver with an oscilloscope. Turn if necessary the offset potentiometer of the CA45 (see user manual of CA45 for additional information).



We recommend when you tune the regulator to place the Low and High commands with small amplitudes to limit a potential risk of damage on the actuator during an instability phase by limiting the amplitude of the applied voltage on the actuator.

Each channel can be selected and modified with the Channel button. In a 3 channels configuration the operator can select independently the parameters of each channel for the **GENERAL**, **CONTROL**, **FILTER** and **DRIVER** sections.

3.3.4. Summary

Each parameter are summarized in the following table including their states.

Name	Range
Connection Section	
COM	1 to 12
Parameters Section	
Command	Internal: Command from HMI / External: Command from BNC
Applied Voltage	-1 to 7.5V in Internal mode
OL/CL	OL: Open loop / CL: Closed Loop
Sensor Invert	On : data's sensor invert / Off : data's sensor not invert
Δ Sensibility	0 to 10 - resolution 1e-5
P	0 to 10 - resolution 1e-5
I	0 to 32000 - resolution 1e-5
D	0 to 1e-2 - resolution 1e-5
Filter type	Low pass, Order : 2 Notch, Order : 2 Notch, Order : 4 2 Notchs, Order : 2 None
Frequency filter #1	Frequency of the filter number 1 - 50 to 2000Hz
Frequency filter #2	Frequency of the filter number 2 - 50 to 2000Hz
Low	-20 to 150V
High	-20 to 150V
TEDS	
Serial Number - UC45	
Channel - UC45	
Sensor	SG75/ECS75
Serial Number of sensor	
Last Calibration	DD/MM/YYYY
Calibration Period	month
SNR in dB	
Low cut off frequency	at -3dB in Hz
High cut off frequency	at -3dB in Hz
Calibration for SG75	Strain Gages gain ($\mu\text{m}/\text{V}$); Amplifier Gain (V/V); System Gain ($\mu\text{m}/\text{V}$)
Calibration for ECS75:	Gain in $\mu\text{m}/\text{V}$; Linearity error in %
General command section	
RUNNING / NO COMMUNICATION	Display the state of the communication between the PC and the boards.
SAVE PARAMETERS	Save the parameters at the screen.
RELOAD	Call back the parameters from the SAVE PARAMETERS action.
DEFAULT	Call back initial parameters.
HELP	Display a short form of the user manual
LOCAL / REMOTE	REMOTE: The USB link is disable and the HMI is disconnected from the UC45 controller / LOCAL: The USB link is enable and the HMI is connected to the UC45 controller
EMERGENCY STOP	Stop the software

4. WORKING MODES OF THE EDUCATIONNAL KIT

The educational kit can operate in 2 working modes.

The first mode is in closed loop. The input of the electronics is null (see Figure 8). The actuator APA60SM is used to damp the vibrations of the beam. This is the normal working condition.

The second mode is in open loop. It uses the actuator as a forced exciter of the beam (see Figure 9). A signal between (-1V..7.5V) is sent on the input of the electronics, goes through the amplifier and supplies the actuator. If the input signal is a sine, the beam starts to oscillate at the same frequency and with proportional amplitude. **It is highly recommended to be in open loop in this mode and to work at low level of voltage (0V..3V on the input) to avoid damages at resonance. The Servo has to OFF.**

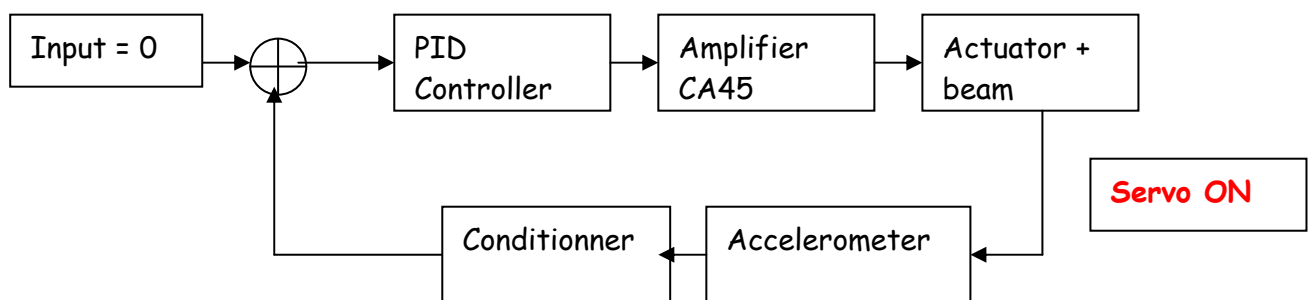


Figure 8: First working mode of the educational kit (Active Control of Vibrations)

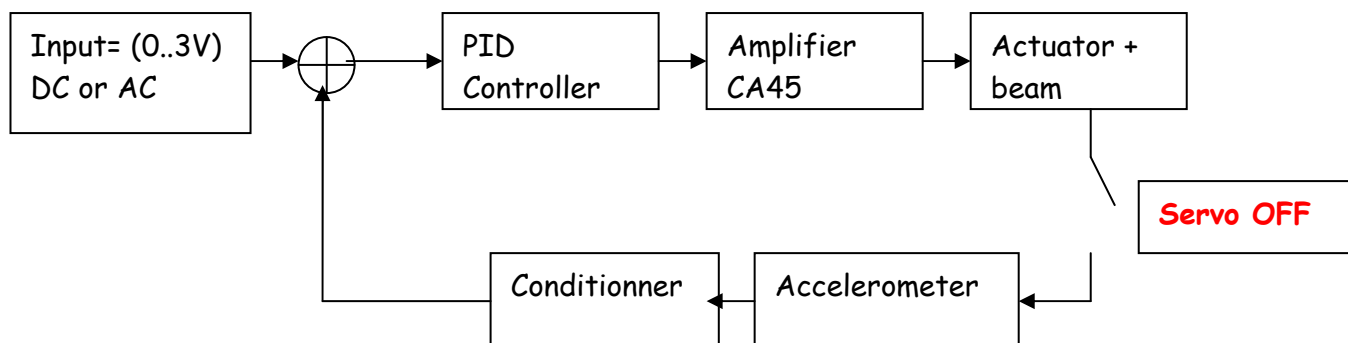


Figure 9: Second working mode of the educational kit (Forced Excitation of the beam)

5. ELECTROMAGNET OPTION

In construction...

6. WARRANTY CONDITIONS AND EXCEPTIONS

The equipment is warranted for a period of one year from date of shipment, including parts and labor, and only under standard technical conditions as outlined above and expressly mentioned in the technical data sheet. Repairs will be carried out at Cedrat Technologies or through your vendor. During the warranty period, Cedrat Technologies will, at its option, either repair or replace products which prove to be defective.

Interventions or attempts to service or repair the Actuators by any unauthorized persons will invalidate this warranty.

In addition, this warranty will not apply if the actuator is subjected to any of the following:

- improper handling, including, but not limited to, shocks and abrasions
- improper installation, including, but not limited to, excessive mechanical forces and moments, failure to use the standard electrical and mechanical interfaces
- excessive voltage, including, but not limited to, peak values outside the recommended operating range, DC values applied for excessive time periods
- inappropriate environmental conditions, including, but not limited to, high temperatures or high humidity
- attempt to modify the standard electrical connection of the APA (soldering out of electrical wires, plugs change,...) or the standard mechanical interfaces

No other warranty is expressed or implied. Cedrat Technologies specifically disclaims the implied warranties of merchantability and fitness for a particular purpose

7. INSPECTION UPON RECEIPT

This product has been inspected and shown to operate correctly at the time of shipment, as verified by the Factory Verification form that accompanies the actuator.

Immediately upon receipt of the product, it should be inspected carefully for any signs of damage that may have occurred during shipment. If any damage is found, a claim should be filed with the carrier.

The package should also be inspected for completeness according to the enclosed packing list. If an order is incorrect or incomplete, contact your distributor.

8. AFTER-SALE SERVICE

If a device requires service, please contact Cedrat Technologies or your local vendor. Please include the device model and serial number in all correspondence with Cedrat Technologies or your vendor.

ANNEX 1 : TROUBLE SHOOTING FORM

In case of trouble or breakdown with the piezo actuator,
- please check the electrical impedance (capacitance and insulation resistance) of the actuator and communicate it to your vendor.

This form must be completed by the customer in order to :

- allow Cedrat Technologies to authorise the product return back to the factory,
- help Cedrat Technologies in repairing it.

Product: Please give mention here the references and delivery date,

History: Please summarise here every action which has been performed with the device since the delivery,

Problem description: Please describe here the problems