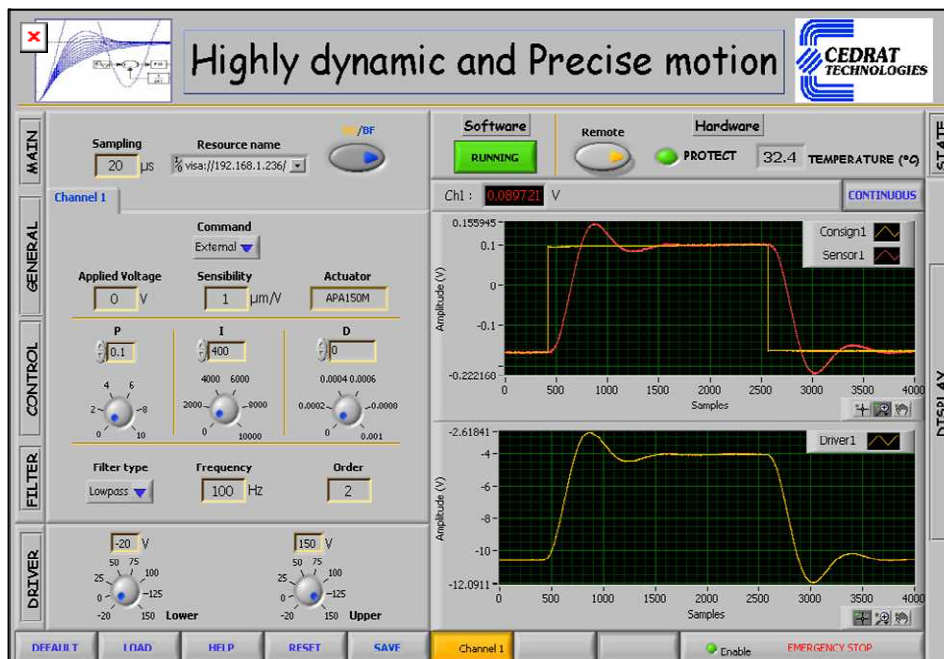


# UC75 / UC75-MC - Real time controller for multi-channel actuators

## PRODUCT AND WARRANTY INFORMATION



**Version : 1.3**  
**Date: 01/12/07**

## **CAUTION: READ BEFORE OPENING**

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

This digital controller is dedicated to control actuators with specific regulators.

The operator must read the user manual "LA75 - Linear amplifier for piezoelectric actuators - Product and warranty information" dedicated to the LA75x driver before powering the UC75 / UC75-MC controller.

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.

This pictograms  is placed to focus the attention on potential hazards.

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## 1. INTRODUCTION

The UC75 / UC75-MC is a plate-form including real time targets able to improve the performances of the control techniques of the actuators. The UC75 / UC75-MC include a National Instrument Core based on Compact RIO®NI and the power of the Labview®NI Libraries to control any system with fast ticks with deterministic time.

The core of the controller is based on a FPGA chip which permits a parallel execution of the tasks without shared channel. This configuration is developed for real time applications as control loops where a deterministic time is required for each channel.

Finally, the FPGA with a high speed internal clock authorizes fast timed cycle loop from acquisition

With the UC75 / UC75-MC controller, Cedrat Technologies provides a free NI® licenses software which includes a setup section to modify in real time, the parameters of the control loop and a display section to gives information on the response of the multi pairs actuators/sensors.

With a dedicated regulator, the operator can change the different parameters to optimize the behaviors of the loop in term of accuracy, speed,...

The UC75 / UC75-MC controller is compatible with the different racks of the standard product and can be connected (via an optional external user port) to the application (command, other sensors, telemetries, telecommands)

The dimensions of the front face are:

UC75 block
Width : 26F
Length: 260 mm
Height: 3U

*Figure 1-1 - Dimension of the UC75 front panel*

UC75-MC stands for a Multi-channel application and is based of an FPGA including more than 3 millions of gates.

## 2. GENERAL THEORY

The UC75 / UC75-MC controller is used to control in multi pair actuators-sensors feedback loops with dedicated regulators and includes parallel acquisition/generation boards using multi ADC and DAC converters. Before connecting the UC75 / UC75-MC controller, the operator will find in the next paragraph the behaviors of each function of the regulator.

### 2.1. Theory of a control loop

#### 2.1.1. The different functions

The basic scheme of one channel control loop is the following. It includes some regulators based on analogue/digital converters and a robust PID controller.

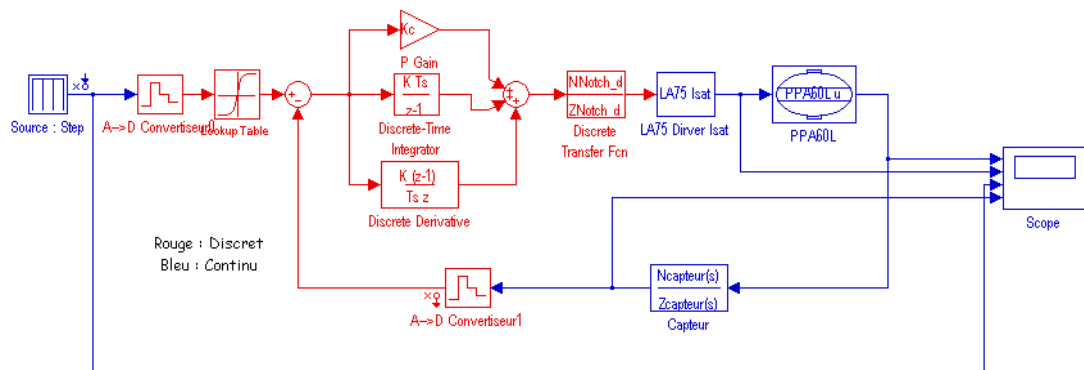


Figure 2-1 - Schematic of a basic digital control loop

In this example, the displacement of a PPA60L piezo actuator is controlled: each block is represented with an input and an output to model the behavior of the reality. The control loop includes the following blocs:

- The actuator and its driver (in this case the LA75x driver),
- The sensor and its conditioner,

These parts are called the continuous plants and have a continuous behavior (in opposite of digital behavior)

- Two analogue to digital converters including if necessary the anti-aliasing filters, These blocs are characterized by sample and hold and quantization functions (the quantization is function of the resolution of the A/D converter)

- A digital to analogue converter to convert the digital command (generally in 16 or 12 bits) applied on the actuator in an analogue command

This bloc is generally characterized with the maximum range and the resolution in term of bits.

- The regulator which computes the error between the command and the real position monitored by the sensor applied through a specific controller an order. The

controller is computed to maintain a closed loop stable with the desired performances (accuracy, speed,...)

Some pre-filters/pre-shapers can be added outside the feedback loop to help the system to be stable.

### ***2.1.2. Definition of the regulator***

A robust feedback controller is implemented in the regulator. It includes a PID regulator in series with a dedicated filter. A pre-shaper can be added in the case of a step command is required.

A filter is placed inline to limit the effect of the resonant frequency of the actuator. In the case of the actuator is characterized with a low quality factor, this filter can be deleted and only an adjustment of the PID parameters can optimize the behavior of the loop.

A PID controller attempts to correct the error between a measured process variable and a desired set point by calculating and then outputting a corrective action that can adjust the process accordingly

It is used to ensure an optimum response behavior of the actuator to its input commands- reducing error in velocity, acceleration and mainly in position.

The pre-shaper is a smooth command generated by a loaded look-up table. This technique compared with the two others is a open loop technique which doesn't reduce the error position but helps only the dynamic response (see next paragraph).

#### **PID regulator:**

**P=Proportional Gain** - This term determines the overall responses of a system to position errors, providing an output signal proportional to the error at any time low proportional gain provides a system which is very stable (without oscillation, i.e stable), has low stiffness and possibility large position errors under load. A high proportional gain provides high stiffness and small position errors under load, but may be unstable.

**I= integral Gain** - This term helps the system to eliminate positional errors but in static condition by increasing the output to the actuator until the error reduces to zero. This error is added or integrated over time and eventually the controller generates a sufficient output to reduce it. A low Integral gain may allow positional error at rest, which depends on the static load.

**D=Derivative Gain** - this term provides damping and stability to the system by preventing overshoot.

On the following frequency response, the impact of each term is traced.

Effect of the I term      Effect of the P term      Effect of the D term

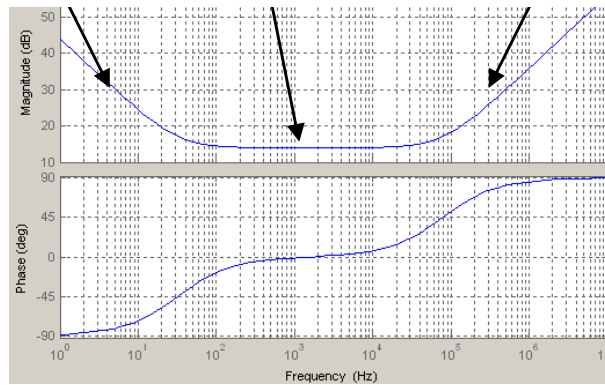


Figure 2-2 - Frequency response of a PID controller

Generally the PID regulator can be written with the following formulae:

$$y(t) = \varepsilon(t) \times P + \frac{1}{I} \int \varepsilon(t) dt + D \times \frac{d\varepsilon(t)}{dt}$$

With the  $j\omega$  operator:

$$\frac{y(j\omega)}{\varepsilon(j\omega)} = \frac{D \times (j\omega)^2 + I \times (j\omega) + P}{j\omega}$$

Where:  $y(j\omega)$  is the output of the regulator,  $\varepsilon(j\omega)$  is the input of the regulator or the error.

Generally to suppress high frequency noise the D term is limited with a 1<sup>st</sup> order low pass filter to limit the high frequency gain.

Impact of the terms:

Closed loop response	Rise time	Overshoot	Settling time	Final error
P	Decrease	Increase	Small change	Decrease
I	Decrease	Increase	Increase	Eliminate
D	Small change	Decrease	Decrease	Small change

Figure 2-3 - Impact of the different parameters on the output

To learn more, please see below §2.1.3. & 5. sections

**Added filter:**

A PID controller can be followed with a filter to limit the impact of the resonant frequency of the actuator. 2 factory tuned types of filters are implemented in the controller:

- The first one is a 2<sup>nd</sup> order low pass filter (Butterworth type) which has a low cut off frequency to reduce with its roll off of 40dB/decade the impact of the resonant frequency of the actuator. This filter is well adapted for static application where a low bandwidth is required.
- The second one is a 2<sup>nd</sup> order stop band filter placed at the resonant frequency of the actuator (see the next paragraph for more detail). This filter is well adapted for applications which require more bandwidth.

In any case, these filters increase the time response of the actuators to reach the desired position.

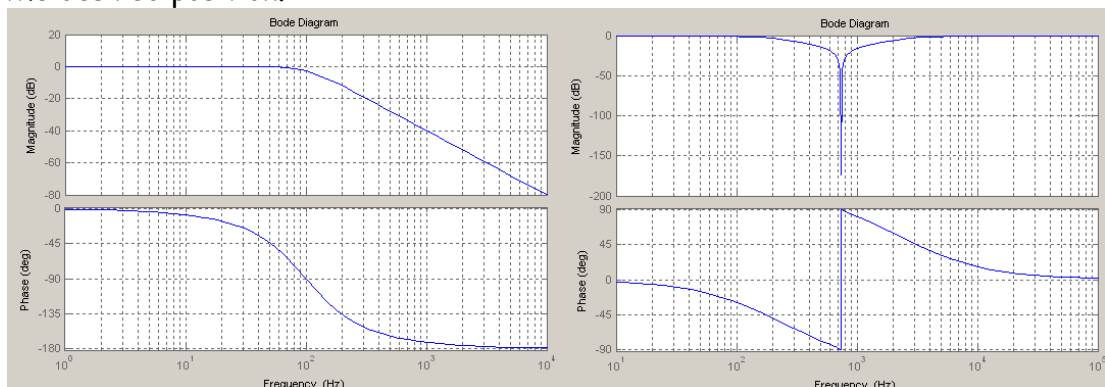


Figure 2-4 - Frequency response of different ideal filters: low pass filter and Stop band filter

The low pass filter is a 2<sup>nd</sup> order low pass Butterworth filter described with the following formulae:

$$\frac{Out(j\omega)}{In(j\omega)} = \frac{1}{\frac{(j\omega)^2}{(\omega_o)^2} + 2 \times z \times j\omega + 1}$$

With  $\omega_o$ , the cut off pulsation of the filter and z the damping.

The stop band filter is a 2<sup>nd</sup> order stop band Butterworth filter described with the following formulae:

$$\frac{Out(j\omega)}{In(j\omega)} = \frac{\left(\frac{j\omega}{\omega_o}\right)^2 + 1}{\left(\frac{j\omega}{\omega_o}\right)^2 + \frac{j\omega}{\omega_o} \times 2 \times z + 1}$$

With  $\omega_o$ , the centre pulsation of the filter and z the damping.

To learn more, please see below §2.1.3. & 5. sections.



### Pre-shaper:

The pre-shaper is used principally when a step response is required. This function helps the regulator when large D term must be added or when higher mechanical modes exist with a large contribution (the pre-shaper limits the energy at high frequency existing in a pulse command). The D term decreases the time response of the loop by adding gain at high frequency. As the driver is limited by its current limitation, it doesn't follow fast signals and so limits the slew rate of the output signal injected in the actuator. To reduce the impact of this limitation especially when fast edges are required, the pre-shaper function could include three phases: a soft launching/landing phase and an acceleration phase.

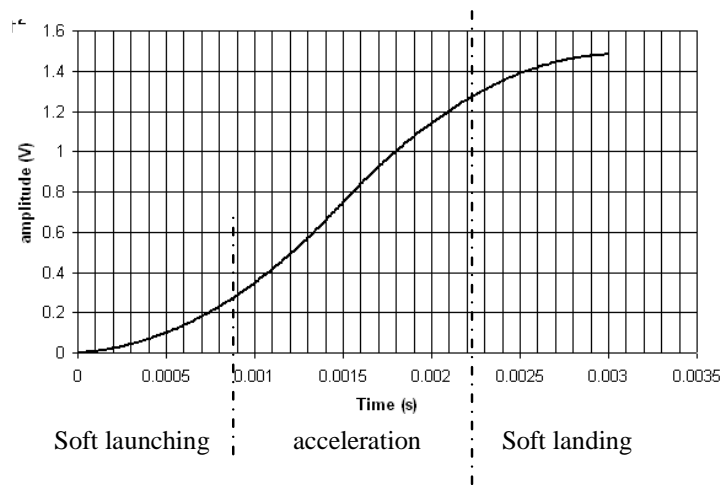


Figure 2-5 - Transient response of a pre-shaper

In the UC75 / UC75-MC configuration, the pre-shaper is an option and the operator must connect a trigger on the front face (see User Port paragraph) to start the reading of the waveform. The operator can modify as he wants the shape of the function in an excel file (see operating instruction paragraph).

A second use of the pre-shaper is when the operator wants to send to the actuator an arbitrary waveform built with an excel sheet. In this case, the trigger detects the start of the pattern and the controller applies the memory to the command of the actuator (in the same time the regulator in closed loop follows the command).

**To learn more, please see below §2.1.3. & 5. sections.**

### 2.1.3. Advanced performances

For people who want to understand the impact of such filters described below (frequency, type) / PID parameters this section gives some details/inputs to study the behavior of the control loop and the impact of these elements and how the operator must analyze the loop.

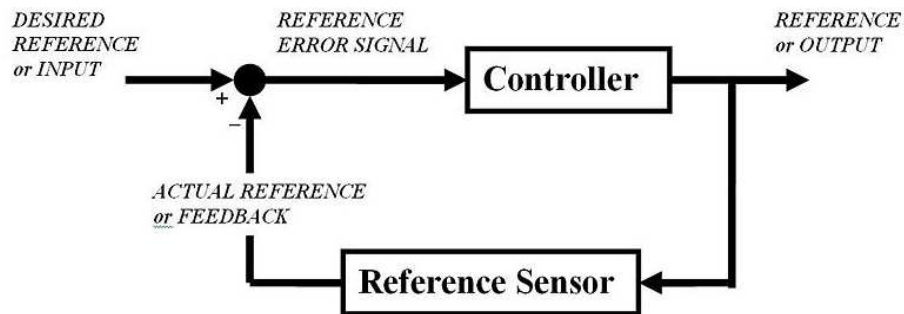


Figure 2-6 - Schematic of a feedback loop

A common process begins with the study of the behavior in open loop and in closed loop. In this case, we will define the phase and gain margins with additional filters working as stabilizing filters.

The steps to optimize the closed loop are the following:

1. Definition of the models with the different blocks constituting the entire loop (continuous plant, acquisition, treatment, drivers, sensors,...),
2. Choice of the type of regulator with analyze in open loop and closed loop in the frequency and transient domains,
3. Tests in the real world.

To develop these stages, we will use the example of the position control of a PPA60L piezo actuator with a strain gage position sensor.

The next figure represents this position loop:

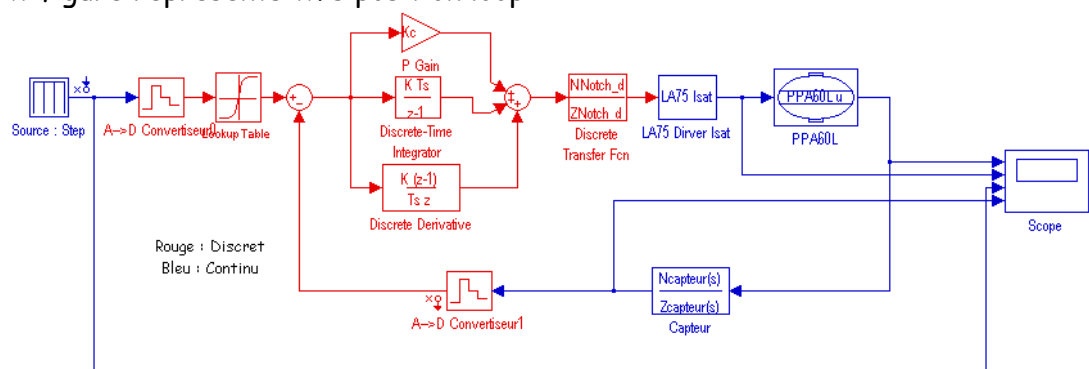


Figure 2-7 - Schematic of a Position control loop

Before analyzing the behavior of the loop, a first step is the definition of the model and its accuracy. In quasi-static condition, a model of the piezo actuator with its fundamental mode can be used. (see **Application Note on the numerical control from the standard catalogue of piezo actuators, drivers & controllers ©2007**).

$$H(j\omega) = \frac{u}{V} = \frac{Nc_m}{1 + r_m c_m j\omega + m_m c_m (j\omega)^2}$$

This transfer function represents the displacement of the actuator in function of the applied voltage on the ceramics. This transfer function of course is linear and doesn't take into account the creep effect or the intrinsic hysteresis. (If necessary we suggest to use simulation software to include these nonlinearities)



**Caution:** When high settling time is required, the elementary model is not enough to be used in the complete model. We suggest a modal identification from Finite Element Model software of the mechanism or a hardware-in-the loop identification process to take into account the other modes at higher frequency.

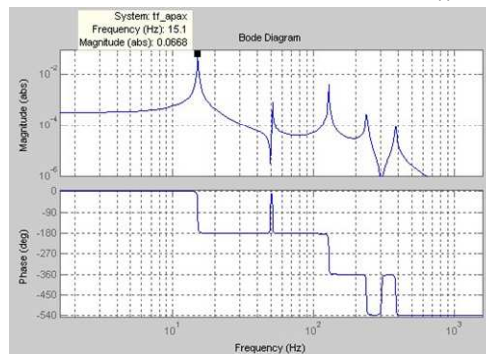


Figure 2-8 - Modal identification of a mechanism

In first approximation (for quasi-static application), the driver is a pure gain. You should integrate the current limitation when the system requires bandwidth.

$$Driver(j\omega) = \frac{Out}{In} = 20$$

A sensor can be represented with a pure gain. If you use a strain gages sensor from Cedrat Technologies (SG75 board), this gain is defined as:

$$Sensor(j\omega) = \frac{Out}{In} = \frac{Maximal\_stroke}{Maximal\_input\_voltage}$$

Numerical application: For an APA120ML, the maximum stroke is 120 $\mu$ m and the maximum voltage order is 8.5V: The gain is 70833 V/m

The study can be realized in continuous domain in which the controller is represented by a continuous transfer function without frequency limitation from the sample rate of the loop or in discrete domain where the controller is digitalized and represented with a z transfer function. In this case, the loop includes the sample & hold and the quantization of the analogue to digital converter and the digital to analogue converter.

The aim of the control is to increase the accuracy, the settling time without destabilizing the loop. The last point is very important and must follow a specific study.

Stability (in control theory) often means that for any bounded input over any amount of time, the output will also be bounded. This is known as BIBO stability (see also Lyapunov stability). If a system is BIBO stable then the output cannot "blow up" (i.e., become infinite) if the input remains finite. Mathematically, this means that for a causal linear system to be stable all of the poles of its transfer function must satisfy some criteria depending on whether a continuous or discrete time analysis is used:

- In continuous time, the Laplace transform is used to obtain the transfer function. A system is stable if the poles of this transfer function lie in the closed left half of the complex plane. I.e. the real part of all the poles is less than or equal to zero).

OR

- In discrete time the Z-transform is used. A system is stable if the poles of this transfer function lie on or inside the unit circle. I.e. the magnitude of the poles is less than or equal to one)

The study of the stability of the loop must be realized in parallel of the study of the performance: "A good choice in term of performance can bring an unstable system".

The study of the stability is directly linked to the open loop transfer function. The following diagram shows an alternative representation of a feedback loop.

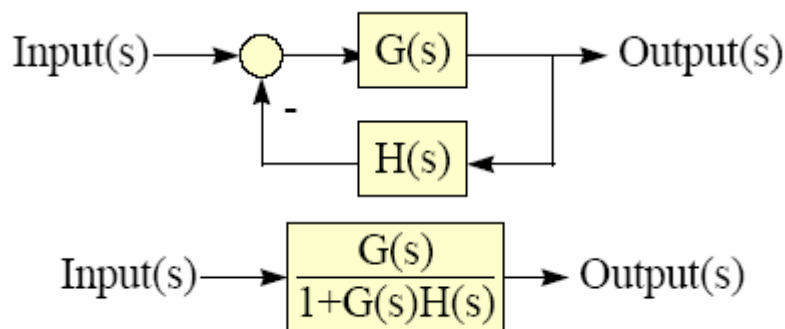


Figure 2-9 - General representation of a feedback loop

The stability is the study of the equation  $1 + G(s)H(s) = 0$  with  $G(s)$  the plant in line with the controller and  $H(s)$  the sensor.  $G(s)H(s)$  is called the open loop transfer function.

Instability occurs when the denominator in Figure 10 becomes zero. In other words, when  $G(s)H(s) = -1$ .

This equation can be resolved with mathematic formulae but it is more easy to trace in the frequency domain the module and the argument of this transfer function.

- Pn are real negative → stable system,
- Pn are complex with real negative parts → critically stable system,
- Pn are imaginary complex → Unstable system.

Recalling that 0 dB is equivalent to unity, -1 can be written as 0dB -180°. We introduce the Bode diagram as a representation in the frequency domain of the module and argument of a transfer function.

The open-loop method works by estimating two measures of stability or *margins*. The first is *phase margin* or *PM*. Find PM by locating the frequency where the loop gain is 0 dB.

*Gain margin* or *GM* is similar. Find the frequency where the open-loop phase is -180° and then measure the gain. Since the system will be unstable at 0dB -180°, the *GM* is 0dB less the gain.

→ **Example: Open loop transfer function and their margins.**

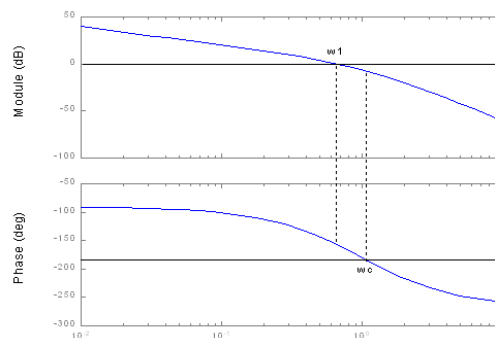


Figure 2-10 - Frequency response of the open loop transfer function- Bode diagram

The study of the performances is based on the study of  $\frac{G(s)}{1+G(s)H(s)}$  in closed loop. To optimize the response to a step, we analyze the transfer function:

$$\frac{\text{Output}}{\text{Input}} = \frac{G(s)}{1+G(s)H(s)}$$

To optimize the regulation of the impact of the disturbance, the operator must analyze the next transfer function:

$$\frac{\text{Disturbance}}{\text{Input}} = \frac{1}{1+G(s)H(s)}$$

In any case if  $GH \gg 1$  then Input = Output for the first equation and Disturbance  $\ll$  Input".

→ **Example: Correlation in closed loop**

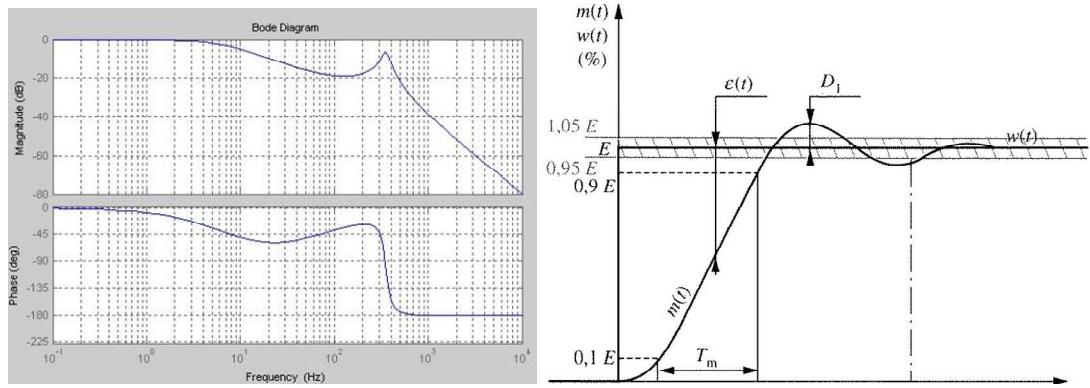


Figure 2-11 - a- Frequency response of the closed loop transfer function, b transient response

We recommend using dedicated software like MATLAB/Simulink from The MATHWORKS® to trace the different Bode diagrams and transient responses.

In an actuator with a large peak at its resonant frequency (high quality factor) the PID regulator can be not enough to stabilize the closed loop and the state of the art is to add in line a specific filter defined above.

On the following Bode diagram we show the impact of stabilizing filters on a standard analogue PID controller coupled with a piezoactuator.

The stability can be assured with the low pass filter and the placement of the cut off frequency below the resonant frequency of the actuator. A low pass filter or an integrator term slow down the time response of the system

→ Example: Impact of the stabilizing filters on open loop/closed loops transfer function/transient responses of a piezo actuator, a PID regulator and some stabilized filters:

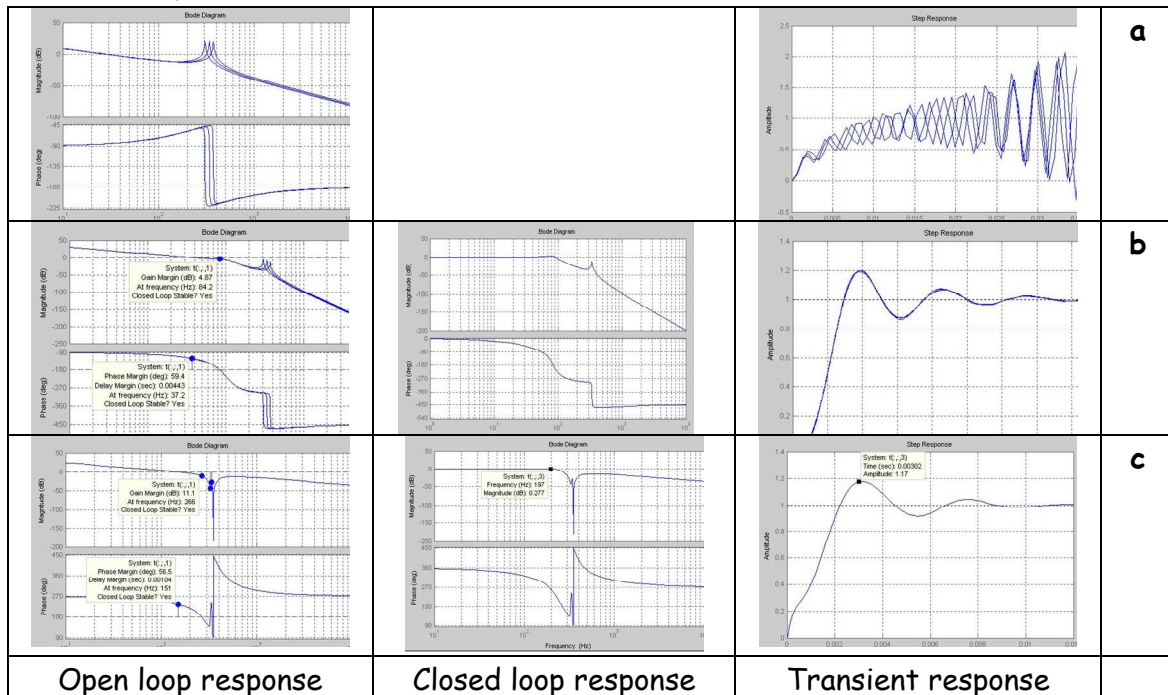


Figure 2-12 - Frequency response of the open loop transfer function/closed loop transfer function and transient response a- without filter, b- with Low pass filter, c- with Notch filter

**Numerical application:**

Input Data :

APA400M with 50gr:

- $Q = 100$ ,
- Load = 50gr,
- $F_r = 340\text{Hz} \pm 10\%$

First case: with a low pass filter:  $f_c=100\text{Hz}$ , 2nd order

Results:

With  $P=0.1$ ,  $I=250$ :Overshoot: 20%, Stability: 5dB,  $60^\circ$ ,  $F_c$  in closed loop  $\approx 100\text{Hz}$ Modification PID parameters:  $P=0.1$ ,  $I=300$ Overshoot: 40%, Stability: 3dB,  $45^\circ$ ,  $F_c \approx 100\text{Hz}$ 

The low pass filter fixes the cut off frequency of the closed loop. The I term doesn't play a large role after the cut off frequency of the low pass filter.

Modification Cut off frequency of the low pass filter  $\rightarrow 300\text{Hz}$ Stability: 4dB,  $20^\circ$ ,  $F_c \approx 150\text{Hz}$ ,

The system is not really stable

Second case: with a Notch filter:  $F_c=F_r$ , 2nd order

Results:

With  $P=0.1$ ,  $I=1000$  &  $D=1e-4$ :Overshoot is reduced, Settling time 3ms, Stability: 11dB,  $56^\circ$ ,  $F_c \approx 200\text{Hz}$  but phase lag at low frequency

Parameters	Without stabilizing filter	With low pass filter	With Notch filter
Closed loop	Practically unstable - stable with a simple model	Stable is Cut-off frequency below $F_r/3$ , Phase lag	Stable is Cut-off frequency equals $F_r$ , Phase lag
Transient response to a step	Practically unstable - stable with a simple model	Low response time	Fast response time

Figure 2-13 - Table of behavior of the loop with different filters.

If the operator wants to reduce the phase lag, the controller is designed without stabilizing filters. In this case, the PID terms must be correctly optimized to increase the phase/gain margin. This condition of operation is not really easy to tune and must be used with caution.

This methodology can be applied directly on other kind of control loop (vibration control, servo speed,...) with only a modification of the sensor block, the regulator.



## 2.2. Method of operation with the UC75 / UC75-MC Digital controller

The previous theories can be exactly applied on the Real time UC75 / UC75-MC controller. The base of this controller includes the possibility to change the PID parameters and the stabilizing filters in real time. As the controller can be connected to a host, the operator can analyze in real time the behavior of the system, to adjust the parameters of the loops via an Ethernet links at 100Mbytes/s or to be stand alone without actions on the process.

Basically, the main operations of the controller are analogue to digital conversions, digital treatments and digital to analogue conversions.

This module can be coupled with standard racks of the standard product of Cedrat Technologies with internal connections or can be linked with a user port on its front face. An Ethernet link on the front face allows sending and receiving data from the unit to display and manage the behaviors of the controller for each channel

The system combines an open embedded architecture with small size, extreme ruggedness, and hot-swappable industrial I/O modules. Compact®RIO is powered by reconfigurable I/O (RIO) FPGA technology. The native parallelism of graphical programming is an ideal counterpart to the physical implementation of FPGAs since parallel loops map to separate regions of FPGA silicon and operate truly in parallel. The net sum is that speed, parallelism, and power of FPGAs are now accessible to anyone and this presents a powerful plate-form for implementing control loop with fast parallel process as tracking servo, all running with absolute timing determinacy to drive and control the CEDRAT TECHNOLOGIES's actuators.

To reach the fast sampling rate, the UC75 / UC75-MC uses the FPGA chip to the different conversions between the analogue and digital converters and to realize the different processing to achieve the correct regulator. These operations doesn't need high speed link with high speed transfer because of inside the chip.

To manage the Ethernet link with the host, a shared real time micro-controller is used to realize the communication between the FPGA chip and the host.

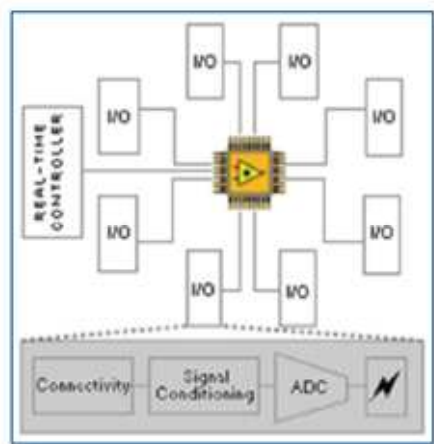


Figure 2-14 - hardware architecture of the UC75



As this micro controller is a shared resource, all the control functions (regulators, filters, pre-shaper,...) are not implemented inside and are coded in the FPGA chip. Then the FPGA chip communicates with the I/O blocks (digital or analogue) with very fast links and realizes the functions of compensators (PID, filters,...) in parallel to avoid shared time between each channel or each function.

A dedicated software is provided to manage mono or multi-channel PID regulators with specific filters computed in factory (see software description paragraph).

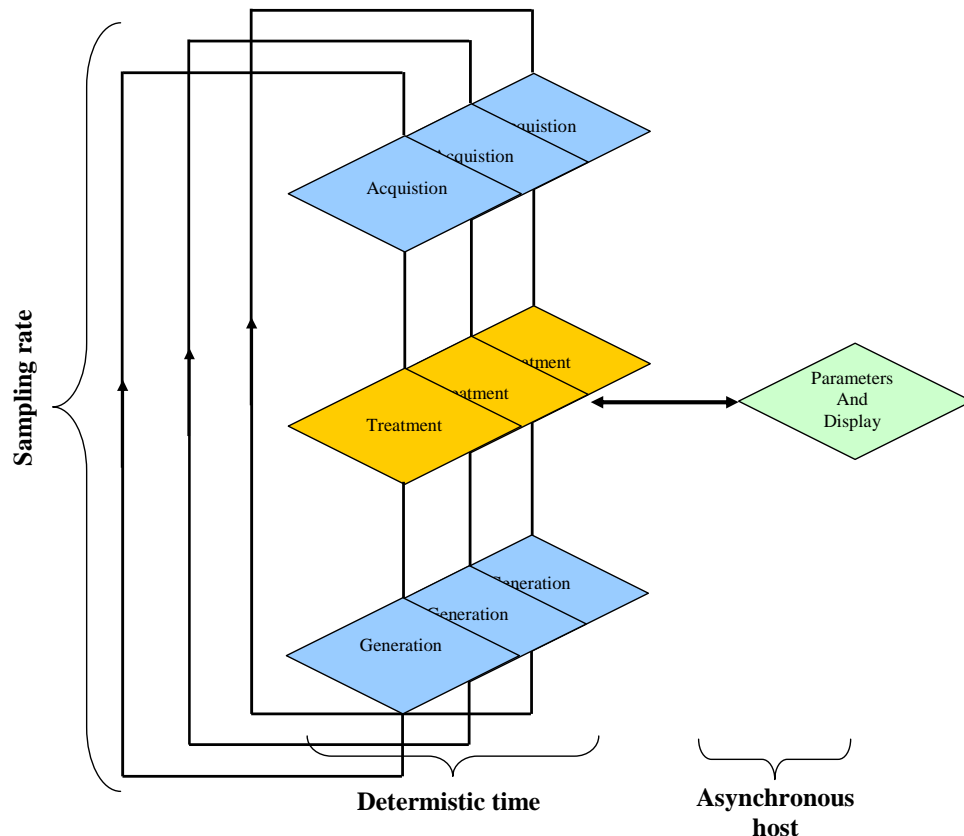


Figure 2-15 - Software architecture of the UC75

The software includes loops cadenced with a deterministic time to realize the acquisition, treatment and generation phases.

The sampling rate (i.e. based on the time to realize a cycle) is principally due to the hardware acquisition and generation and depends of the number of channel. (See hardware performance paragraph for more details).



**Caution:** In factory the filters are adjusted to the mechanism (principally the PID parameters with low pass filter configuration and the Notch filter parameters). In this case if the resonant frequency changes the Notch filter can be out of tuned and the loop can be unstable.

### 3. HARDWARE DESCRIPTION

The UC75 / UC75-MC controller has several electrical interfaces.

#### 3.1. Standard configuration

In the standard configuration, the UC75 / UC75-MC is connected in a standard rack from the Cedrat Technologies product via the rear connector DIN41612 with a dedicated electrical interface. It is not possible to be connected to this connector. The UC75 / UC75-MC controller proposes in option an additional connector including all the connections (analogue, digital Inputs/Outputs) with the embedded controller on the front face. This connector in standard is disable but on request, Cedrat Technologies can enable several pins (trigger, Digital Inputs/Outputs,...).

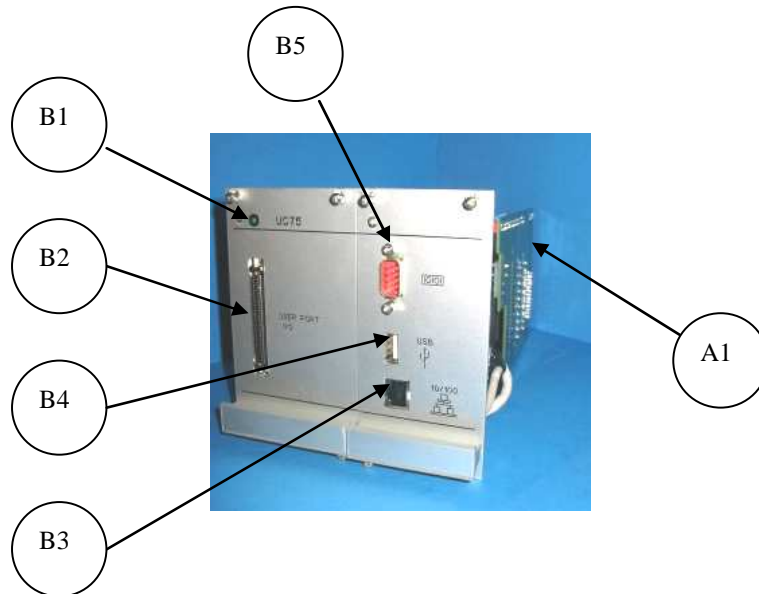


Figure 3-1- Description of the UC75 hardware

REFERENCE	DESIGNATION
<b>1<sup>st</sup> section</b>	<b>Rear panel</b>
A1	DIN 41612: electrical interface with other module in rack 42F, 63F or 84F.
<b>2<sup>nd</sup> section</b>	<b>Front panel</b>
B1	Status Led indicating the power
B2	User port: see next paragraph for pins assignment
B3	Ethernet connector
B4	USB connector: not used
B5	RS232 connector for RS232 link with other instruments: not used

Figure 3-2 - Table of description of the different functions on the front panel

### 3.2. Optional user port configuration

In case of the application requires an input in the UC75 / UC75-MC controller, the operator can use the user port as an optional connector. An optional block is provided including a shielded 68 pins cable.

Pins	Reference	Pins	Reference
35	GND	1	GND
36	Not used	2	Not used
37	AO_7	3	AI_31
38	AO_3	4	AI_30
39	AO_6	5	AI_29
40	AO_2 (*)	6	AI_28
41	Not used	7	AI_27
42	Not used	8	AI_26
43	DO_3	9	AI_25
44	DO_2	10	AI_24
45	DO_1	11	AI_23
46	DO_0	12	AI_22
47	Not used	13	AI_21
48	DI_0 (*)	14	AI_20
49	DI_1 (*)	15	AI_19
50	DI_2 (*) Trigger reserved	16	AI_18
51	DI_3 (*) Enable reserved	17	AI_17
52	GND	18	AI_16
53	Not used	19	AI_15
54	Not used	20	AI_14 (*)
55	AO_1 (*)	21	AI_13 (*)
56	AO_5	22	AI_12 (*)
57	AO_0 (*)	23	AI_11
58	AO_4	24	AI_10
59	Not used	25	AI_9 (*)
60	AI_35	26	AI_8
61	AI_34	27	AI_7
62	AI_33	28	AI_6
63	AI_32	29	AI_5 (*)
64	Not used	30	AI_4 (*)
65	PFI_0	31	AI_3 (*)
66	DO_0 (auxiliary)	32	AI_2 (*)
67	Used	33	AI_1 (*)
68	GND	34	AI_0 (*)

Figure 3-3 - Pins assignment in configuration 32 analogue Inputs and 8 analogue Outputs

(\*) This line is used when connected in a standard rack

The operator can realize its own cable with the following reference of the connector or use the TBX68 from National Instrument® to connect the optional **User port** to the application.

Parting Reference: Male Connector for crimp contacts 60 03 068 52 00



Figure 3-4 - Screws fixture

The TBX-68 is a termination accessory with 68 screw terminals for easy connection of field I/O signals to the UC75 / UC75-MC controller via the Optional **User port**. The TBX-68 is mounted in a protective plastic base with hardware for mounting on a standard DIN rail.

Dimensions: 12.50 by 10.74cm.

## 4. INSTALLING INSTRUCTIONS

This paragraph describes the different instructions to connect the UC75 / UC75-MC controller 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".

### 4.1. Hardware connections

The hardware connection permits the connection of the UC75 / UC75-MC controller to a network and the connections with the command signal and optional signals.

#### 4.1.1. Connecting the UC75 / UC75-MC controller to a network

Connect the controller with an Ethernet cable using the RJ-45 Ethernet port on the controller front panel. **Use a standard Category 5 (CAT-5) or better Ethernet cable to connect the controller to an Ethernet hub, or use an Ethernet crossover cable to connect the controller directly to a computer.**



**Caution:** To prevent data loss and to maintain the integrity of your Ethernet installation, do not use a cable longer than 100m. If you are using 100 Mbps Ethernet, Cedrat Technologies recommends using a CAT-5 or better shielded twisted-pair Ethernet cable. If you need to build your own cable, refer to the Cabling section for more information about Ethernet cable wiring connections. The host computer communicates with the controller over a standard Ethernet connection. If the host computer is on a network, you must configure the controller on the same subnet as the host computer. If neither the host computer nor the UC75 / UC75-MC controller is connected to a network, you can connect the two directly using a crossover cable. If you want to use the controller on a subnet other than the one the host computer is on, first connect the controller on the same subnet as the host computer.

Pin	Connector 1	Connector 2 (normal with an hub)	Connector 2 (crossover when directed on the PC)
1	White/orange	White/orange	White/green
2	Orange	Orange	Green
3	White/green	White/green	White/orange
4	Blue	Blue	Blue
5	White/blue	White/blue	White/blue
6	Green	Green	Orange
7	White/brown	White/brown	White/brown
8	Brown	Brown	Brown

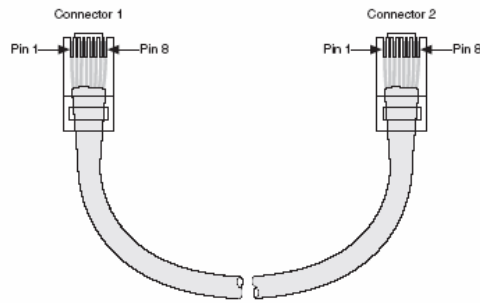


Figure 4-1 : Ethernet Connector Pinout

#### 4.1.2. Connecting the UC75 / UC75-MC controller to a driver



The UC75 / UC75-MC controller is able to be connected on the standard racks from the LA75 series, drivers and controllers catalog on the rear face through a DIN41612 connector or with a specific user port connector on the front face. This specific connector allows to reach analogue input/output or digital Input/output.

In standard, this connector is disable (only the trigger signal is enable). For specific application Cedrat Technologies can enable several pins to authorize for example a trigger action.

#### 4.1.3. Powering on the UC75 / UC75-MC controller



**Caution:** The UC75 controller must be mounted in a rack and be tightened with the captive screws before applying power to the rack. Installing the controller while power is applied to it can cause damage to the rack.

Plug the power supply to the rack. The controller runs a power-on self test (POST). This initialization time can take few seconds (typically 1minute).

#### 4.1.4. Connecting the Command signal

If an external signal is used to command the mechanism this signal must be applied on the BNC connector on the front face of the LA75x (see User manual of the LA75x for more information). The next figure recalls the different connections on the front face of the rack.

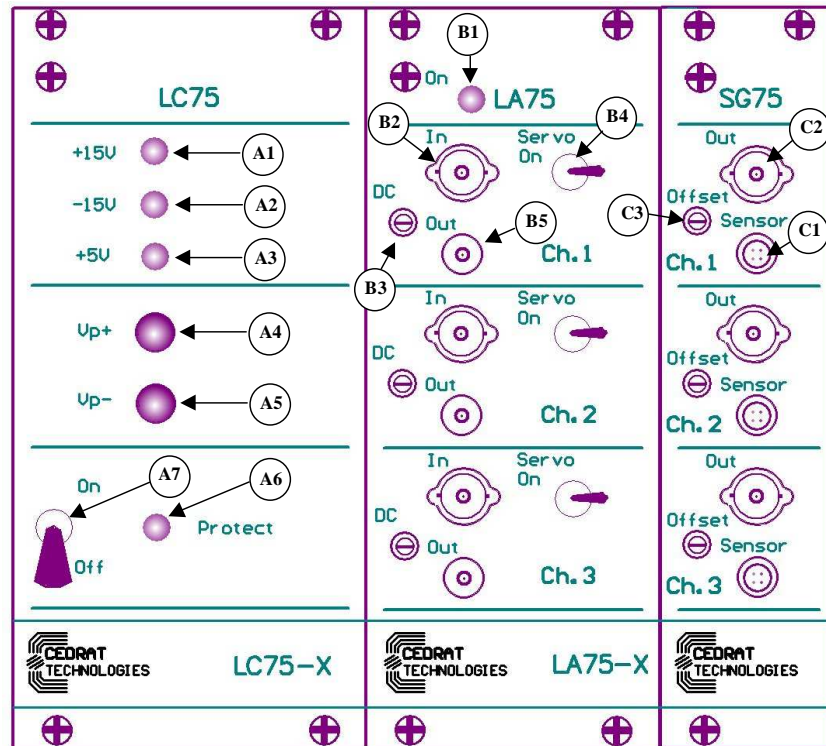


Figure 4-2 : Command connection on the front face of the LA75x

The command is connected on the B2 connector.

#### 4.1.5. Connecting a trigger signal (In trigger mode only)

If the application requires a loaded waveform, a trigger signal which starts the samples must be connected on the pin 50 (or DI\_3) on the optional **User port**.

#### 4.1.6. Connecting an Enable signal (If required)

If the UC75 / UC75-MC controller must be commanded with an external supervisor, the Enable Input must be connected. The pin 51 (or DI\_2) must be connected on the optional **User port**: Open or 0V: the system works, +15V the system is stopped.

## 4.2. Software Installation

### 4.2.1. 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.
- If you choose a direct connection between the UC75 / UC75-MC controller and your PC, the firewall must be disabled.
- Your screen cannot be higher than 1200 per 800 pixels.

The installation requires 2 operations:

- The first one includes the installation of the drivers to dialogue with the UC75 controller [CD1] & [CD2].
- The second one includes the installer for the application software. It contains the autonomous application [CD2].

#### 4.2.2. First time installation

1. The operator has to run the [CD 1] containing a part of the drivers, following the giving indications.

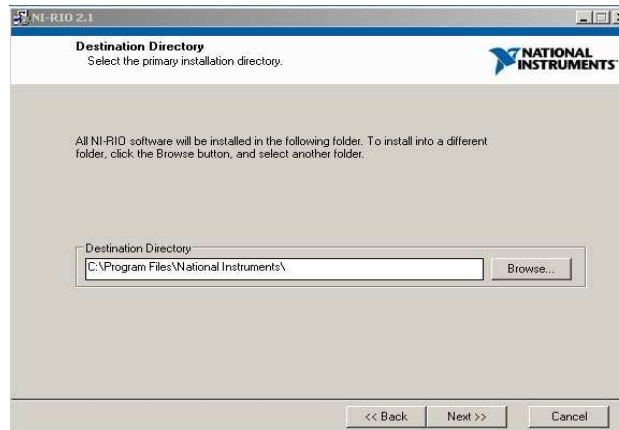


Figure 4-3: Destination directory

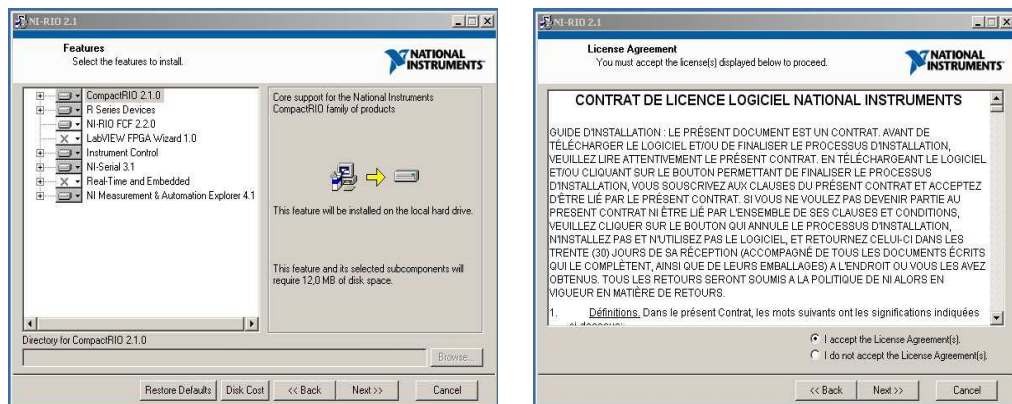


Figure 4-4 : Features & License Agreement.

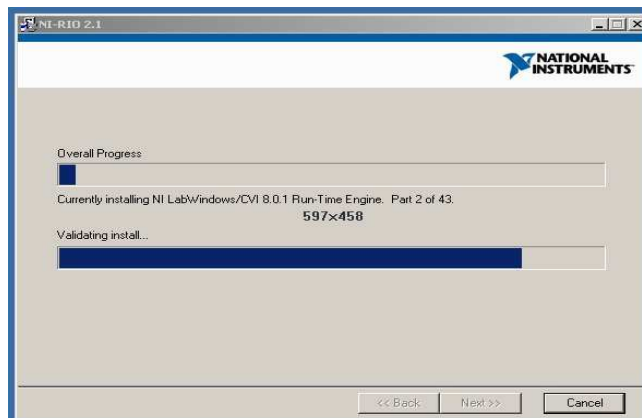


Figure 4-5: Starting Installation.



2. After few minutes, a second message appears to insert the [CD 2].

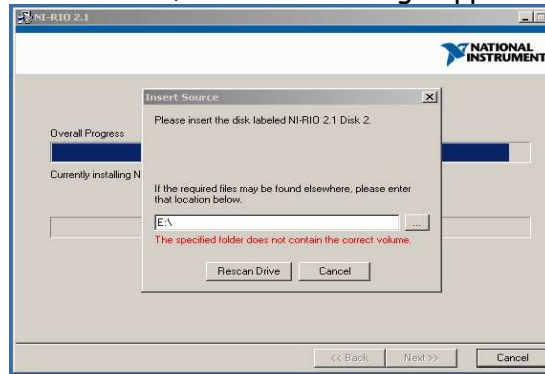


Figure 4-6 : Insert the second CD.

3. When the driver's installation is finished do not restart yet your PC. Copy the repertory named: "HDPM\_1ch\_v12" in C:\Program Files\ on your PC from the [CD2]. **This path is mandatory.**

After this repertory copying in C:\Program Files\, you can run the file name "setup.exe" that is on the [CD 2].



**Caution:** You cannot go on with the installation if the repertory named: "HDPM\_1ch\_v12" is not in C:\Program Files\.

4. After this installation is finished, restart your PC.

5. Connect your PC with the UC75 by an Ethernet cable (see 4.1) and power on the rack.

6. Before running the software, it is necessary to check if the dialogue between your PC and the Hardware is correct, to do that:

- ✓ Open the MAX (Measurement & Automation Explorer) which is on your desktop.
- ✓ Refresh the explorer, clicking on F5; and the UC75 controller will appear on the MAX with an IP address at 0.0.0.0
- ✓ Choose an IP address with the same 6 first numbers as the IP address of your PC.
- ✓ Choose a "masque de sous-réseau" at 255.255.0.0
- ✓ Click on "appliquer" to apply this new IP address on the UC75 controller. It will restart the controller.
- ✓ Wait a few minutes until the controller has restart.
- ✓ The CRIO-9101 will appears under the "devices and interfaces" files. If it is not the case, click on refresh (or F5)
- ✓ The connection is correct, if you see CRIO-9012 & CRIO-9101 connected.

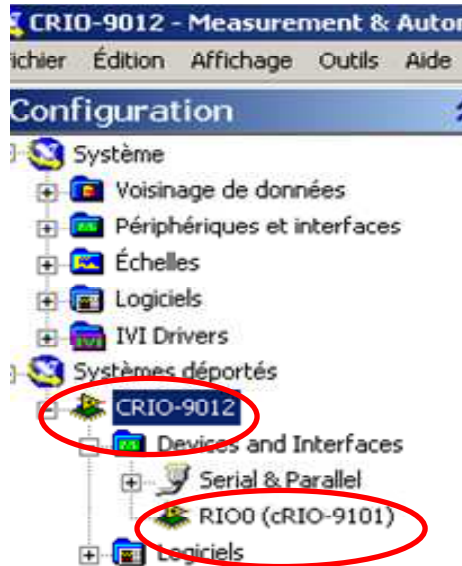


Figure 4-7 : CRIO-9012 & cRIO-9101 connected

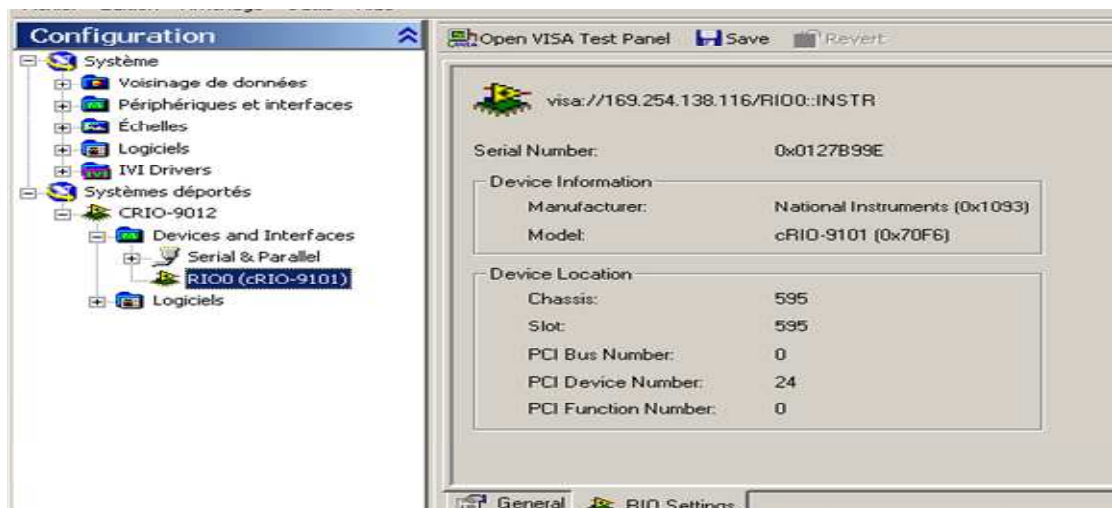
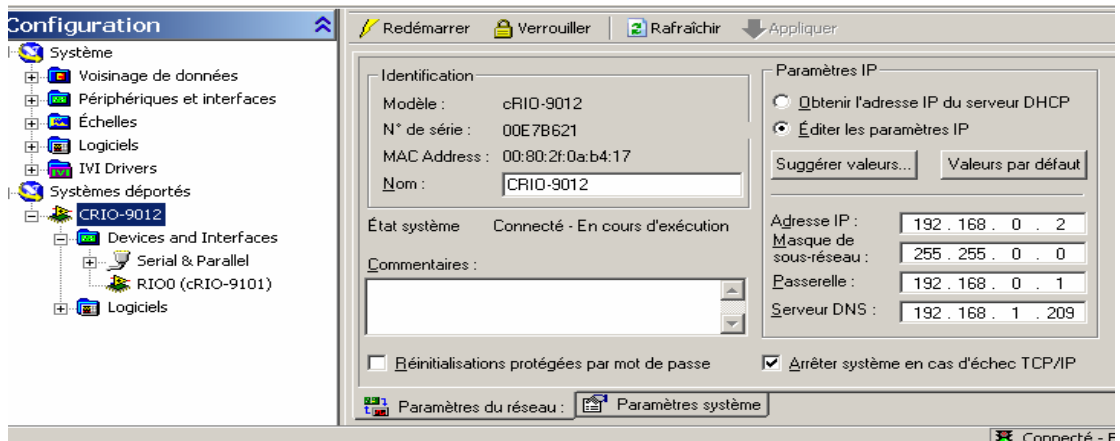


Figure 4-8 : Measurement Automation & Explorer

7. Now the operator can run the software "HDPM\_1ch\_v12.exe" which is normally on your desktop.

Note: A part of the software is deployed inside the UC75 controller (the FPGA part). In other words, the software is stand alone and you can disconnect the Ethernet link when you have set up the parameters of the controller.

## 5. “HIGHLY DYNAMIC AND PRECISE MOTION” SOFTWARE

### 5.1. Introduction

In this paragraph, we describe how to use the “Highly dynamic and precise motion” software with a pair piezo actuator/sensor.

The NI® license-free software provided with the UC75 / UC75-MC permits to command and display some parameters. The screen is divided in three areas.

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

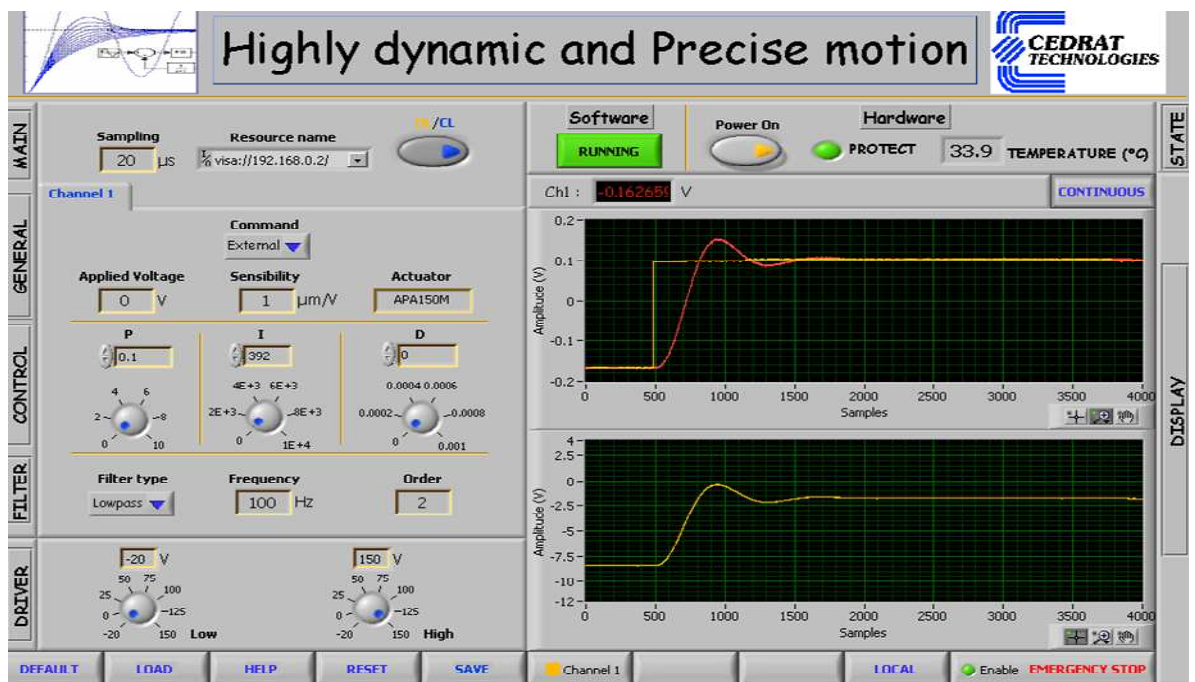


Figure 5-1 : Human Machine Interface description

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

### 5.2. Parameters section

On the left side, the screen is composed of five sections and are principally sections where the operator could pass different parameter for the PID controller :

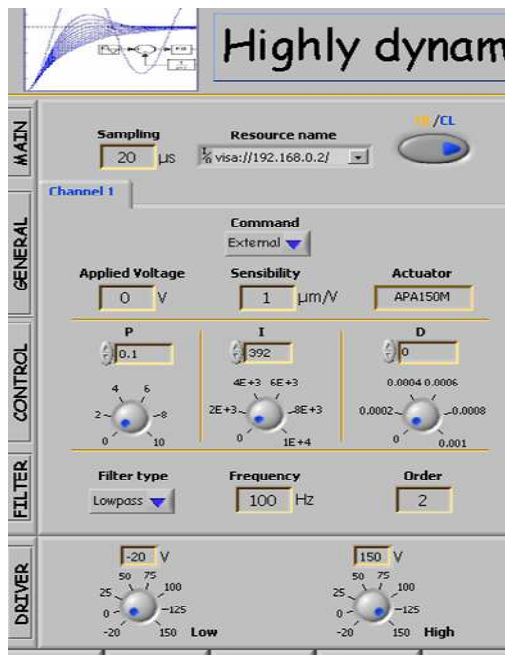


Figure 5-2 : Left section of the HMI: parameter section

1. **MAIN:** This section gives some general information:
  - **Sampling** is the sampling rate of the digital loop and cannot be modified by the operator.
  - **Resource name** is a command to select the IP address of the UC75 controller
  - **OL/CL** is a command to closed 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)
  
2. **GENERAL:**
  - **Command** is a selector to chose between three 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 LA75x and send in the controller to command the actuator. This command must be adjusted between -1 to 7.5 Volts.
    - **Trigger:** In this case the command is issued from an internal memory to send an arbitrary waveform (a pre-shaper for example) on the actuator. In this case if a waveform was loaded in the memory of the controller (see next section) and if a trigger is sent on the optional user

port, the loaded waveform is applied on the actuator 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.
- **Sensibility** is an indicator to give the sensibility of the sensor to convert the voltage from the display or the **Applied voltage** command in a position if only the control loop is closed (**OL/CL** command is in BF position). In open loop, the actuator is not calibrated.
- **Actuator** indicates the name of the actuator that is connected to the channel.

### **3. CONTROL:**

- **P, I, D** commands adjust the PID parameters as described in the previous paragraphs.
  - The **P** parameter can be adjust between 0 to 10 by step of 0.01
  - The **I** parameter can be adjust between 0 to 10000 by step of 196.
  - The **D** term can be adjust between 0 to  $1e-3$  by step of  $1e-5$ .

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

### **4. FILTER:**

- **Filter type** indicates the kind of filter is inline with the PID regulator:
  - **Low pass** filter based on a 2<sup>nd</sup> order Butterworth low pass filter. In this case the **frequency** and **order** indicators gives respectively the frequency and the order of the factory model implemented in the UC75 controller
  - **Notch** based on a 2<sup>nd</sup> order Butterworth stop band filter. In this case the **frequency** and **order** indicators gives respectively the frequency and the order of the factory model implemented in the UC75 controller
  - **None** indicates that no filter is added with the PID controller.

### **5. DRIVER:**

- **Lower** indicates the lower limitation of the voltage output of the driver.
- **Upper** indicates the lower limitation of the voltage output of the driver

These values are correct if the offset of the driver is adjusted near 0 Volt. To verify place the **command** in the **internal** mode (section **General**) and check the value of the driver (in the **Display** section). Turn if necessary the offset potentiometer of the LA75x (see user manual of LA75x for additional information).



We recommend when you tune the regulator to place the **Lower** and **Upper** commands with small amplitudes to limit a potential risk of damage on the actuator during a 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** and **FILTER** sections.

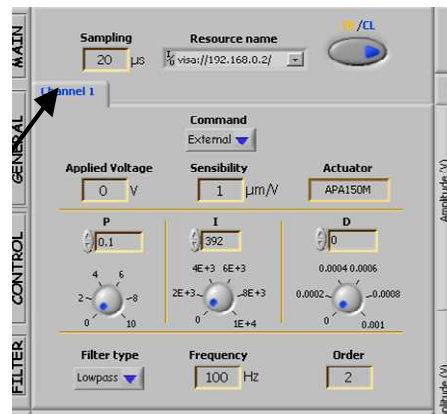


Figure 5-3 : Selection of multi-channels

### 5.3. States section

On the right side, the screen is composed of two sections which give the states of the control loop:

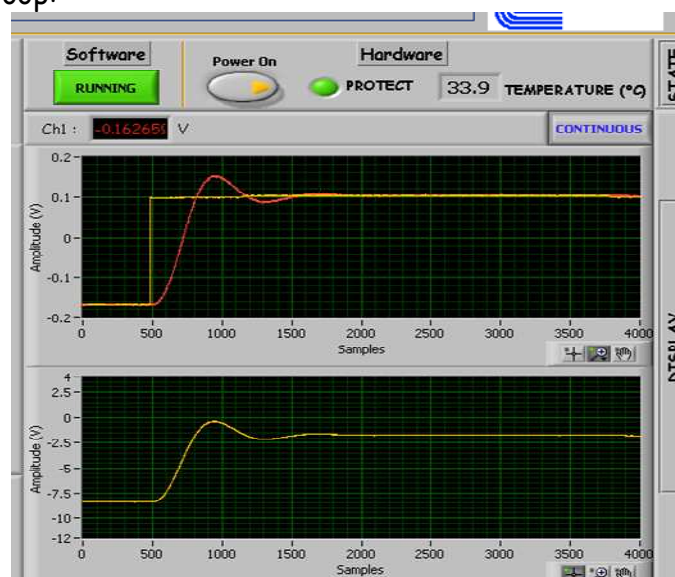


Figure 5-4 : Right section of the HMI: states section



## 6. DISPLAY:

2 graphs represent the responses from the actuator and the driver: The samples are traced on the X axis and the amplitudes are traced on the Y axis in Volts.

- The first one on the top of the screen includes the command and sensor for 1, 2 or 3 channels. The operator can display one, two or three pairs of signal with the **Channel x** button by selecting the small colored square.



Figure 5-5 : Selection button to display the Command-sensor pair

By clicking on the background colour of this button the operator can display or mask the legend of the graphs.

This display is an asynchronous display. It means that it is not triggered with the command. The number of displayed points is 4000points and cannot be changed. Use the graph palette, shown as follows, to interact with a graph or chart while the software is running.



Figure 5-6 : display tool bar: Display section

With the graph palette, you can move cursors, zoom, and pan the display. Right-click the graph or chart and select **Visible Items>Graph Palette** from the shortcut menu to display the graph palette. The graph palette appears with the following buttons, in order from left to right:



Figure 5-7 : Graph palette

- **Cursor Movement Tool** (graph only): Moves the cursor on the display.



- **Zoom:** Zooms in and out of the display. Use the Operating tool to click the **Zoom** button and select from the following options, clockwise from the top left, to zoom in and out of the graph:
  - **Zoom to Rectangle**—With this option, click a point on the display you want to be the corner of the zoom area and drag the tool until the rectangle covers the zoom area.
  - **X-zoom**—Use this option to zoom in on an area of the graph along the x-axis.
  - **Y-zoom**—Use this option to zoom in on an area of the graph along the y-axis.
  - **Zoom In about Point**—With this option, click a point you want to zoom in on. Press and hold the <Shift> key to switch between Zoom In about Point and Zoom Out about Point.
  - **Zoom Out about Point**—With this option, click a point you want to zoom out from.
  - **Zoom to Fit**—Use this option to autoscale all x- and y-scales on the graph or chart.
- **Panning Tool:** Picks up the plot and moves it around on the display.
- The second one includes the response of the driver for 1, 2 or 3 channels. The operator can display one, two or three signals with the **Channel x** button by selecting the small colored square (see figure 25). Like the same top display the operator can modified with the **display tool bar** the display with a zoom, some cursors
- The **CH1** display is a real time display of the position of the actuator. In a multi-channels configuration 1, 2 or 3 positions are displayed. The displayed value is in Volts.
- **Continuous/Finite** button permits to select a continuous display or a finite display. In the first case the selected graphs are displayed in continuous with asynchronous packs of 4000 samples. In the second case only 4000 samples are displayed and the graphs are stopped. To restart select **Continuous**. Of course the control loop continues to work.

## 7. STATE:

In this section the operator could display the state of the hardware/software via some indicators/commands.



Figure 5-8 : Bottom section of the HMI: General command section

- **Temperature** indicates the temperature of the output stage of the driver. The driver is maintained in protection if the temperature is above 85°C.
- **Protect** indicates if the driver is in protection or not. If the power of the LC75 is in off position the protect indicator is red and no voltage can be applied on the actuator.  
If the power of the LC75 is in off position the protect indicator is green and a voltage can be applied on the actuator from the Human machine interface (via **command**).
- **Power On** permits to switch on or switch off the power of the actuator via a software command. The mechanical switch on the front face must be maintained in a off position.
- **Software** indicates the state of the software:
  - **RUNNING**: No error
  - **ERROR**: A problem is occurred (transmission, memory,...)
 You can reset the error by clicking on the **RESET** button or by switch off- switch on the power on rear face of the rack. In these two cases 1minute is necessary to reconnect the transmission and to initialize the software.

#### 5.4. General command section

On the bottom side, the screen is composed of several buttons to manage some information:



Figure 5-9 : Bottom section of the HMI: General command section

- **DEFAULT** button permits to change all the parameters with the factory configuration. A .ini file initialized in factory is loaded with a standard configuration.
- **LOAD** button is coupled with the **Trigger** command in the **General** section. When **Trigger** command is selected **Load** button permits to select .txt file containing the data to send on the actuator with a rise edge trigger. The following screen appears to indicate the loading process in the FPGA memory of the UC75. The memory proof is up to 16384 samples.

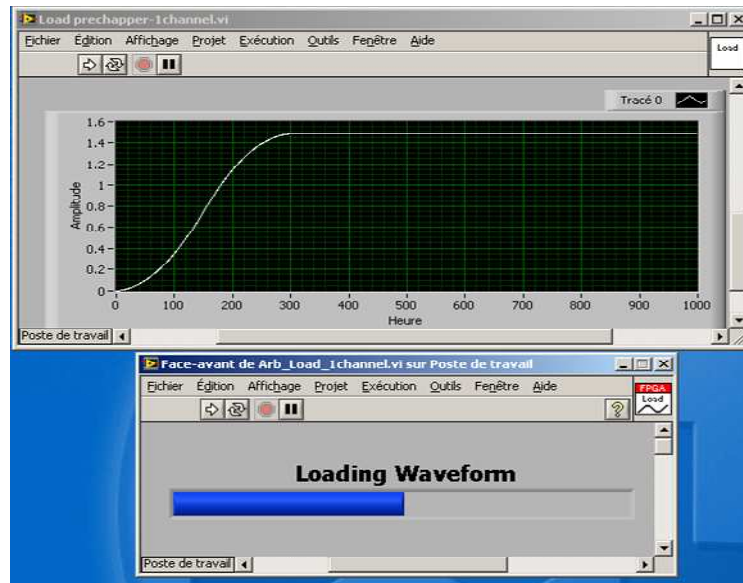


Figure 5-10 : Load screen after a load selection

Once the memory loaded, only a **LOAD** action can change the values of the waveform. **RESET** or **STOP** actions cannot erase the memory.

- **HELP** button permits to find the user manual at screen in .doc format
- **RESET** button permit to initialise the Ethernet connexion with UC75 if this connexion is not lost. In this case the main action to reset the UC75 controller is to switch off the rack on the rear face and to switch on. Wait 1 minute to establish a new connexion.
- **SAVE** button saves the data appearing on the display with up to 4000 samples in a .txt file.

The file is composed of 9 columns:

- The third first one are allocated for the channel 1.
- The third next one are allocated for the channel 2.
- The third last one are allocated for the channel 3.

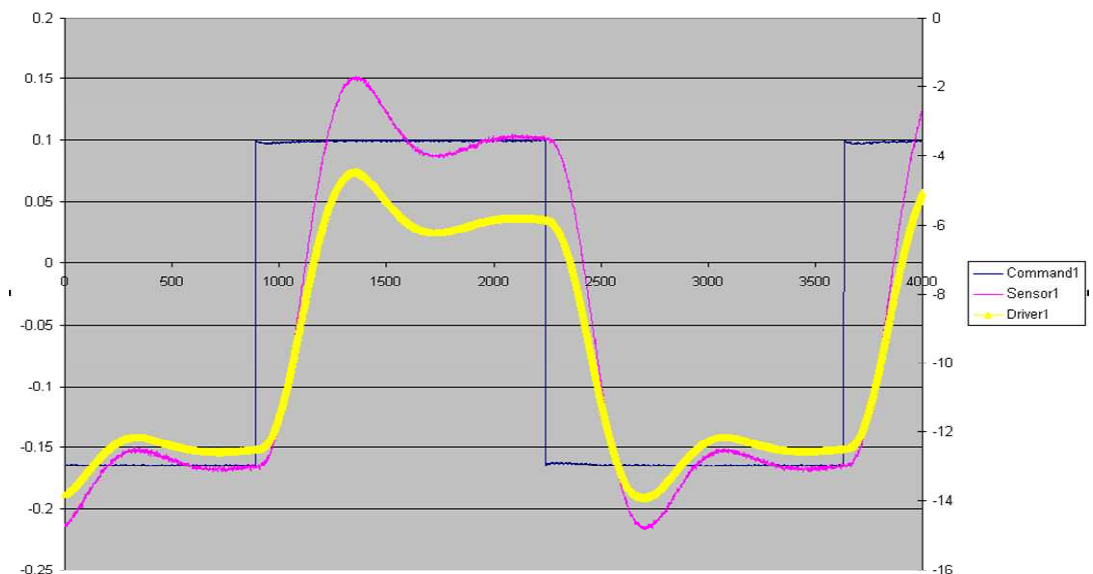


Figure 5-11 : Definition of the saved column in the .txt file.

- **REMOTE** button permits to work in stand alone configuration: The UC75 controller works alone and the Ethernet link is disable. In this case, the HMI is disconnected from the UC75 controller. To reconnect the HMI with the UC75 controller, click again on the **LOCAL** button to enable the Ethernet link.

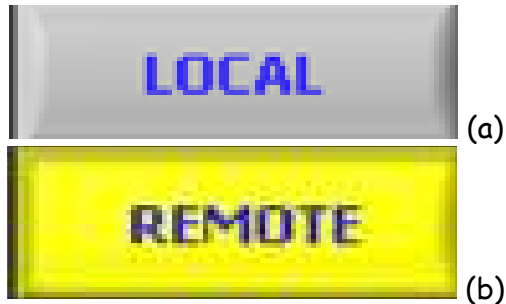


Figure 5-12 : REMOTE button: a- LOCAL action, b- REMOTE action

- **EMERGENCY STOP** permits to stop the software if the connexion is ok. In this case the mechanism is placed in the following configuration:
  - **Open loop**
  - **Internal** Command with 0v applied on the mechanism
  - **Power ON** in Off state
 An input line ( digital 0-15V: 0V ok and 15V stop) can realise the same operation via the user port (**see the pin out table for more details**)

## 5.5. Summary

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

Name	Type	Range
<b>Parameters Section</b>		
Sampling	Indicator	
Resource name	Command	
OL/CL	Command	OL: Open loop CL: Closed Loop
Command	Command	Internal: Command from HMI External: Command from BNC Trigger: Command from Memory
Applied Voltage	Command	-1 to 7.5V in Internal mode
Sensibility	Indicator	
Actuator	Indicator	
P	Command	0 to 10 - resolution 1e-2
I	Command	0 to 10000 - resolution 196
D	Command	0 to 1e-3 - resolution 1e-5
Filter type	Command	Low pass Notch None
Frequency	Indicator	Frequency of the filter
Order	Indicator	Order of the filter
Low	Command	-20 to 150V
High		-20 to 150V

<b>Display section</b>		
Commandx	Graph	-10V to 10V with a resolution of 1/2 <sup>16</sup> - 4000 samples
Sensorx	Graph	-10V to 10V with a resolution of 1/2 <sup>16</sup> - 4000 samples
Driverx	Graph	-200V to 200V with a resolution of 1/2 <sup>16</sup> - 4000 samples
Continuous/Finite	Command	Continuous: Asynchronous acquisition of 4000 samples in continuous. Finite: Asynchronous acquisition of 4000 samples.
<b>State section</b>		
Power On	Command	On: The power is applied on the mechanism Off: The power is not applied on the mechanism
Protect	Indicator	Red: the power is not applied on the actuator or a rack protection is on Green: The power is applied. The rack is ok
Temperature	Indicator	Analogue temperature of the driver: resolution 0.1°C
<b>General command section</b>		
DEFAULT	Command	Recall the factory configuration
LOAD	Command	Load the waveform from a txt file
HELP	Command	Display the user manual
RESET	Command	Reset the UC75 controller if the connection is ok
SAVE	Command	Save the values of the commandx, sensorx and driver x from the graphs
REMOTE	Command	REMOTE: The Ethernet link is disable and the HMI is disconnected from the UC75 controller LOCAL: The Ethernet link is enable and the HMI is connected to the UC75 controller
EMERGENCY STOP	Command	Stop the software with OV on the actuator and OL on the OL/CL button

*Figure 5-13 : summarize table of each parameter*

## 6. OPERATING INSTRUCTIONS

In this paragraph we give some operating instructions to avoid damages on the mechanism for a first time user.

### 6.1. Initial settings

The "Highly dynamic and precise motion" software is delivered with a initialization file including the standard parameters to control the mechanism:

- PID term with Low pass filter,
- Sensibility of the sensor and the calibration of the position sensor,

The .ini file initializes the following parameters with the following value.

Parameters	Values	Remarks
OL/CL	BO or open loop	Open/closed Loop switch
Sampling	20 $\mu$ s if 1channel	Indicator
Command	Internal	
Applied Value	0V	
Sensibility	Depends of the driven actuator	
Actuator	Depends of the driven actuator	
P	0.1	Can be modified with the mechanism
I	200	
D	0	
Filter	Low pass	
Frequency	100Hz	Can be modified with the mechanism
Order	2	
Lower	-20V	
Upper	+150V	

Figure 6-1 : Defaults parameters

### 6.2. Step by step instructions



The operator will find in this instruction paragraph the most common uses of the product. For first time, follow step by step the following instructions:

We recommend connecting an oscilloscope on the following signals to display in real time the behaviour of the loop and then to check the instability:

- Command Input on the front face of the rack,
- Position Output from the position sensor.

We suppose that the operator has correctly installed the driver of the UC75 / UC75-MC controller and the application "Highly dynamic and precise motion" (see §4.2)

0. Power on the rack by switch on the rear connector. If the rack is not powered on the UC75 controller is not supplied and the HMI is not connected to the controller.

1. Check the dialogue between the host and the UC75 controller:  
Use the MAX Explorer to verify the connection (see 4.2.2).

1. Check the different necessary connections: Optionally and if required the trigger signal and the Enable signal must be connected.

2. Select the correct IP address in the **Resource name** selector. Refresh by selecting "rafraichir" the IP address by clicking on the **resource name** selector and select the IP address corresponding to the UC75 controller.

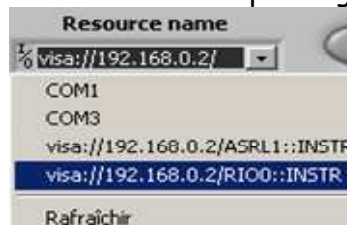


Figure 6-2 : Refresh action on the resource name selector

3. Launch the "Highly dynamic and precise motion" software with the button on the top and left side.

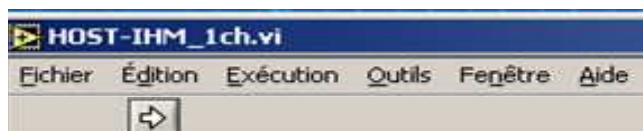


Figure 6-3 : The software is not running.

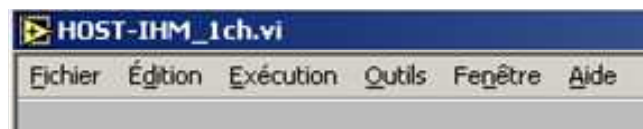


Figure 6-4 : The software is running.

The parameters are now enabled and the operator can change each parameter. The software will run if the enable pin on the user port (see Figure 3.3) is at 0V. If this pin is at +15V level the software will stop immediately.

4. Choose the type of command: **Internal**, **External** or **Trigger**. If **Trigger** is chosen for the first time the operator must load the waveform by clicking on the **Load** button (see §6.3). We recommend to check the

command signal on the display graph by selecting the displayed channel before switch on the power supply of the driver.

5. Don't forget to switch on the LC75 power supply with the **Power On/Off** command on the front panel of the HMI to provide the power supply to the mechanism. The mechanical switch of the LC75 is not used to switch on the power of the mechanism.

6. At this level the mechanism is driven in open loop. In this case the position is not controlled and so the displayed sensibility is not applicable. While starting control parameters are initialised with default configuration (.ini file loaded) (see §6.1)

7. You can display the signals from the command, the sensor or the driver with the graphs on the right side. These graphs are asynchronous.

8. For first time we recommend to adjust Lower and Upper with a small Delta voltage to limit the amplitude of the mechanism able to create damage on the mechanism.

9. Adjust **PID** parameters, **Filter** parameter with your application. We recommend to remain in open loop during the modification of these parameters to avoid a typing error and so a bad parameter.

10. Close the loop by clicking on **OL/CL** button. Now the mechanism is controlled in position with the programmed parameters on the HMI. If you hear a sound from the mechanism click immediately on the **OL/CL** button to pass in open loop. The closed loop is unstable!!! Change the **PID** and **Filter** parameters to be stable (see §2.1.)

11. To change the type of command between **Internal**, **External** or **Trigger** we recommend being in Open loop by clicking on the **OL/CL** button before selecting the new type.

12. To save the recorded samples on the display, we recommend to use the **Continuous/Finite** button before saving by clicking on the **SAVE** button.

13. To stop the mechanism, the operator must click on the **Emergency Stop** button. This action stops the mechanism by applied a 0V on the command before disconnecting properly the HMI from the UC75 / UC75-MC controller.

Note: Each button is described in the 5. Paragraph.



### 6.3. Trigger mode

The trigger mode is used when the operator wants to send to the actuator a defined waveform. The "Highly dynamic and precise motion" software permits to load a memory of up to  $2^{14}$  samples to be read at a **Sampling** rate of the control loop (the maximum time is 327.68ms). Principally the operator has to generate a .txt file with only one column describing the amplitude of the waveform (the interval between each sample is the sampling rate  $T_s$ ). Please follow the next instruction to program the file to be loaded in the internal memory:

1. Generate an Excel file with your samples. A first column gives the time and the second one the amplitude of the signal (between -1 to 7.5Volts) and  $2^{14}$  samples maximum with an interval of  $T_s$  ( $T_s$  can be  $20\mu s$  for 1 channel configuration,  $25\mu s$  for 2 channels and  $30\mu s$  for 3 channels).

2. Save the second column in .txt format to be compatible with the "Highly dynamic and precise motion" software

3. In the "Highly dynamic and precise motion" software, select **Trigger** in the command section and click on the **LOAD** button to load the .txt file. A Load bar appears which indicates that the memory of the UC75 / UC75-MC controller is loading (see figure 5.10)



4. The waveform will be sent to the mechanism when a rise edge of the trigger signal will be received on the user port connector. (see Table 19). This function is retriggerable (i.e. if the trigger appears before the end of the sequence, the sequence is reinitialised and restart at the sample number 1). This behaviour can send a step in the mechanism. The maximum programmable interval is 327.68ms in a 1 channel configuration.

We recommend checking the waveform before power on the power supply of the mechanism by displaying the command on the display graph.

An example file is provided on the CD:

- Load the **preshaper.txt** file.

This file includes a waveform used to limit the impact of a short rise edge.

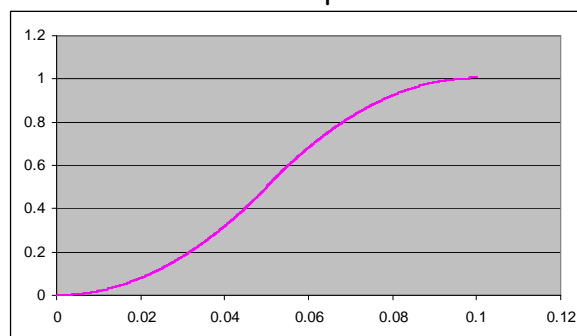


Figure 6-5 : Example file

Properties of the specific waveform: amplitude of 1V, Period of 0.1ms (5000 samples)

#### **6.4. Stand alone application**

When the UC75 / UC75-MC controller must be configured in a stand alone controller, click on the **REMOTE** button to pass from a **Local** configuration to a **Remote** configuration. The controller works continuously but any change can not be done. In this configuration the Ethernet link can be disconnected. To modify a parameter, reconnect the Ethernet link and click on the **REMOTE** button to pass in **Local** connexion: the HMI and the UC75 / UC75-MC controller dialogue together again.

The Remote button must be pushed when the operator is sure that no new modification of parameters will be done.

#### **6.5. Single troubleshooting**

##### **The UC75 / UC75-MC controller doesn't respond:**

1. Check the power supply of the rack: the power must be in on state,
2. Check the Ethernet link: In a standard configuration where the UC75 / UC75-MC controller is connected directly with the Host (the Personal computer which is running with the "Highly dynamic and precise motion" software) a crossover cable is used. When the UC75 / UC75-MC controller is connected via a hub a direct cable is used,
3. Verify the dialogue with the MAX explorer,
4. Select the right resource name via the Resource name command,
5. Run the "Highly dynamic and precise motion" software with t the button on the top and left side of the screen,
6. In a standard state the Temperature of the driver is at the ambient temperature. If no dialogue between the host and the UC75 / UC75-MC controller the temperature is not sent via the Ethernet link (NaN can be displayed or -273°) and check the previous points.
7. The Remote button is in **Local** state and so the controller is in stand alone configuration: To change a parameter or display a curve this button must be in a **Remote** configuration.

##### **When launching the software the HMI is directly switch off after one second:**

1. The software is running correctly but the enable command via the optional user port is in Off state. Check the state of this pin: 0V Enable, +15V Disable.
2. The Emergency stop button is in stop position. Re-launch the software to pass in a correct state.
3. Select the right resource name via the Resource name command.

##### **The actuator doesn't move:**

1. The power must be applied via the **Power on** command. In this case the VP+ and VP- leds must be lighted,
2. The Type command is in **internal** position with 0 Volts applied. Pass the type command in External position and applied a 1Hz 0.1V square signal on the BNC input connector of the LA75x. A little noise must be heard,
3. The type command is in **Trigger** position but no waveform is sent to the mechanism: click on the **Load** button to write in the memory the data,
4. The type command is in **External** position but no signal is send on the BNC input,
5. In **CL** position the Parameters of the regulator are 0.

**In the trigger mode, the actuator doesn't follow the command from the .txt file:**

1. The regional parameters of the PC must be configured in "." instead of ","
2. To load the data in the memory of the controller the operator must follow the instructions:
  - Pass the Type command in **Trigger** mode,
  - Load via the Load button the .txt including only one column corresponding to the amplitude of the signal applied on the mechanism
3. Check the command with the display graph before sending on the mechanism.
4. Use the example file provided (preshaper.txt) with the CDs to show how build the .txt file. This file sends to the mechanism a specific waveform with an amplitude of 1V on a period of 0.1ms (5000 samples)

**Any curves appear on the graphs:**

1. Check the configuration of the Finite /Continuous button: In a Finite mode the curves are displayed only one time with 4000 samples. In continuous mode the curves are displayed in continuous with packets of 4000 samples,
2. Click on the small colored square inside the **Channel x** button: When the display is selected the small colored square is orange for the channel 1,
3. Use the Zoom palette to auto zoom on the curves,
4. The **Local/Remote** button is in Local mode. In this case the Host is not in dialogue mode and so no curve can be displayed.

**The Protect led on the HMI is continuously red:**

1. The Power On button is in Off state: the colour of the small arrow is orange. Click on the power On button to pass the arrow colour in blue. The VP+ and VP- of the Rack must be lightened.

**The VP+ and VP- leds on the rack are continuously lightened:**

1. The Power On button is in On state: the colour of the small arrow is blue. Click on the power On button to pass the arrow colour in orange. The VP+ and VP- of the Rack must be extinguished,

2. The Protect switch on the rack is in on position. When the UC75 / UC75-MC controller is used to control this switch, the mechanical position of the Protect switch must be in off position.

## **7. FIRMWARE UPGRADE**

The application can be upgraded with a new version of software directly from our Web site. An installation sequence as the first installation described in paragraph 4.2.2 is NOT necessary, only the download of the file named HDPM\_1channel\_vxx.exe is necessary.

We recommend contacting us and going on our website to download the latest version of the software.

<http://www.cedrat-groupe.com/>

## 8. HARDWARE PERFORMANCES

In the following table, we summarize the different performances of the UC75 / UC75-MC with the highly dynamic and precise motion software in function of the number of channel.

	1 Channel	2 Channels	3 Channels
Sampling rate Ts (*)	20 $\mu$ s	25 $\mu$ s (TBC)	30 $\mu$ s (TBC)
Resolution (*)	16 bits		
Range	+/-10V		
Number of channels from User ports (**)	16 analogue Inputs (13 are used to control/display the behaviours of the actuator with sensor, command and driver) 4 analogue outputs (3 are used to command the actuator) 8 digital Inputs/Outputs (3 are used to control the driver)		
Pre-shaper (***)	Yes with a memory proof up to 16385 samples with a sampling rate of Ts		
Type of control	PID regulator		
Added filter	Low pass 2 <sup>nd</sup> order filter with cutoff frequency adjusted in factory Stop band 2 <sup>nd</sup> order filter with stop frequency adjusted in factory		
Output voltage limitation of the driver	Yes between -20 to +150V		
Power supply	15 to 30Volts DC @200mA		

Figure 8-1 - Performances of the UC75 / UC75-MC

### Remarks.

(\*) Cedrat Technologies can provide different configurations to increase the sampling rate by modifying the acquisition/generation capabilities (ie the numbers of bits or the numbers of inputs/outputs). **Please contact us for more information.**

(\*\*) The numbers of channels don't include the internal connections from the rear connector in a standard rack. **Please contact us for more information.**

(\*\*\*) With trigger on the front user port.

## **9. 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 power supply

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.