# LA75 - LINEAR AMPLIFIER FOR PIEZOELECTRIC ACTUATORS - CA45 COMPACT STANDALONE AMPLIFIER
# PRODUCT AND WARRANTY INFORMATION

**Version : 3.2.3**
**Date: 04/11/13**


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# CAUTION: READ BEFORE OPENING

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

**This power amplifier is dedicated to multilayers piezoelectric actuators.**

**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.**

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# 1. SYNOPTIC

The linear electronic LA75 multi-channel consists in a 19 inches casing to the following dimensions:

| Rack 42F | Rack 63F-4U | Rack 84F-4U |
|---|---|---|
| Width : 260 mm<br>Length: 310 mm<br>Height: 160 mm | Width : 365 mm<br>Length: 310 mm<br>Height: 200 mm | Width : 470 mm<br>Length: 310 mm<br>Height: 200 mm |

This electronic is a modular one; which means that a rack42F, for instance, may receive one power supply unit (LC75A) and up to 6 amplification channels, as well as sensors conditioning units:

- strain gauges sensors conditioner (SG75 unit),
- eddy current sensors conditioner (ECS75 unit).

The rear panel includes the main power connection, the ON/OFF switch and the fuses. The front panel includes the connections with actuators, orders and the switches to close the loop (SERVO) (Cf. Figure 1). The rack can include other boards described in separate documentations.

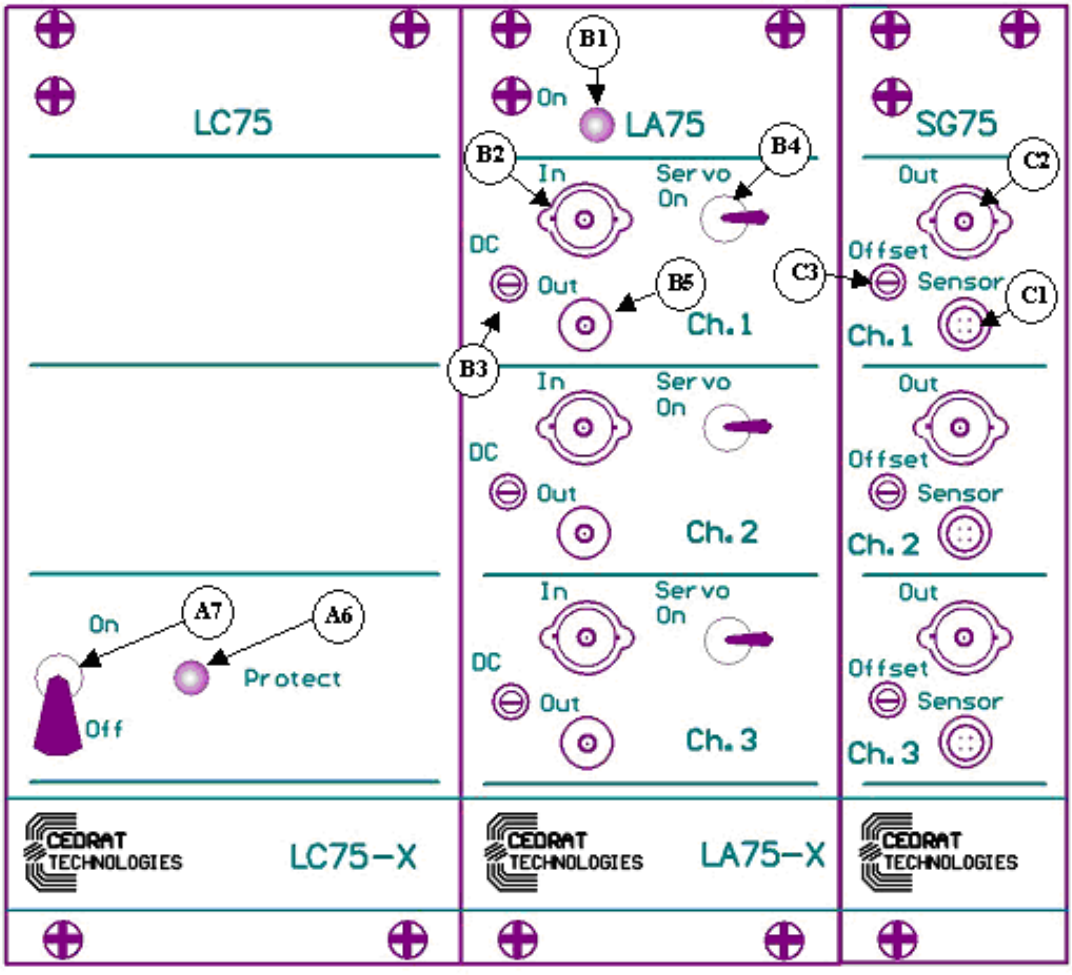



*Figure 1 - Front panel of the LA75 power supply*

Nota: " X " refers to the "A" ,"B" or "C" version of the driving electronics

| REFERENCE | DESIGNATION |
|---|---|
| **1st module** | Main power supply unit - LC75X |
| A6 | Led protect |
| A7 | Vp voltage switch |
| | |
| **2nd module** | Linear amplifier - LA75X |
| B1 | Led power supply presence |
| B2 | Order BNC connector – channel 1 |
| B3 | DC offset order potentiometer (10 turn screw)- channel 1 |
| B4 | Closed loop selector (SERVO ON / OFF) – channel 1 |
| B5 | LEMO connector for piezo actuator (3 pins lemo for push-pull option)– channel 1 |
| | |
| **3rd module** | SG75 – Strain Gauge conditioner (optional) |
| C1 | LEMO connector for the gauges bridge – channel 1 |
| C2 | BNC connector of the conditioner signal response - channel 1 |
| C3 | Regulation potentiometer of the offset (10 turn screw) – channel 1 |

## WARNING

**A special care in the use of the LEMO connections should be taken in plugging and unplugging them: you have to pull onto the connector and not the cable.**
**It is strictly forbidden to connect the electrical output channels in parallel.**

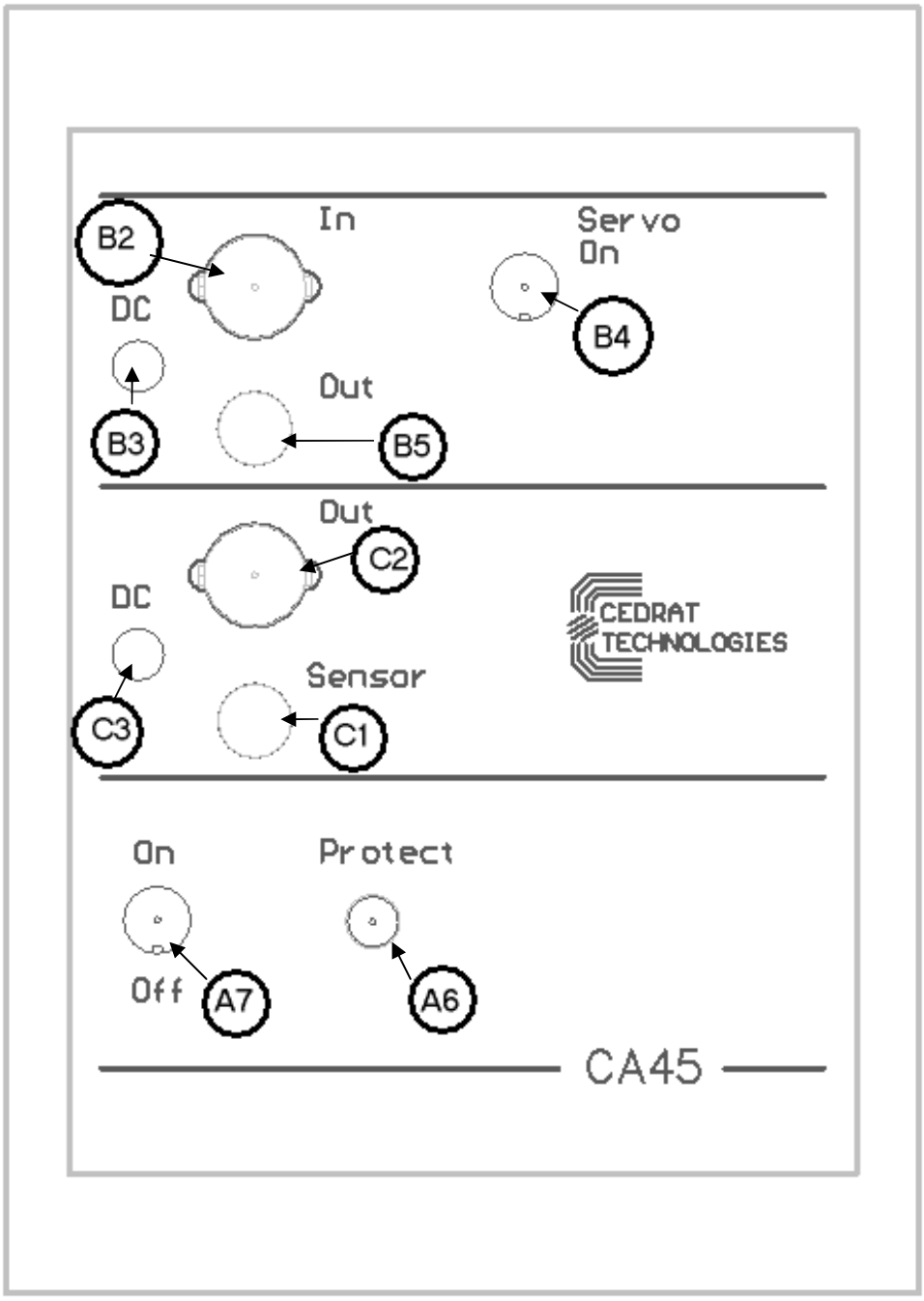



*Figure 2 - Front panel of the CA45 compact standalone amplifier*

# 2. GENERAL DESCRIPTION

The linear electronic LA75 is dedicated to the supply and control of piezoelectric actuators based on multi-layers piezoelectric ceramics such as APA or PPA from CEDRAT TECHNOLOGIES. The LA75X consists in a power supply with a maximal power given in the attached technical data sheet, including:

- A linear power supply (LC75X)providing a continuous voltage from the main power (1st module),
- A linear amplifier (LA75X) dedicated to capacitive load allowing excitation of piezoelectric actuators between –20 and 150 V (2nd module),
- A strain gauge conditioner (SG75) allowing to measure the displacement of piezoelectric actuators equipped with gauges (optional module),
- A servo controller (SC75) allowing to close the loop and to insure a feedback control on the actuator (optional module)

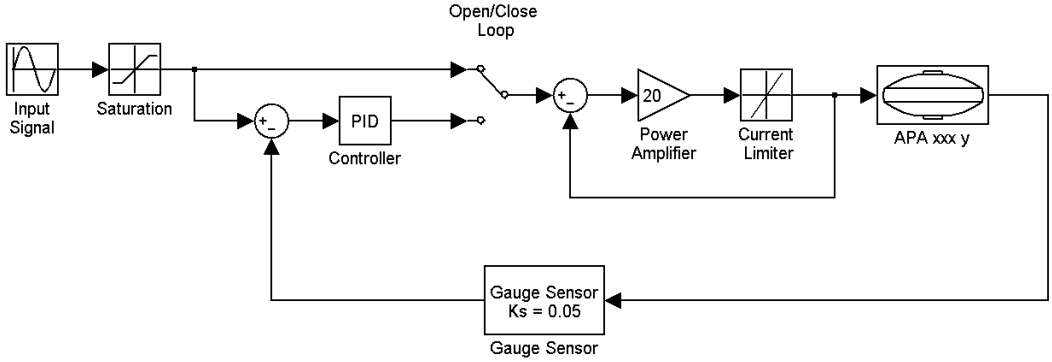



*Figure 3 - Synoptic of the electronic control of a piezo actuator*

The CA45 compact standalone amplifier consists in a board including the linear power supply providing a continuous voltage from the main power, the linear amplifier, the strain gauge conditioner (option) and a servo controller (SC75) (option).

# 3. MAIN CONNEXIONS

## *3.1. Fuses*

| Main: 230 V AC / 50 Hz or : 110 VAC / 60 Hz | | |
|---|---|---|
| CA45 | LA75A / LA75B | LA75C |
| fuse : 250V 1A F type* | fuse 1: 250V 2A T type<br>fuse 2: 250V 2A T type | fuse 1: 250V 6.3A T type<br>fuse 2: 250V 6.3A T type |

* CMS fuse : the customer is not allowed to change it without authorisation

## 3.2. Voltage selection

The rack is equipped with a main selector (several configurations) integrated to the power entry module that allows the user to select the main voltage by himself, except for the CA45, the selector been inside the RK12F rack.

### 3.2.1. LA75A/ LA75B rack

*Figure 4: power entry module of the LA75A/ LA75B rack*

The voltage selected is visible through the fusedrawer little window ("230" on the figure above).


Voltage Selector

To change the voltage:
- unplug the power cord
- extract the fusedrawer with the 2 fuses
- extract the voltage selector (small insert with the "115" and "230" markings, see figure above)
- rotate it accordingly.
- plug it back in the power entry module
- push in the fusedrawer with the 2 fuses mounted on it until it locks itself ("clic" sound).
- check to see the desired voltage through the window

### *3.2.2. LA75C rack*

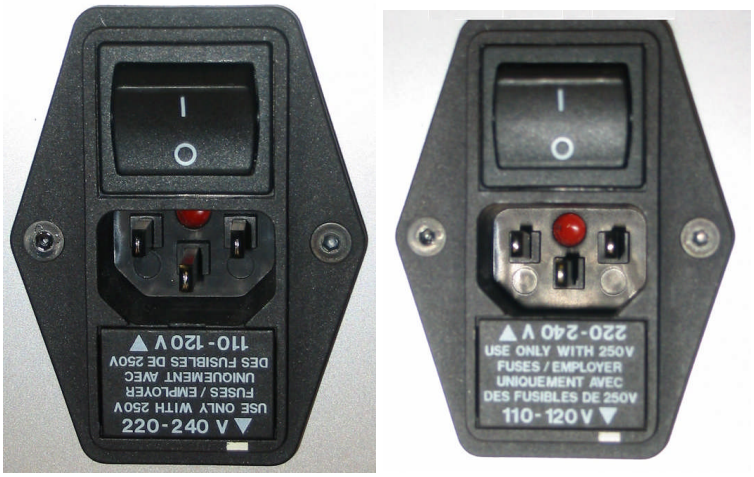



*Figure 5 : LA75C rack power entry module: 230v selected (left), 115v selected (right)*

The voltage selected is readable at the bottom of power entry module

To change the voltage:
- unplug the power cord
- extract the fusedrawer with the fuse
- rotate it 180 degrees
- change place of the fuse
- push the fusedrawer back in

# 4. OPERATING INSTRUCTION FOR THE LINEAR POWER SUPPLY, AC/DC CONVERTER, (LC75X)

This module produces from the mains, the regulated DC voltage to the amplifier functioning needs:

- +15 / -15 V : signal processing,
- +150 V : positive direct voltage,
- -20 V : negative direct voltage.

It is possible to neutralise supplied power voltages by using the switch A7. This switch is the easiest way to disable the piezoelectric actuator as soon as required. However, few seconds are necessary to come to a completely discharged actuator.
This module is protected against over temperature, over voltage and over current conditions.

**It is recommended to keep free space all around the electronic rack while driving in order to make the ventilation easier and to obtain the nominal performance of the driving electronics.**
**Note: Do use the tilt feet for the LA75B and LA75C rack versions.**

# 5. OPERATING INSTRUCTION FOR THE AMPLIFIER (LA75X)

## *5.1. General instructions*

The linear amplifier allows to apply to the actuator a signal comparable to the order's one, with a gain of 20 (see Figure 6).

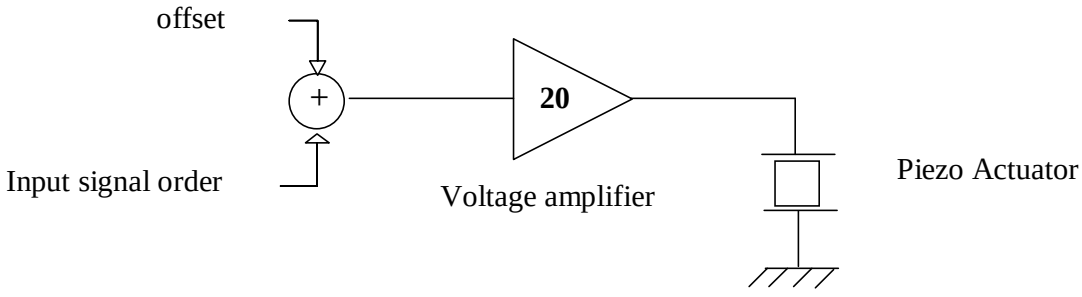



*Figure 6 - Principle of linear voltage amplifier*

The order may be applied in two different and complementary manners:

- static offset (potentiometer): B3 screw,
- dynamic order: B2 connectors.

These two signals are added and their sum should fall between –1V and 7.5V.

To connect the actuator to the voltage amplifier, the standard cable available is a coaxial LEMO connector in one end and 2 banana plugs in second end (see Annex 1).

## 5.2. Voltage control and current limitation

If the order signal is below –1 V or above 7.5 V, a protective diode and the power amplifier saturation will clamp the signal so that the voltage applied to the actuator stays roughly between –20 V and 150 V.
There is some limitation to the constant gain of the amplifier. Indeed, when the variation speed of the input signal (order) increases, the current limitation of the amplifier limits the slew rate of the output voltage. This current limitation varies with the power amplifier (LA75X) version (see annex 3).
Note: the use of an digital input signal (B2) may generate parasitic noise so that an additional filter may be necessary.

## 5.3. Open/closed loop

By default, the open/closed loop selector should be set on the mode open loop (SERVO OFF): in that mode, the amplifier applies a voltage gain of 20 to the input.
A displacement sensor, its conditioner and a servo controller will be necessary to use the closed loop (SERVO ON); otherwise the order will be set to zero.

## 5.4. Using the push–pull mode (optional) (only for LA75X-X)

For some piezoelectric devices such as the piezoelectric tilts or XY stages, it is necessary to supply two actuators simultaneously. A zero positioning is achieved with an electrical centring. Such a configuration could easily be achieved by using one amplifier, according to the figure shown below.

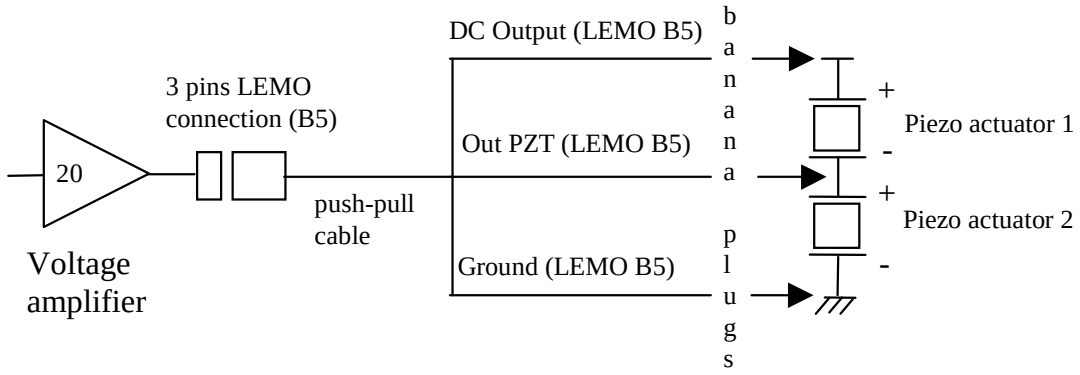



*Figure 7 - Principle of power supply for an actuator centred electrically*

To use this optional mode, a DC regulator shall be implemented inside the LA75 and a modified lemo plug shall be integrated in the front of the LA75. That is why a special cable is available at CEDRAT TECHNOLOGIES including a 3 pins LEMO connector in one end and 4 banana plugs in second end is necessary (see Annex 2).

Note: the electrical charge seen by the power amplifier is twice the capacitance of a single actuator, so the bandwidth is twice smaller than for a single actuator.

**WARNING**

**In that mode where one of the actuator is constantly under direct voltage, it is recommended to limit in time the supply of the actuator. Use the A7 switch when the actuator does not need to be supplied.**

## 5.5. Using the optional board CI75-x

One alternative, using the Command Inverter board CI75-x, to power a mechanical push-pull system is to use two amplifiers. The first amplifier will receive the direct command signal meanwhile the second have to receive a complementary signal of the first channel.

Due to this way of excitation, the mechanical system has to be polarised at its centered position through the command offset.

Taking into account the assumption that the command can vary between –1V and 7.5V and that the mechanical centered position is obtained at the middle level command range of ( 8.5 / 2) –1V = 3.25V, The complementary command is obtained from the first command through the following relationship :

**Vch2 = 3.25V – Vch1**

The offset for channel 1 have to be set to 3.25V.

### 5.5.1. Connection with CI75-x

The input command voltage for channel 1 has to be connected to the channel 1 B2 of the LA75-x and at the input of the CI75-x D1 through the front panel. The output channel of the CI75-x D2 has to be connected to the input of channel 2 B6 of the LA75-x through the front panel.

### 5.5.2. Offset setting

The offset voltage has to set to 0V on the first channel of the LA75-x B3.
The offset voltage has to set to 0V on the second channel of the LA75-x B7.
The offset voltage D3 has to set to 6.5V on the CI75-x.

### 5.5.3. Front panel of the CI75-x

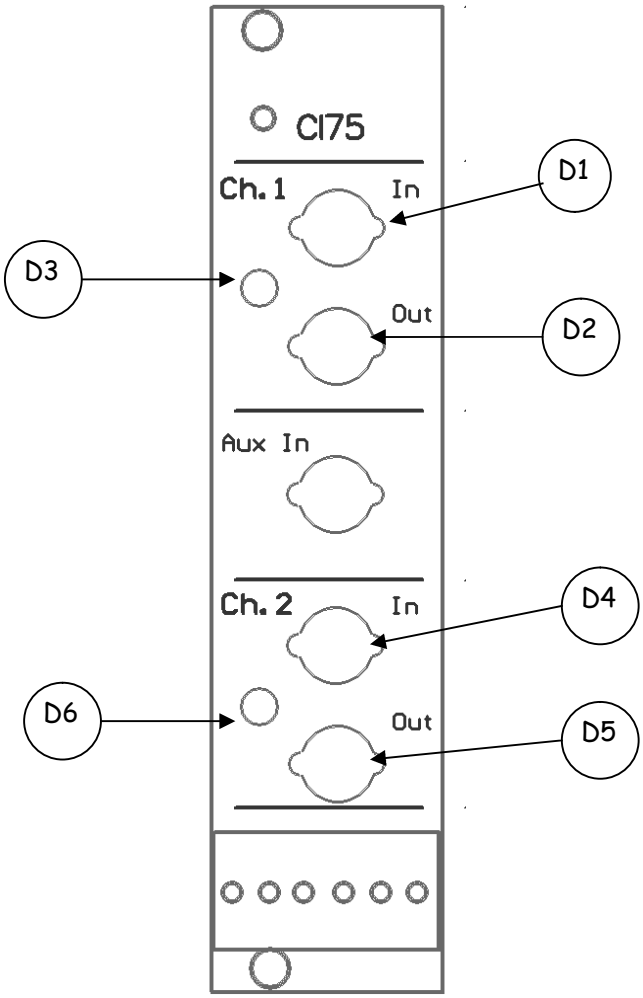



*Figure 8 : - Front panel of the CI75-x board*

## 5.6. Using the optional board CPH75

The CPH75 board is an analog dephasing circuit that produces an additional command with a settable out of phase. The range of frequency is 500 – 5000 Hz (can be modified at the factory under costumer's request). The achievable phases range is from –160° to 160°.

### 5.6.1. Connection with CPH75

The user command should be provided to the In connection E1.

The following operations are performed :
**E4 : Out1 = In**
**E6 : Out2 = In*Phase**

Should **Inv** E3 is set high (Analog 0-10 V), the following operations are performed :
**E6 : Out2 = In**
**E4 : Out1 = In*Phase**

It can be noticed that through the **Inv** command signal, the relative phase between Out1 and Out2 can be positive or negative.

### 5.6.2. Front panel of the CPH75

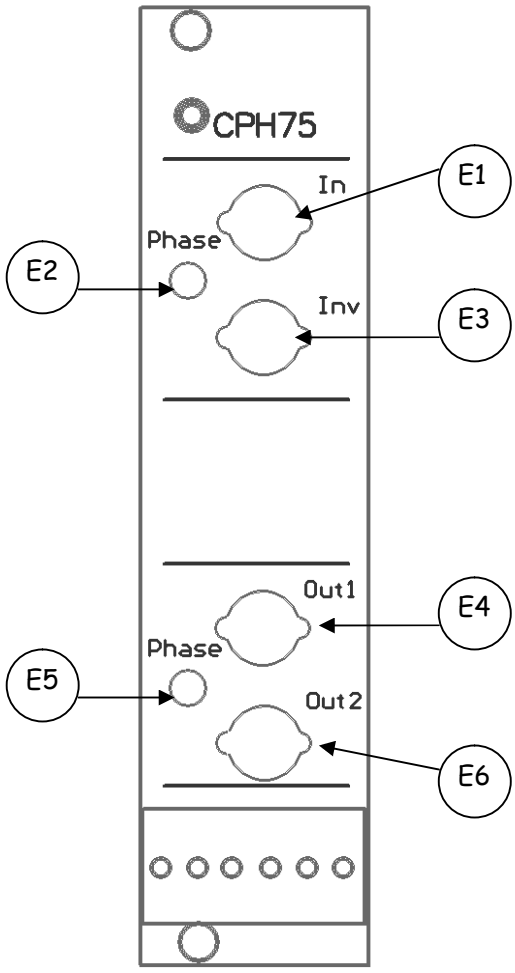



*Figure 9 : - Front panel of the CPH75 board*

# 6. OPERATING INSTRUCTIONS FOR THE SG75 STRAIN GAUGES CONDITIONER

## 6.1. General instructions

This module allows reading up to three strain gauges bridges. For each one of them, you can:

- Read the signal emitted by the conditioner (C2),
- Adjust the offset (C3).

The gain and the offset of the conditioner are adjusted at the factory on a gauge bridge set on the piezoelectric actuator, but only the offset is accessible to the user (C3). If you wish to use the conditioner with another actuator, it may be necessary to modify the gain at the factory.

## 6.2. Thermal effect

The strain gauges solution is the easiest way to operate a piezoelectric actuator in a closed loop. The best accuracy that can be achieved with this sensor is around 0.025%.
However, the strain gauges sensor is temperature dependent, so that the offset may vary with temperature.

# 7. OPERATING INSTRUCTIONS FOR THE ECS75 EDDY CURRENT SENSOR CONDITIONER

## 7.1. General instructions

The ECS75 card includes up to 2 channels of Eddy Current sensors, which have been calibrated at the factory. Only the offset can externally corrected (F2, F5 trimmers).

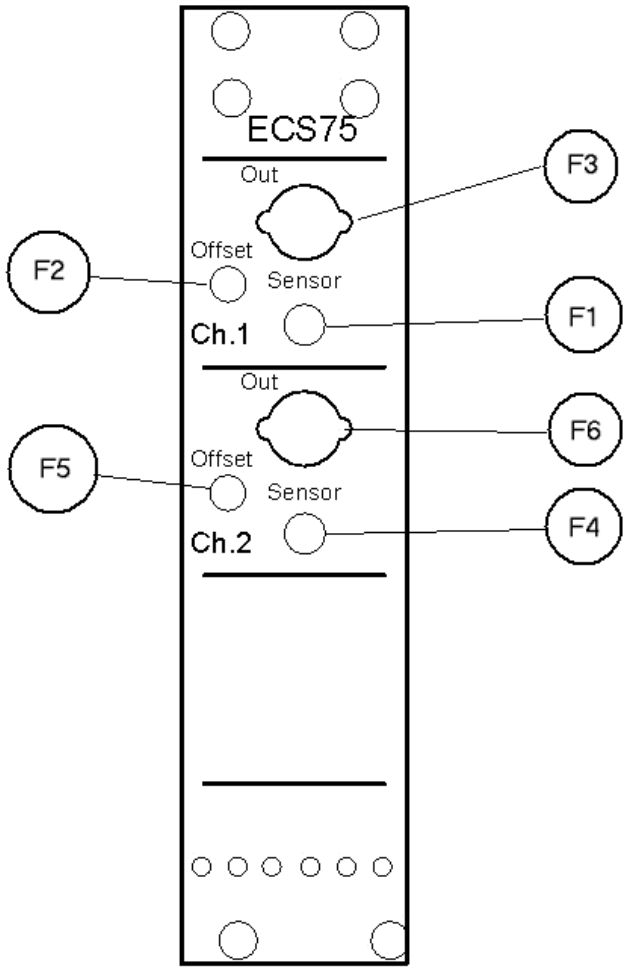



*Figure 10 : - Front panel of the ECS75-2 board*

## 7.2. Eddy current displacement sensors

The Eddy Current displacement sensor is a non contact proximity sensor using the eddy current effect generated by the probe in a (preferably) nonferrous material target. The eddy current changes the impedance of the probe, which is read by the conditioner.

Although the probe is calibrated with the target, the gain is somewhat dependent on the angle between the probe and the target, the target's thickness.

# 8. OPERATING INSTRUCTIONS FOR THE UC45 DIGITAL CONTROLLER (OPTION)

## 8.1. Introduction

This mezzanine (optional) board UC45 is stackable on the amplifier board and allows the support of three channels. Only one controller is available on the UC45 board, except in the case of the control of XY stage with Eddy Current Sensors. Only the input and output channel selection is configurable on a single board. Three boards with appropriate input/output selection are necessary for a 3 channel application.

The optional board UC45 is available for the boards CA45, LA75A-x, LA75B-x and LA75C-1. It performs digital closed loop control with a PID and output filter configuration. The output filter can be either of type notch or lowpass. The optional board UC45 is delivered with a free standard version (latest version downloadable on the web site) of a (Graphical User Interface) GUI software HPDM45. This GUI is a Labview® executable software (the Labview® from National Instruments is not transferred) and provides the following functionalities:

- Remote control of the drive electronic,
- Change of the parameters of the controller PID and filter,
- Order selection between internal (e.g. generated by the GUI), external (analogue order),
- Reading of the calibration parameters of the sensor using the TEDS functionality.

For further details, see the user's manual for the UC45 controller.

## 8.2. Terms and definition

Resolution: the resolution is the smallest displacement that the sensor (and its conditioning electronic) is able to measure. The resolution is preferably given with a relative value (a percentage of the total range of measurement).

Precision error in closed loop: the precision error is the difference between the command and the effective value of the displacement. Several contributors play a role in the precision error (resolution of the sensor, sensitivity to external parameters – ageing, temperature …), corrector error. The precision error is preferably given with a relative value (a percentage of the total displacement).

The following table gives the performances of the position sensor

| Sensor type | Resolution | Precision error | Most contributing factors |
|---|---|---|---|
| Strain Gauge (SG) | $10^{-4}$ | $10^{-3}$ | Temperature |
| Eddy Current Sensor (ECS) | $10^{-5}$ | $10^{-4}$ | Temperature ; material of the target |
| Capacitive sensor (CS) | $10^{-5}$ | $5.10^{-5}$ | Tilt effect between the target and the probe<br>Humidity |

*Table 1 : Performances of the sensors*

## 8.3. Pin out description

| JP1 | | |
|---|---|---|
| 1 | GND | Ground |
| 2 | SDI / MISO | SPI Master Serial Data In (MISO) |
| 3 | SDO /MOSI | SPI Master Serial Datat out (MOSI) |
| 4 | SC / SCLK | SPI Serial Clock |
| 5 | GND | Ground |
| 6 | +15 | +15V supply |
| 7 | -15 | -15V supply |
| 8 | +5 | +5V supply |
| 9 | GND | Ground |
| 10 | CS_Ad0 | Chip Select adress 0 / LSB |
| 11 | CS_Ad1 | Chip Select adress 1 |
| 12 | CS_Ad2 | Chip Select adress 2 / MSB |
| 13 | GND | Ground |
| 14 | GND | Ground |

*Table 2: Connector Jp1 Pin Out*

| JP2 | | | |
|---|---|---|---|
| 1 | PID3 | Controler output | Channel 3 |
| 2 | MeasSensor3 | Same as SG Out but inverted or not depending board setting | Channel 3 |
| 3 | SGOut3 | Strain gages conditionner output | Channel 3 |
| 4 | Order3 | Command signal | Channel 3 |
| 5 | GND | | |
| 6 | PID1 | Controler output | Channel 2 |
| 7 | MeasSensor2 | Same as SG Out but inverted or not depending board setting | Channel 2 |
| 8 | SGOut2 | Strain gages conditionner output | Channel 2 |
| 9 | Order2 | Command signal | Channel 2 |
| 10 | GND | | |
| 11 | PID1 | Controler output | Channel1 |
| 12 | MeasSensor1 | Same as SG Out but inverted or not depending board setting | Channel1 |
| 13 | SGOut1 | Strain gages conditionner output | Channel1 |
| 14 | Order1 | Command signal | Channel1 |

*Table 3 Connector Jp1 Pin Out*

## 8.4. Schematic pin out

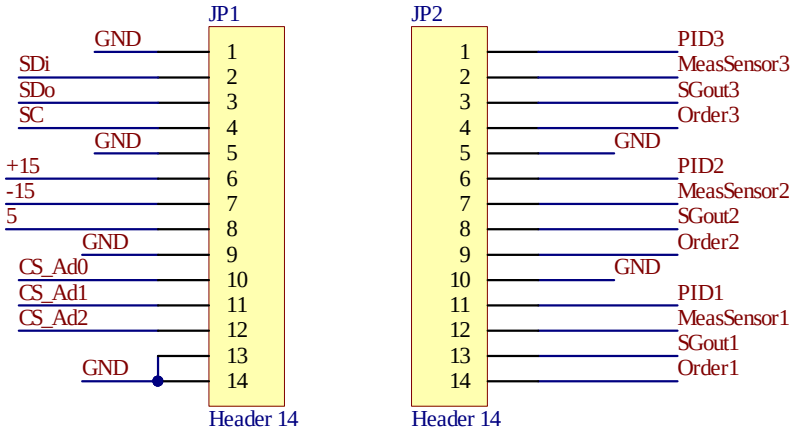



*Figure 11: Schematic pin out of the connector*

## 8.5. Board Layout

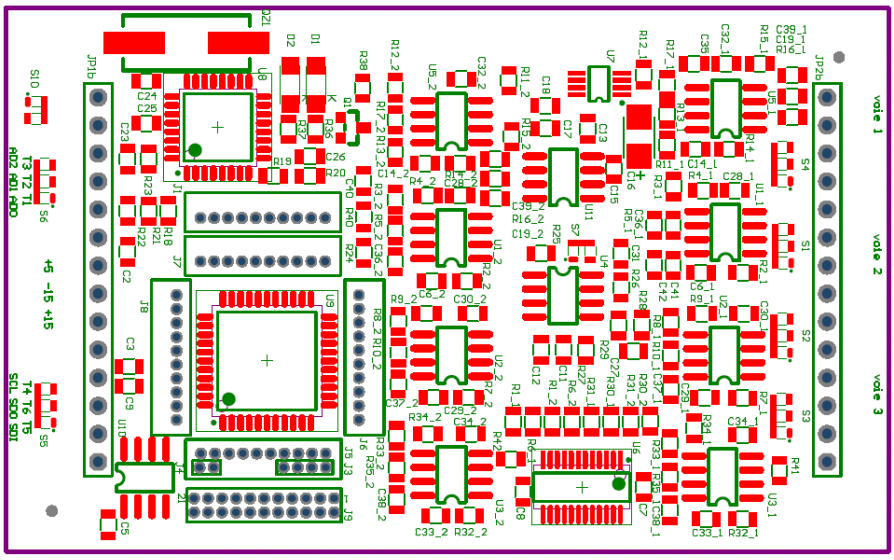


*Figure 12: Top view of the board*

## 8.6. Synoptic

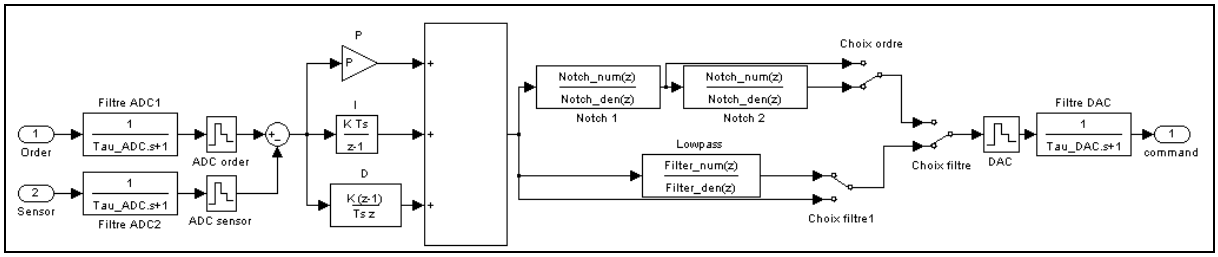



*Figure 13: Synoptic of the UC45 controller*

# 9. TROUBLE SHOOTING

**PROBLEMS:** THE PLUGGED PIEZO ACTUATOR DOES NOT MOVE WHILE THE REAR CONNECTION AND THE A7 ARE SWITCHED ON

| ACTION | POSSIBLE CAUSES |
|---|---|
| Check the led A6 : | |
| a) If A6 is off | |
| - check the main cable and the fuses at the rear panel | - misconnection with main cable or burnt fuses |
| b) If A6 is red | - The electronics is in protection |
| - check the connection lines to the piezo actuator / disconnect every LEMO cable. Test the electronics with the unplugged and plugged piezo actuator, as follows | - May be a short circuit through the cable connection or through the piezo actuator occurred |
| - switch A7 off | |
| If A6 is green | |
| - switch A7 on | |
| if the electronics works, | - an external parasitic noise might have disturbed it |
| if the electronics doesn't work, | - a breakdown is certain |
| If A6 is red | |
| - Wait for 10 minutes and switch A7 on | |
| if the electronics works, | - The electronics was in thermal protection and needed to cool itself down |
| if the electronics doesn't work, | - a breakdown is certain |

**PROBLEMS:** INCOHERENT RESPONSE FROM THE ACTUATOR IN OPEN LOOP

| ACTION | POSSIBLE CAUSES |
|---|---|
| Check the output signal (B5)<br><br>If the DC offset is wrong, turn (B3) to settle it* | - the DC offset may be wrong |

**PROBLEMS:** INCOHERENT RESPONSE FROM THE ACTUATOR IN CLOSED LOOP

| ACTION | POSSIBLE CAUSES |
|---|---|
| Go back in mode SERVO OFF (B4) and check the sensor's response (C2)** | - the strain gauges offset (C3) may be wrong |

* 10 turns potentiometers are used: do not hesitate to rotate the potentiometers and keep attention to the 'clic' noise arising at the end of the trimmer range.

** Adjusting the Strain Gauge offset

- Apply a command of 0V (by a 50 Ohms BNC connector on B2 for instance),
- Check that the voltage output on B5 is nearly zero,
- Adjust the potentiometer B3 to get the output B5 near zero,
- Measure the output of the Strain Gauge conditioner C2,
- Adjust the potentiometer C3, so that the output C2 is 0.38 V

One has :
Vsg =(SetPointLA + 1) / MaxAmplitudeLA * MaxAmplitudeSG - 0,5
With :
MaxAmplitudeLA = 8.5
MaxAmplitudeSG = 7.5

The customer is not entitled to modify the power supply or the linear amplifier. The only manipulations allowed to him are described in the set here above, including the replacement of (the) external fuse(s.). For any other matter or breakdown suspicion, we suggest the customer to contact the local vendor.

# 10. WARRANTY CONDITIONS AND EXCEPTIONS

The equipment is warranted for one year, including parts and labour, 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. Shipping, handling and insurance costs to return a part for repair must be paid by the customer.

**Interventions or attempts to service or repair the LA75 by any unauthorised persons will invalidate this warranty.**

# 11. 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.

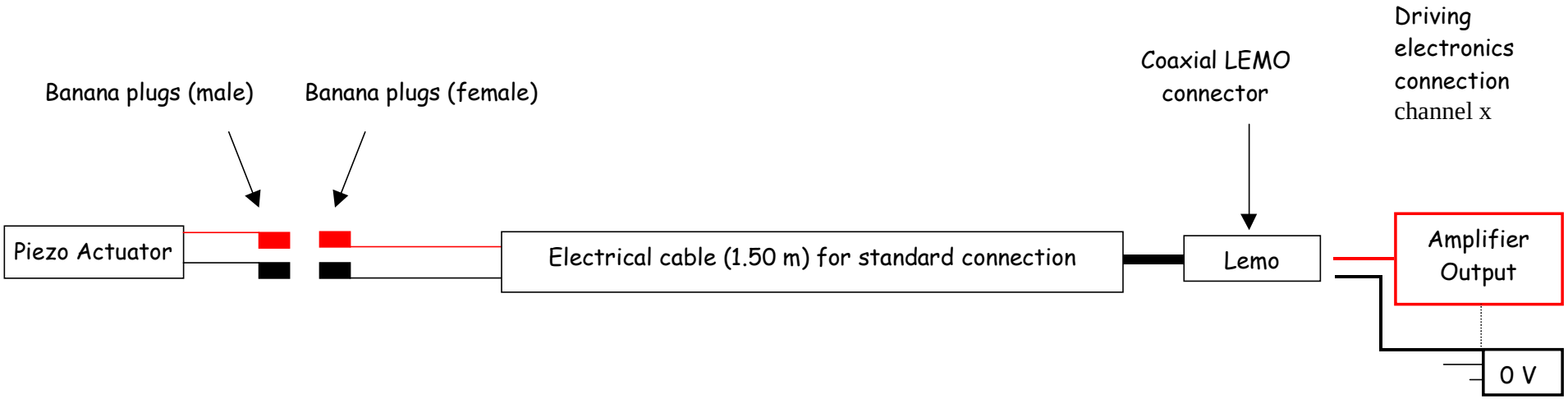
CEDRAT TECHNOLOGIES recommends the customer to keep the original package for any further carriage of the electronic product.

# 12. AFTER-SALES SERVICE

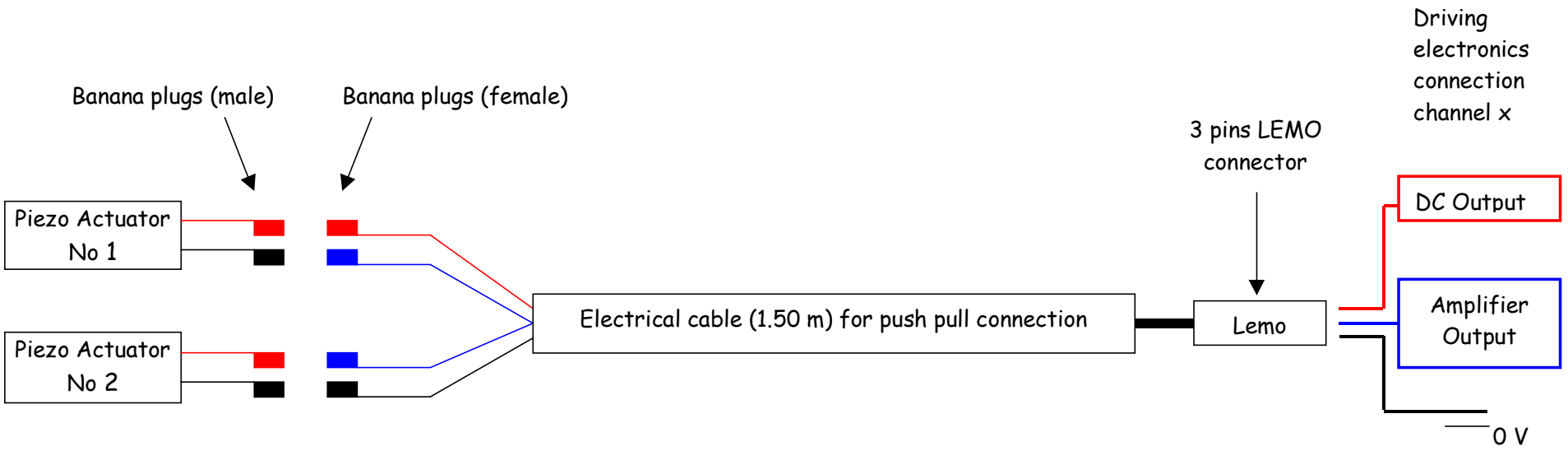
If a device requires service, please contact CEDRAT TECHNOLOGIES or your local vendor. Please include the device model and serial number in all correspondence with CEDRAT TECHNOLOGIES or your vendor.

# ANNEX 1 : CONNECTIONS

## *Scheme of the cable connection for standard electrical configuration*



## Scheme of the cable connection for the Push Pull electrical configuration



# ANNEX 2 : EFFECT OF THE CURRENT LIMITATION

With a linear amplifier the applied voltage to the actuator is directly proportional to the input signal. The gain of the power amplifier LA75x is set to 20.
So, to obtain the whole stroke of a given actuator, one should input a signal varying from –1V to 7.5V. The applied voltage on the actuator will then vary from –20 to 150V.
There is some limitation to the constant gain of the amplifier. Indeed, when the variation speed of the input signal (order) increases, the current limitation of the amplifier limits the slew rate of the output voltage. The current provided to a piezo ceramic is depending on its capacitance and on the variation speed of the applied voltage.

*The current for a capacitive load is given by the following expression:*

$$I_{piezo} = C_{piezo} \times \frac{dv}{dt}$$

*For a given current limitation, the shortest load time is given by:*

$$t_{load} = \frac{\Delta V \times C_{piezo}}{I_{\lim}}$$

*The max frequency for a triangle signal is given by:*

$$f_{triangle\ \max} = \frac{I_{\lim}}{2 \times \Delta V \times C_{piezo}}$$

*If we consider a sine signal, then the maximal frequency is given by:*

$$f_{\sin \max} = \frac{2 \times I_{\lim}}{\Delta V \times C_{piezo} \times 2\pi}$$

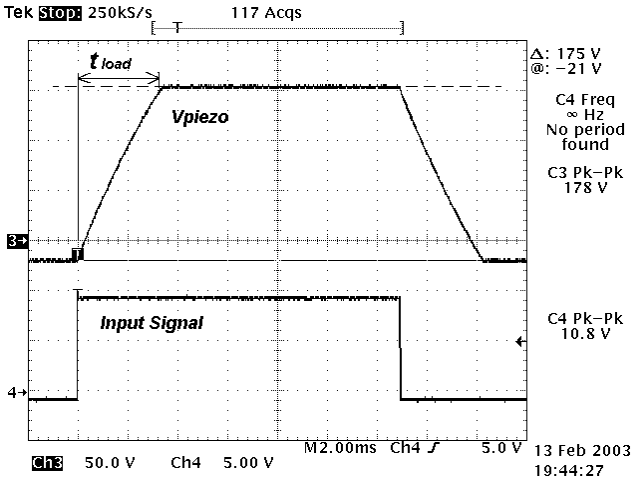



*Figure A 1 - The current limitation limits the voltage slew rate of the piezo*

| Type of linear amplifier | CA45 | LA75A | LA75B | LA75C |
|---|---|---|---|---|
| Current limitation (A) per channel | 0.03 | 0.09 | 0.36 | 2.4 |

## Ratings of LA75X-x on piezo actuator series

Considering a scale variation of ΔV = 120V and taking into account the current limitation of the LA75X, the following table summarises the load time and bandwidth values for different piezo actuator series :

| Actuator serie | Capacitance µF | Load time @ 120 V (ms) | | | |
|---|---|---|---|---|---|
| MLA_2*5*10 - APA - XS | 0,25 | 1,00 | 0,33 | 0,08 | 0,01 |
| MLA_5*5*20 - APA - S, SM | 1,55 | 6,20 | 2,07 | 0,52 | 0,08 |
| APA - M | 3,15 | 12,60 | 4,20 | 1,05 | 0,16 |
| APA - ML | 20,00 | 80,00 | 26,67 | 6,67 | 1,00 |
| APA - L | 40,00 | 160,00 | 53,33 | 13,33 | 2,00 |
| APA - XL | 110,00 | 440,00 | 146,67 | 36,67 | 5,50 |
| MLA_5*5*10 - PPA10M | 0,70 | 2,80 | 0,93 | 0,23 | 0,04 |
| PPA20M | 1,40 | 5,60 | 1,87 | 0,47 | 0,07 |
| PPA40M | 2,70 | 10,80 | 3,60 | 0,90 | 0,14 |
| PPA40L | 13,30 | 53,20 | 17,73 | 4,43 | 0,67 |
| PPA60L | 20,00 | 80,00 | 26,67 | 6,67 | 1,00 |
| PPA80L | 26,60 | 106,40 | 35,47 | 8,87 | 1,33 |
| PPA40XL | 24,00 | 96,00 | 32,00 | 8,00 | 1,20 |
| PPA80XL | 48,00 | 192,00 | 64,00 | 16,00 | 2,40 |
| PPA120XL | 72,00 | 288,00 | 96,00 | 24,00 | 3,60 |

*(*) the capacitance values are those at low frequency and room temperature.*

# ANNEX 3 : UNDERSTANDING THE FACTORY VERIFICATION SHEET

CEDRAT TECHNOLOGIES
Innovation in Mechatronics

**Linear Amplifier**
**Factory Verification**

| LA75B-12037 | **Date of test (DD/MM/YY)** | Stamp and signature |
|---|---|---|
| CH 1 | 11/02/2013 | |
| | **Test performed by** AP | |

**Procedure :** AQ7701-2 1.5

Representative load

**Electrical Load:** 2.3 µF

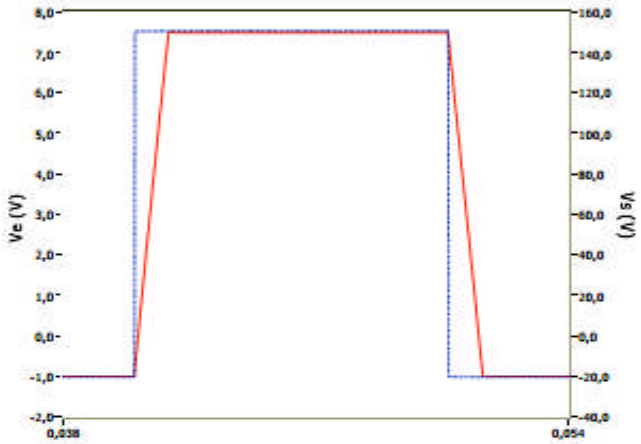
**Input frequency:** 50 Hz

**Rise time (10 - 90%):** 0,88 ms
Acceptance limits (ms): 0.82 ≤ Tr ≤ 1.01

**Fall time (90 - 10%):** 0,88 ms
Acceptance limits (ms): 0.82 ≤ Tf ≤ 1.01

Verification tests

**Output voltage to Square input voltage**




Representative load

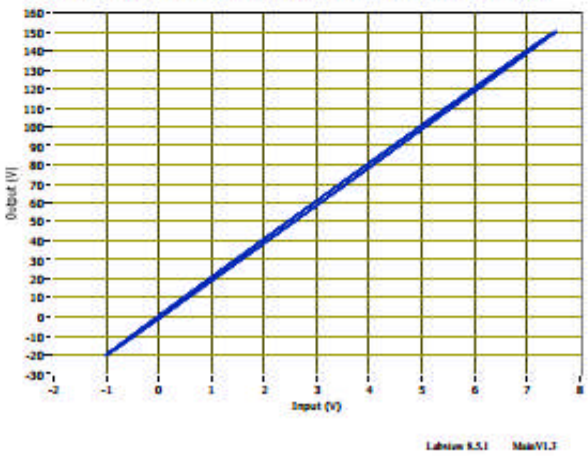
**Electrical Load:** 2.3 µF

**Input frequency:** 250 Hz

**Gain (Vs/Ve):** 20,0

Verification tests

**Linearity Output voltage vs. Input voltage**



CEDRAT TECHNOLOGIES

# Linear Amplifier Factory Verification

SG75-11034

CH 1

**Date of test (DD/MM/YY)** 10/01/2012

**Test performed by** AP

Stamp and signature

**Procedure:** AQ7705-1 1.6

## Output sensor voltage vs. Input voltage

**Electrical Load:** APA600MML 12-004

**Input frequency:** 1.00 Hz

**Sensor Type:** Strain Gages

Serial number of the associated actuator

**Strain gages Gain (µm/V):** 84.78

SG 75 Output voltage vs actuator displacement (In open loop only)

**Amplifier Gain (V/V):** 366.69

SG 75 Output voltage vs input voltage of strain gages

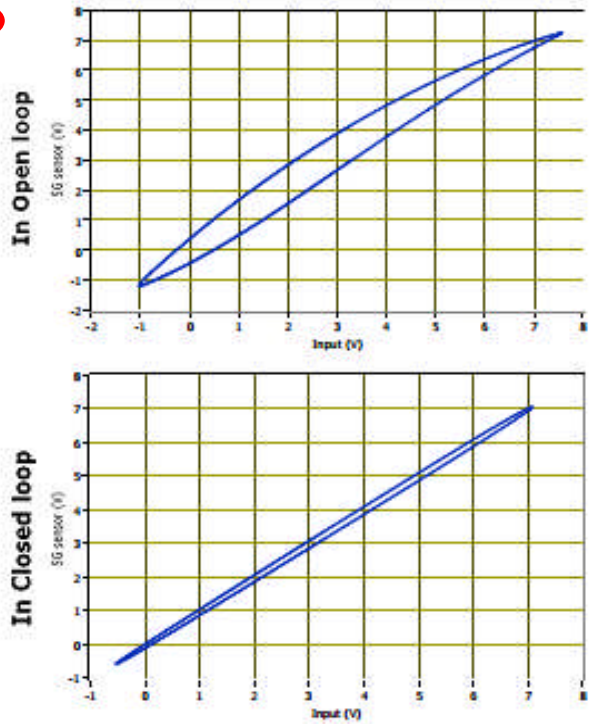
**System Gain (µm/V):** 83.00

Output displacement vs input command ( In closed loop only)

Notes :

Δ Sensitivity = 0.5

SG conditioner gain calibration




## Step response in closed loop

**Electrical Load:** APA600MML 12-004

**Input frequency:** 1.00 Hz

**Sensor Type:** Strain Gages

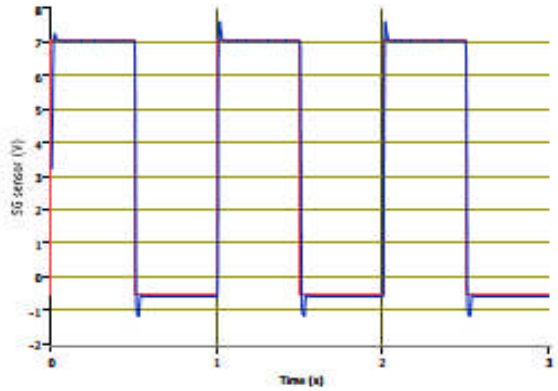
**Response time 10%-90% :**

**Rise time (ms):** 5.80

**Fall time (ms):** 6.05

Notes :

Δ Sensitivity = 0.5



# ANNEX 4 : LA75A-X TECHNICAL DATA SHEET [1]

Table of standard properties of use and measurement

The properties defined in the table below, are set up according to the technical conditions of use and measurement. These properties are warranted within their variation range and in compliance with the standard technical conditions of use.

| Properties LA75A-x | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| Notes | | | x : number of channel | | |
| Function | | | Linear amplifier | | |
| Max. number of channels | | | 3 | | |
| Cooling | | | Natural convection (Forced convection for 3 channels) | | |
| Protection | | | Thermal | | |
| Negative supply voltage | Standard environment | V | -36 | -30,0 | -40,0 |
| Positive supply voltage | Standard environment | V | 165 | 160,0 | 180,0 |
| Min. input voltage | Standard environment | V | -1,2 | -1,3 | -1,1 |
| Max. input voltage | Standard environment | V | 7,7 | 7,6 | 7,9 |
| Min. output voltage | Standard environment | V | -20 | -20,0 | -24,0 |
| Max. output voltage | Standard environment | V | 150 | 150,0 | 156,0 |
| Gain | Standard environment | V/V | 20 | 19,8 | 20,2 |
| Max. output current | | A | 0,09 | 0,09 | 0,12 |
| Max. output load capacitance | | µF | 400 | 360,0 | 440,0 |
| Signal to noise ratio | Noise measurement conditions | dB | 85 | 70,0 | 100,0 |
| Unloaded output bandwith (-3dB) | | Hz | 33000 | 29700 | 36300 |
| Loaded Output bandwidth (-3dB) | Standard load | Hz | 154 | 138,6 | 169,4 |
| Input impedance | | kOhms | 10 | 9,5 | 10,5 |
| Mass | | g | 800 | - | - |
| Dimensions | | mm | 10F wide, 3H high | | |

| Option SC75 | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| Notes | | | Option on amplifier board | | |
| Function | | | Servo controller | | |
| Signal to noise ratio | Noise measurement conditions | dB | 80 | 68 | 92 |
| Output bandwidth* | | Hz | 2000 | 1800 | 2200 |
| Accuracy (closed loop) | Standard environment | % | 0,1 | 0,07 | 0,13 |

*Bandwidth settled according to your specifications; by default 1 Hz.*

[1] In all CEDRAT TECHNOLOGIES SA documents, the decimal sign is a comma on the line (ISO 31-0:1992).

| Properties LC75A | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| *Notes* | | | *-* | | |
| *Function* | | | *Bipolar AC/DC linear converter* | | |
| *Cooling* | | | *Natural convection* | | |
| *Protection* | | | *Thermal Overcurrent Overvoltage* | | |
| *Main voltage* | *Standard main supply* | *VAC* | *230* | *190* | *250* |
| *Main frequency* | *Standard main supply* | *Hz* | *50* | *45* | *65* |
| *Negative output voltage* | *Standard environment* | *VDC* | *-36* | *-30,0* | *-40,0* |
| *Positive output voltage* | *Standard environment* | *VDC* | *165* | *160,0* | *180,0* |
| *Current limitation* | *Standard environment* | *A* | *0,12* | *0,114* | *0,126* |
| *Mass* | | *g* | *680* | *-* | *-* |
| *Dimensions* | | *mm* | *12F wide, 3H high* | *-* | *-* |
| **Properties SG75-x** | **Standard technical conditions** | **Unit** | **Nominal values** | **Min. values** | **Max. values** |
| *Notes* | | | *x : number of channel* | | |
| *Fonction* | | | *Strain Gauges conditioner* | | |
| *Max. number of channels* | | | *3* | | |
| *Min. supply voltage* | | *VDC* | *-15* | *-14,3* | *-15,8* |
| *Max. supply voltage* | | *VDC* | *15* | *14,3* | *15,8* |
| *Min. output voltage* | | *VDC* | *-12* | *-11,4* | *-12,6* |
| *Max. output voltage* | | *VDC* | *12* | *11,4* | *12,6* |
| *Signal to noise ratio* | *Noise measurement conditions* | *dB* | *70* | *56,0* | *84,0* |
| *Output bandwith (-3dB)** | | *Hz* | *2000* | *1600* | *2400* |
| *Mass* | | *g* | *150* | *-* | *-* |
| *Dimensions* | | *mm* | *6F wide, 3H high* | | |

**Bandwidth settled according to your specifications*

Properties standard technical conditions of use and measurement

| | | |
|---|---|---|
| **Quasistatic excitation** | : | AC voltage between –20 and 150 V at 1 Hz |
| **Environment** | : | Ambient temperature (15-25°C) and dry air (Humidity < 50 % rH) |
| **Standard main supply** | : | Main according to directive HD472; could be adapted to 110 VAC on request |
| **Noise measurement conditions** | : | Excitation 0.5 Vrms ; reading bandwidth 1 Hz to 1 kHz |
| **Standard load** | : | Actuator APA from series S or SM : 1.55 µF (load test may be different) |

Any technical conditions of use, different from those defined above, can lead to temporary or definitive alterations of properties. Thank you to contact CEDRAT TECHNOLOGIES before using actuators under non standard technical conditions.

Factory tests carried out

☒ Test 1: Load and discharge time

☒ Test 2: Linearity output voltage vs. input voltage

Extra factory tests

☐ Test 3: Gain and linearity in closed loop

☐ Test 4: Step response in closed loop (sensor output voltage versus command voltage

☐ Test 5: Thermal test at full load

Available options

☒ [ SC ] Servo controller ☒ [ PP ] Push-pull

# LA75B-x TECHNICAL DATA SHEET

## Table of standard properties of use and measurement

The properties defined in the table below, are set up according to the technical conditions of use and measurement. These properties are warranted within their variation range and in compliance with the standard technical conditions of use.

| Properties LA75B-x | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| Notes | | | x : number of channel | | |
| Function | | | Linear amplifier | | |
| Max. number of channels | | | 2 | | |
| Cooling | | | Natural convection (Forced convection for 2 channels) | | |
| Protection | | | Thermal | | |
| Negative supply voltage | Standard environment | V | -36 | -30,0 | -40,0 |
| Positive supply voltage | Standard environment | V | 165 | 160,0 | 180,0 |
| Min. input voltage | Standard environment | V | -1,2 | -1,1 | -1,3 |
| Max. input voltage | Standard environment | V | 7,7 | 7,6 | 7,9 |
| Min. output voltage | Standard environment | V | -20 | -20,0 | -24,0 |
| Max. output voltage | Standard environment | V | 150 | 150,0 | 156,0 |
| Gain | Standard environment | V/V | 20 | 19,8 | 20,2 |
| Max. output current | | A | 0,36 | 0,360 | 0,400 |
| Max. output load capacitance | | µF | 400 | 360,0 | 440,0 |
| Signal to noise ratio | Noise measurement conditions | dB | 85 | 70,0 | 100,0 |
| Unloaded output bandwith (-3dB) | | Hz | 33000 | 29700 | 36300 |
| Loaded Output bandwidth (-3dB) | Standard load | Hz | 616 | 554,5 | 677,7 |
| Input impedance | | kOhms | 10 | 9,5 | 10,5 |
| Mass | | kg | 1 | - | - |
| Dimensions | | mm | 10F wide, 3H high | | |

| Option SC75 | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| Notes | | | Option on amplifier board | | |
| Function | | | Servo controller | | |
| Signal to noise ratio | Noise measurement conditions | dB | 80 | 68 | 92 |
| Output bandwidth* | | Hz | 2000 | 1800 | 2200 |
| Accuracy (closed loop) | Standard environment | % | 0,1 | 0,07 | 0,13 |

**Bandwidth settled according to your specifications; by default 1 Hz.*

| Properties LC75B | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| *Notes* | | | - | | |
| *Function* | | | *Bipolar AC/DC linear converter* | | |
| *Cooling* | | | *Forced air* | | |
| *Protection* | | | *Thermal Overcurrent Overvoltage* | | |
| *Main voltage* | *Standard main supply* | *VAC* | *230* | *190* | *250* |
| *Main frequency* | *Standard main supply* | *Hz* | *50* | *45* | *65* |
| *Negative output voltage* | *Standard environment* | *VDC* | *-36* | *-30,0* | *-40,0* |
| *Positive output voltage* | *Standard environment* | *VDC* | *165* | *160,0* | *180,0* |
| *Current limitation* | *Standard environment* | *A* | *0,60* | *0,57* | *0,63* |
| *Mass* | | *g* | *680* | - | - |
| *Dimensions* | | *mm* | *12F wide, 3H high* | - | - |

| Properties SG75-x | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| *Notes* | | | *x : number of channel* | | |
| *Fonction* | | | *Strain Gauges conditioner* | | |
| *Max. number of channels* | | | *3* | | |
| *Min. supply voltage* | | *VDC* | *-15* | *-14,3* | *-15,8* |
| *Max. supply voltage* | | *VDC* | *15* | *14,3* | *15,8* |
| *Min. output voltage* | | *VDC* | *-12* | *-11,4* | *-12,6* |
| *Max. output voltage* | | *VDC* | *12* | *11,4* | *12,6* |
| *Signal to noise ratio* | *Noise measurement conditions* | *dB* | *70* | *56,0* | *84,0* |
| *Output bandwith (-3dB)** | | *Hz* | *2000* | *1600* | *2400* |
| *Mass* | | *g* | *150* | - | - |
| *Dimensions* | | *mm* | *6F wide, 3H high* | | |

**Bandwidth settled according to your specifications*

Properties standard technical conditions of use and measurement

| | | |
|---|---|---|
| **Quasistatic excitation** | : | AC voltage between –20 and 150 V at 1 Hz |
| **Environment** | : | Ambient temperature (15-25°C) and dry air (Humidity < 50 % rH) |
| **Standard main supply** | : | Main according to directive HD472; could be adapted to 110 VAC on request |
| **Noise measurement conditions** | : | Excitation 0.5 Vrms ; reading bandwidth 1 Hz to 1 kHz |
| **Standard load** | : | Actuator APA from series S or SM : 1.55 µF (load test may be different) |

Any technical conditions of use, different from those defined above, can lead to temporary or definitive alterations of properties. Thank you to contact CEDRAT TECHNOLOGIES before using actuators under non standard technical conditions.

Factory tests carried out

☒ Test 1: Load and discharge time

☒ Test 2: Linearity output voltage vs. input voltage

Extra factory tests

☐ Test 3: Gain and linearity in closed loop

☐ Test 4: Step response in closed loop (sensor output voltage versus command voltage

☐ Test 5: Thermal test at full load

Available options

☒ [ SC ] Servo controller ☒ [ PP ] Push-pull

# LA75C TECHNICAL DATA SHEET

The properties defined in the table below, are set up according to the technical conditions of use and measurement. These properties are warranted within their variation range and in compliance with the standard technical conditions of use.

| Properties LA75C | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| Notes | | | - | | |
| Function | | | Linear amplifier | | |
| Max. number of channels | | | 1 | | |
| Cooling | | | Forced air | | |
| Protection | | | Thermal<br>Short circuit | | |
| Negative supply voltage | Standard environment | V | -36 | -30,0 | -40,0 |
| Positive supply voltage | Standard environment | V | 165 | 160,0 | 180,0 |
| Min. input voltage | Standard environment | V | -1,2 | -1,1 | -1,3 |
| Max. input voltage | Standard environment | V | 7,7 | 7,6 | 7,9 |
| Min. output voltage | Standard environment | V | -20 | -20,0 | -24,0 |
| Max. output voltage | Standard environment | V | 150 | 150,0 | 156,0 |
| Gain | Standard environment | V/V | 20 | 19,8 | 20,2 |
| Max. output current | | A | 2,40 | 2,30 | 2,50 |
| Max. output load capacitance | | µF | 400 | 360,0 | 440,0 |
| Signal to noise ratio | Noise measurement conditions | dB | 85 | 70,0 | 100,0 |
| Unloaded output bandwith (-3dB) | | Hz | 33000 | 29700 | 36300 |
| Loaded Output bandwidth (-3dB) | Standard load | Hz | 4107 | 3697 | 4518 |
| Input impedance | | kOhms | 10 | 9,5 | 10,5 |
| Mass | | g | 860 | - | - |
| Dimensions | | mm | 18F wide, 4H high | | |

| Option SC75 | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| Notes | | | Option on amplifier board | | |
| Function | | | Servo controller | | |
| Signal to noise ratio | Noise measurement conditions | dB | 80 | 68 | 92 |
| Output bandwidth* | | Hz | 2000 | 1800 | 2200 |
| Accuracy (closed loop) | Standard environment | % | 0,1 | 0,07 | 0,13 |

*Bandwidth settled according to your specifications; by default 1 Hz.

| Properties LC75C | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| *Notes* | | | - | | |
| *Function* | | | *Bipolar AC/DC linear converter* | | |
| *Cooling* | | | *Forced air* | | |
| *Protection* | | | *Thermal Overcurrent Overvoltage* | | |
| *Main voltage* | *Standard main supply* | *VAC* | *230* | *190* | *250* |
| *Main frequency* | *Standard main supply* | *Hz* | *50* | *45* | *65* |
| *Negative output voltage* | *Standard environment* | *VDC* | *-36* | *-30,0* | *-40,0* |
| *Positive output voltage* | *Standard environment* | *VDC* | *165* | *160,0* | *180,0* |
| *Current limitation* | *Standard environment* | *A* | *2,40* | *2,28* | *2,52* |
| *Mass* | | *g* | *680* | - | - |
| *Dimensions* | | *mm* | *12F wide, 3H high* | - | - |
| **Properties SG75-x** | **Standard technical conditions** | **Unit** | **Nominal values** | **Min. values** | **Max. values** |
| *Notes* | | | *x : number of channel* | | |
| *Fonction* | | | *Strain Gauges conditioner* | | |
| *Max. number of channels* | | | *3* | | |
| *Min. supply voltage* | | *VDC* | *-15* | *-14,3* | *-15,8* |
| *Max. supply voltage* | | *VDC* | *15* | *14,3* | *15,8* |
| *Min. output voltage* | | *VDC* | *-12* | *-11,4* | *-12,6* |
| *Max. output voltage* | | *VDC* | *12* | *11,4* | *12,6* |
| *Signal to noise ratio* | *Noise measurement conditions* | *dB* | *70* | *56,0* | *84,0* |
| *Output bandwith (-3dB)** | | *Hz* | *2000* | *1600* | *2400* |
| *Mass* | | *g* | *150* | - | - |
| *Dimensions* | | *mm* | *6F wide, 3H high* | | |

**Bandwidth settled according to your specifications*

Properties standard technical conditions of use and measurement

| | | |
|---|---|---|
| **Quasistatic excitation** | : | AC voltage between –20 and 150 V at 1 Hz |
| **Environment** | : | Ambient temperature (15-25°C) and dry air (Humidity < 50 % rH) |
| **Standard main supply** | : | Main according to directive HD472; could be adapted to 110 VAC on request |
| **Noise measurement conditions** | : | Excitation 0.5 Vrms ; reading bandwidth 1 Hz to 1 kHz |
| **Standard load** | : | Actuator APA from series S or SM : 1.55 µF (load test may be different) |

Any technical conditions of use, different from those defined above, can lead to temporary or definitive alterations of properties. Thank you to contact CEDRAT TECHNOLOGIES before using actuators under non standard technical conditions.

Factory tests carried out

☒ Test 1: Load and discharge time

☒ Test 2: Linearity output voltage vs. input voltage

Extra factory tests

☐ Test 3: Gain and linearity in closed loop

☐ Test 4: Step response in closed loop (sensor output voltage versus command voltage

☒ Test 5: Thermal test at full load

Available options

☒ [ SC ] Servo controller ☐ [ PP ] Push-pull

# CA45 TECHNICAL DATA SHEET

## Table of standard properties of use and measurement

The properties defined in the table below, are set up according to the technical conditions of use and measurement. These properties are warranted within their variation range and in compliance with the standard technical conditions of use.

| Properties CA45 | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| Notes | | | - | | |
| Function | | | Standalone voltage amplifier | | |
| Cooling | | | Natural convection | | |
| Protection | | | Thermal<br>Overcurrent<br>Overvoltage | | |
| Main voltage | Standard main supply | VAC | 230 | 190,0 | 250,0 |
| Main frequency | Standard main supply | Hz | 50 | 45,0 | 65,0 |
| Min. input voltage | Standard environment | V | -1,2 | -1,5 | -1,2 |
| Max. input voltage | Standard environment | V | 7,7 | 7,7 | 7,9 |
| Min. output voltage | Standard environment | V | -20 | -20,0 | -25,0 |
| Max. output voltage | Standard environment | V | 150 | 150,0 | 160,0 |
| Gain | Standard environment | V/V | 20 | 19,8 | 20,2 |
| Max. output current | | A | 0,03 | 0,030 | 0,045 |
| Max. output load capacitance | | µF | 400 | 360,0 | 440,0 |
| Signal to noise ratio | Noise measurement conditions | dB | 85 | 80,0 | 90,0 |
| Unloaded output bandwith (-3dB) | | Hz | 10000 | 9000 | 11000 |
| Loaded Output bandwidth (-3dB) | Standard load | Hz | 154 | 154,0 | 169,4 |
| Input impedance | | kOhms | 10 | 9,5 | 10,5 |
| Mass | | g | 1200 | - | - |
| Dimensions | | mm | 12F wide, 3H high | | |

| Option SG | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| Notes | | | Option on amplifier board | | |
| Function | | | Servo controller | | |
| Signal to noise ratio | Noise measurement conditions | dB | 85 | 80 | 90 |
| Output bandwidth* | | Hz | 2000 | 1800 | 2200 |
| Accuracy (closed loop) | | % | 0,1 | 0,07 | 0,13 |

| Option ECS | Standard technical conditions | Unit | Nominal values | Min. values | Max. values |
|---|---|---|---|---|---|
| Notes | | | Option on amplifier board | | |
| Function | | | Servo controller | | |
| Signal to noise ratio | Noise measurement conditions | dB | 100 | 85 | 100 |
| Output bandwidth* | | Hz | 10000 | 9000 | 11000 |
| Accuracy (closed loop) | | % | 0,01 | 0,007 | 0,013 |

**Bandwidth settled according to your specifications; by default 1 Hz.*

Properties standard technical conditions of use and measurement

| | |
|---|---|
| **Quasistatic excitation** | : AC voltage between –20 and 150 V at 1 Hz |
| **Environment** | : Ambient temperature (15-25°C) and dry air (Humidity < 50 % rH) |
| **Standard main supply** | : Main according to directive HD472; could be adapted to 110 VAC on request |
| **Noise measurement conditions** | : Excitation 0.5 Vrms ; reading bandwidth 1 Hz to 1 kHz |
| **Standard load** | : Actuator APA from series S or SM : 1.55 µF (load test may be different) |

Any technical conditions of use, different from those defined above, can lead to temporary or definitive alterations of properties. Thank you to contact CEDRAT TECHNOLOGIES before using actuators under non standard technical conditions.

Factory tests carried out

☒ Test 1: Load and discharge time
☒ Test 2: Linearity output voltage vs. input voltage

Extra factory tests

☐ Test 3: Gain and linearity in closed loop
☐ Test 4: Step response in closed loop (sensor output voltage versus command voltage
☐ Test 5: Bode diagram

Available options

☒ [ SC ] Servo controller ☐ [ PP ] Push-pull

| TECHNICAL DATA SHEET | CA45 | v3.1 |
|---|---|---|

➢ **PROPERTIES STANDARD TECHNICAL CONDITIONS OF USE & MEASUREMENT**

| | |
|---|---|
| **Quasistatic excitation** | : AC voltage between –20 and 150 V at 1 Hz |
| **Environment** | : Ambient temperature (15-25°C) and dry air (Humidity < 50 % rH) |
| **Standard main supply** | : Main according to directive HD472; could be adapted to 110 VAC on request |
| **Noise measurement conditions** | : Excitation 0.5 Vrms ; reading bandwidth 1 Hz to 1 kHz |
| **Standard load** | : Actuator APA from series S or SM : 1.55 µ F (load test may be different) |

Any technical conditions of use, different from those defined above, can lead to temporary or definitive alterations of properties. Thank you to contact CEDRAT TECHNOLOGIES before using actuators under non standard technical conditions.

➢ **FACTORY TESTS CARRIED OUT**

☒ Test 1: Load and discharge time
☒ Test 2: Linearity output voltage vs. input voltage

➢ **EXTRA FACTORY TESTS**

☐ Test 3: Gain and linearity in closed loop
☐ Test 4: Step response in closed loop (sensor output voltage versus command voltage
☐ Test 5: Bode diagram

➢ **AVAILABLE OPTIONS**

☒ [SC] Servo controller ☐ [PP] Push-pull

# ANNEX 4 : TROUBLE SHOOTING FORM

In case of trouble or breakdown with the electronic device, 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 faced with the electronics and which are not described in the paragraph 7,

**Notations:** Please define here the short term used for external devices plugged in the electronics in order to make the writing of "problem identification" easier,

**Problem identification:** Please summarise and describe here, using the "notations", the operation that could lead to problem identification,

**Action:** Please mention and update here every action undertaken by yourself, by Cedrat Technologies or by your local vendor,

***Please note that you need to get the authorisation from CEDRAT TECHNOLOGIES before sending back the hardware.***