

**SP75 - SWITCHING AMPLIFIER FOR  
PIEZOELECTRIC ACTUATORS  
PRODUCT AND WARRANTY INFORMATION**



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**Version : 3.2.1**  
**Date: 28/08/07**

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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 switching power stage electronic SP75 multi-channel consists in a 19'' casing to the following dimensions:

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

This electronic is a modular one; which means that a rack42F, for instance, may receive one power supply unit (LC75B), as well as sensors conditioning units:

- strain gauges sensors conditioner (SG75 unit),
- a RS422 communication link for remote control purpose (option).

The rear panel includes the main power connection, the ON/OFF switch and the fuses. The front panel includes the connections with actuators, orders. (Cf. Figure 1-1).

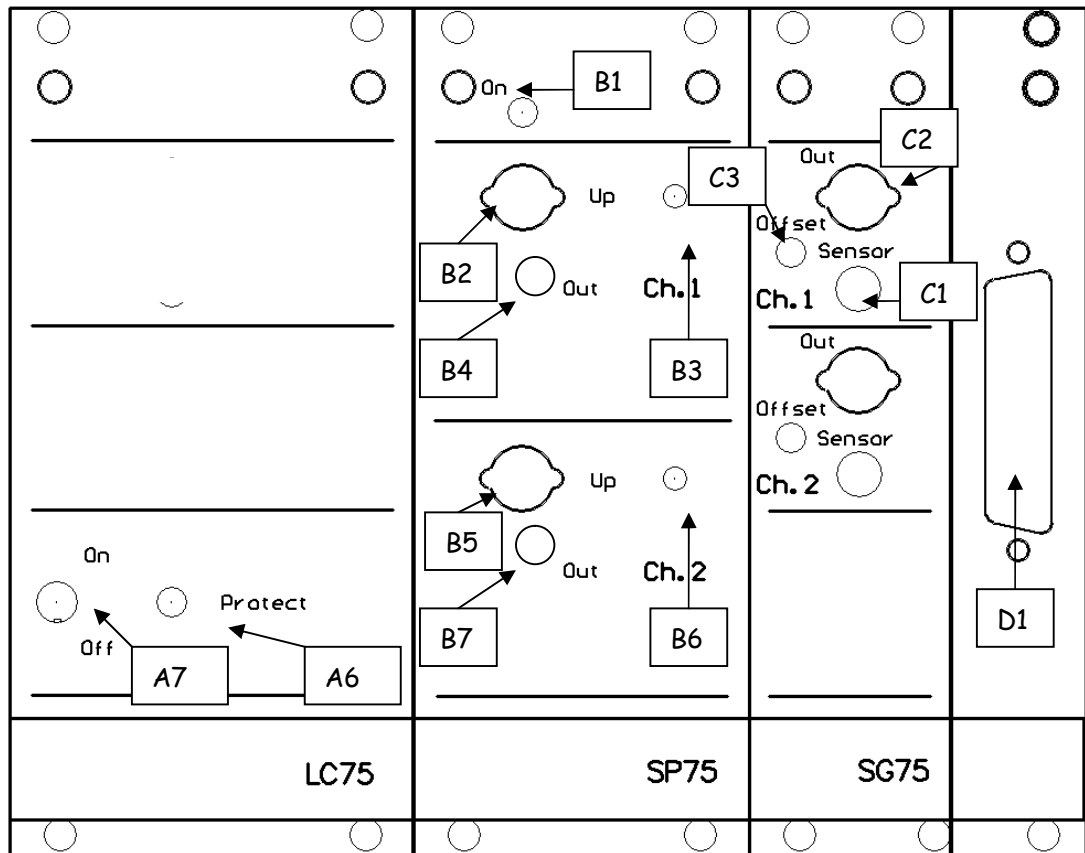


Figure 1-1 - Front panel of the SP75 power supply

Nota: " X " refers to the "A" ,"B" or "C" version of the driving electronics ; "x " refers to the number of channels, on the board.

REFERENCE	DESIGNATION
<b>1<sup>st</sup> module</b>	Main power supply unit - LC75X
A6	Led protect
A7	Vp voltage switch
<b>2<sup>nd</sup> module</b>	Switching power stage - SP75X-x
B1	Led power supply presence
B2	Order BNC connector - channel 1 ( TTL order - open collector)
B3	Status Led (switched on : high voltage)
B4	LEMO connector for the piezo actuator - channel 1
B5	Order BNC connector - channel 2 ( TTL order - open collector)
B6	Status Led (switched on : high voltage)
B7	LEMO connector for the piezo actuator - channel 2
<b>3<sup>rd</sup> module</b>	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
<b>4<sup>th</sup> module</b>	RS422 Link (Option)
D1	Sub-D25 connector for RS422 link

### 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.

## 2. GENERAL DESCRIPTION

The switching power stage electronic SP75X-x is dedicated to the fast drive of piezoelectric actuators based on multi-layers piezoelectric ceramics such as APA or PPA from CEDRAT TECHNOLOGIES. The SP75X-x 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 (1<sup>st</sup> module),
- A switching power stage (SP75X-x) dedicated to capacitive load allowing the fast charge and discharge of piezoelectric actuators between -20 and 150 V (2<sup>nd</sup> module),
- A strain gauge conditioner (SG75) allowing to measure the displacement of piezoelectric actuators equipped with gauges (optional module),
- A RS422 link allowing for a remote control of the rack (optional module).

## 3. MAIN CONNEXIONS

Main: 220 V AC / 50 Hz	
LC75B	LC75C
1 A fuse 1: 250 V F type	6.3 A fuse 1: 250 V T type
1 A fuse 2: 250 V F type T2A	6.3 A fuse 2: 250 V T type
Main: 110 VAC / 60 Hz (on request)	
2 A fuse 1: 250 V F type	8 A fuse 1: 250 V T type
2 A fuse 2: 250 V F type T4A	8 A fuse 2: 250 V T type

The rack equipped with a main selector (several configurations) that allows the user selecting by himself the main.



Figure 2 : Main selector RK42F rack

## **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 SP75B rack version.**

## **5. OPERATING INSTRUCTION FOR THE SWITCHING POWER STAGE (SP75X)**

### **5.1. General instructions**

The switching power stage allows to realise a fast charge and discharge of the actuator according to a TTL order<sup>1</sup>. The regulated voltages applied to the piezo actuator are -20 V and 150 V<sup>2</sup>.

The states are the followings:

- Actuator supplied at -20 V without any TTL order,
- Actuator supplied at -20V with a TTL signal at 1,
- Actuator supplied at 150 V with a TTL signal at 0.

To allow a correct behaviour of the switching power stage, it is necessary to connect a capacitive load to the power stage.

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<sup>1</sup> A 0-10V signal in place of the TTL signal is also possible.

<sup>2</sup> These levels « high » and « low » can be set in the factory, between 0 and - 20 V, and 140 and 160 V, respectively.

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).

The Led B1 indicated the status of the order and the good behaviour of the switching power stage.

## **5.2. Voltage control and current limitation**

There is some time limitation to the charge and discharge of the piezo actuator. This time is depending both on the capacitance of the piezo actuator and the current limitation of the switching power stage (see ANNEX 2).

It is important to send a commutation order compatible with these charge and discharge time. An erratic reply of the piezo actuator is possible, should an additional commutation order is sent before the charge (discharge) process is completed. This time is depending both on the capacitance of the piezo actuator and the current limitation of the switching power stage (see ANNEX 2). Please have a look on the functional test provided with the product.

### **WARNING**

You need to have in mind that the maximum commutation frequency corresponds to one third of the resonance frequency of the actuator (excluding the thermal limitation of the actuator).



## **6. OPERATING INSTRUCTIONS FOR THE SG75 STRAIN GAUGES CONDITIONER**

### **6.1. General instructions**

This module allows to read 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 INSTRUCTION OF THE RS422 LINK (OPTION)**

### **7.1. Remote control through the RS422 link (option)**

It is possible to get a remote control of the SP75X rack through a RS422 link, based on a Sub-D25 connector.

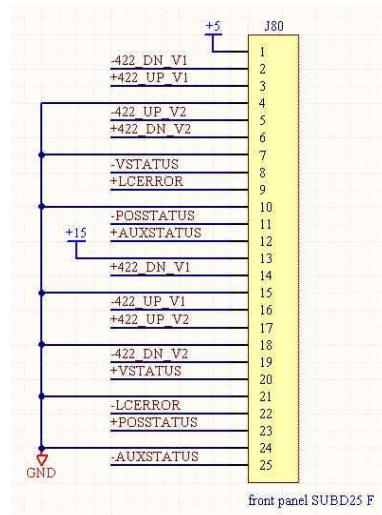


Figure 7-1: SUB-D25 connector

Designation	Sub-D25 pin	Schematic name
Order (channel 1)	3, 16	+422 UP V1 / -422 UP V1
Order (channel 2)	17, 5	+422 UP V2 / -422 UP V2
Actuator drive validation	23, 11	+POSSTATUS / - POSSTATUS
Voltage validation	20, 8	+VSTATUS / -VSTATUS
General error	9, 22	+LCERROR / - LCERROR

LCERROR is set to 1 in case of the LC75X is in protection mode.

## 7.2. Example of use

The threshold settings (+VSTATUS / -VSTATUS) are set at the factory (standard setting is 0 V and 130 V) (Figure 7-2).

To get the status of the actuator position, the Strain Gauges option is necessary.

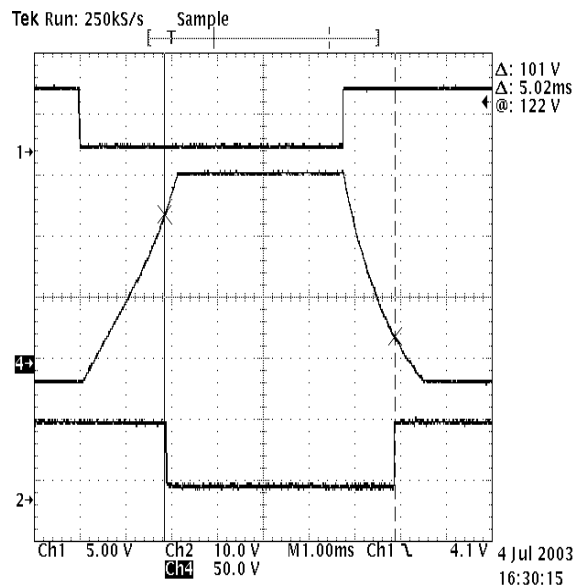


Figure 7-2 : Threshold voltage detection example

## 8. TROUBLE SHOOTING

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

ACTION	POSSIBLE CAUSES
<p>Check the led A6 :</p> <p>a) If A6 is off</p> <ul style="list-style-type: none"> <li>- check the main cable and the fuses at the rear panel</li> </ul> <p>b) If A6 is red</p> <ul style="list-style-type: none"> <li>- check the connection lines to the piezo actuator / disconnect every LEMO cable. Test the electronics with the unplugged and plugged piezo actuator, as follows</li> <li>- switch A7 off                             <ul style="list-style-type: none"> <li>If A6 is green                                     <ul style="list-style-type: none"> <li>- switch A7 on</li> </ul> </li> <li>if the electronic works,</li> <li>if the electronic doesn't work,</li> </ul> </li> <li>If A6 is red                             <ul style="list-style-type: none"> <li>- Wait for 10 minutes and switch A7 on                                     <ul style="list-style-type: none"> <li>if the electronic works,</li> <li>if the electronic doesn't work,</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- misconnection with main cable or burnt fuses</li> <li>- The electronics is in protection</li> <li>- May be a short circuit through the cable connection or through the piezo actuator occurred</li> <li>- an external parasitic noise might have disturbed it</li> <li>- a breakdown is certain</li> <li>- The electronic was in thermal protection and needed to cool itself down</li> <li>- a breakdown is certain</li> </ul>

**PROBLEMS:** INCOHERENT RESPONSE FROM THE ACTUATOR

ACTION	POSSIBLE CAUSES
<p>Check the Led (B1)</p> <p>Check the order (B2) If the order is correct, verify :</p> <ul style="list-style-type: none"> <li>- the commutation frequency of the order</li> <li>- disconnect the RS422 link (D1)</li> </ul>	<ul style="list-style-type: none"> <li>- there might be no correct order</li> <li>- it needs to be compatible with the charge and discharge process of the actuator (annex 2)</li> <li>- possible conflict between the order (B2) and the RS422 link</li> </ul>

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

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.

## **9. 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.

**Interventions or attempts to service or repair the SP75X-x by any unauthorised persons will invalidate this warranty.**

## **10. 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.

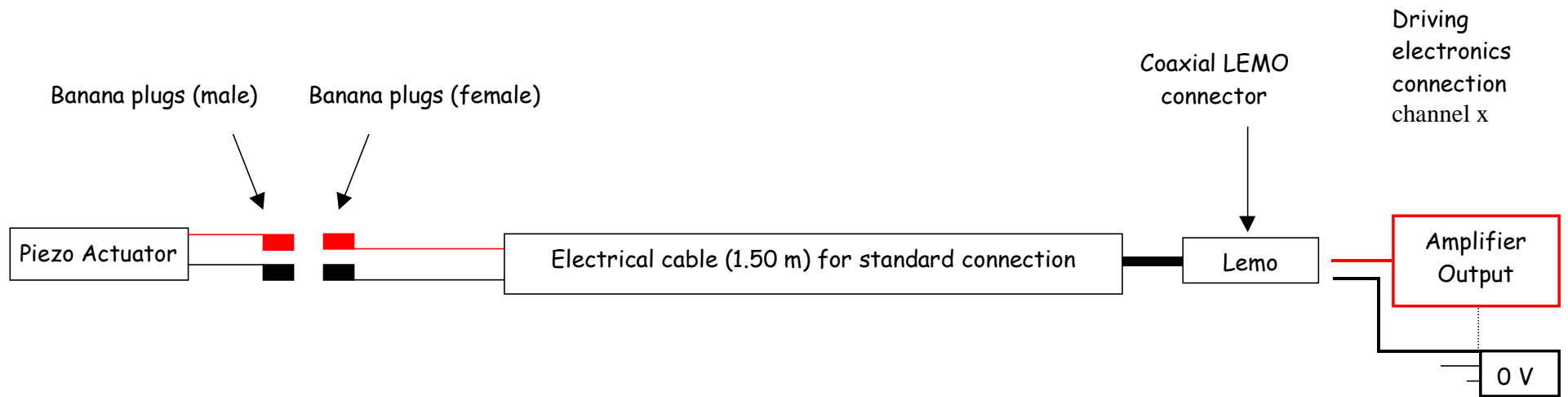
CEDRAT TECHNOLOGIES recommends the customer to keep the original package for any further carriage of the electronic product.

## **11. 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

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



## ANNEX 2

### Effect of the current limitation

With a switching power stage, the applied voltage to the actuator is getting the low and high voltage level, after the charge or discharge time.

This time is depending both on the capacitance of the piezo actuator and the current limitation of the switching power stage.

<p>The current for a capacitive load is given by the following expression:</p> $I_{piezo} = C_{piezo} \times \frac{dv}{dt}$ <p>For a given current limitation, the shortest load time is given by:</p> $t_{load} = \frac{\Delta V \times C_{piezo}}{I_{lim}}$	<p>The max frequency for a triangle signal is given by:</p> $f_{triangle\ max} = \frac{I_{lim}}{2 \times \Delta V \times C_{piezo}}$ <p>If we consider a sine signal, then the maximal frequency is given by:</p> $f_{sin\ max} = \frac{2 \times I_{lim}}{\Delta V \times C_{piezo} \times 2\pi}$
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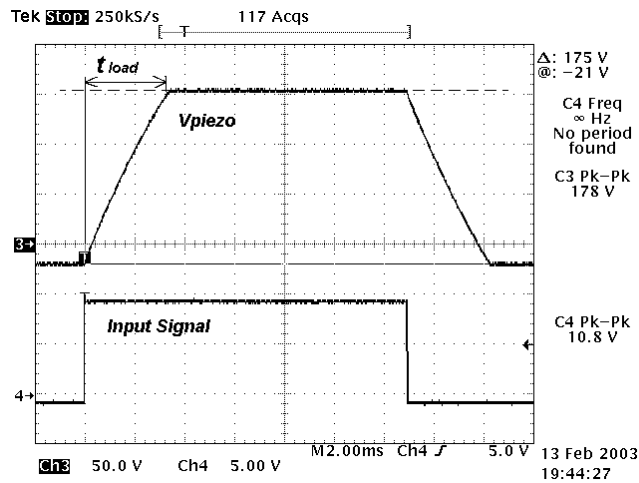


Figure A 1 - The current limitation limits the voltage slew rate of the piezo

Type of linear amplifier	SP75A	SP75B
Current limitation (A) per channel	0.3	3

## ANNEX3 : UNDERSTANDING THE FACTORY VERIFICATION SHEET



### Switching Power Factory Verification

AAV0048	SYNCHROTRON SOLEIL	Stamp and signature
Rack n° 03041 Mains 230Vac / 50 Hz SP75-04004 CH 1	Date of test (DD/MM/YY) 06/10/2005 Test performed by AP	

Electrical load used for the test

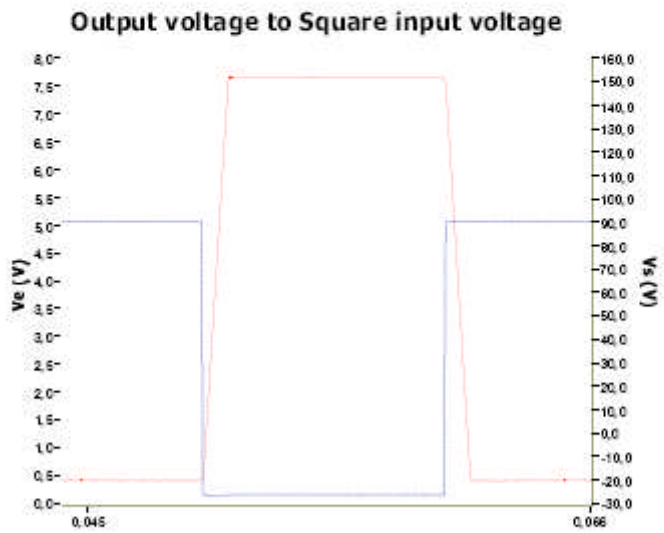
Electrical Load: 2,3  $\mu$ F

Input frequency: 50 Hz

Rise time (10 - 90%): 0,83 ms  
Acceptance limits (ms):  $0,79 \leq Tr \leq 0,96$

Fall time (90 - 10%): 0,81 ms  
Acceptance limits (ms):  $0,79 \leq Tf \leq 0,96$

Measured charge and discharge times



## ANNEX 4 : SP75A-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 SP75A-x	Standard technical conditions	Unit	Nominal values	Min. values	Max. values
Notes			<i>x : number of channel</i>		
Function			Switching power stage		
Max. number of channels			2		
Cooling			Natural convection		
Option			RS422 communication		
Negative supply voltage	Standard environment	VDC	-20	-20,0	-24,0
Positive supply voltage	Standard environment	VDC	150	150,0	156,0
Input voltage	Standard environment	V	TTL signal / CMOS		
Min. output voltage	Standard environment	V	-20	-20,0	-24,0
Max. output voltage	Standard environment	V	150	150	156
Max. output current		A	0,36	0,36	0,40
Max. output load capacitance		$\mu F$	400	360	440
Loaded Output bandwidth	Standard load*	Hz	968	871	1065
Input impedance		kOhms	10	9,5	10,5
Mass		g	500	-	-
Dimensions		mm	10F wide, 3H high		

\*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 bandwidth (-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

<b>Quasistatic excitation</b>	: AC voltage between -20 and 150 V at 1 Hz
<b>Environment</b>	: Ambient temperature (15-25°C) and dry air (Humidity < 50 % rH)
<b>Standard main supply</b>	: Main according to directive HD472; could be adapted to 110 VAC on request
<b>Noise measurement conditions</b>	: Excitation 0.5 Vrms ; reading bandwidth 1 Hz to 1 kHz
<b>Standard load</b>	: 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

**SP75B-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 SP75B-x	Standard technical conditions	Unit	Nominal values	Min. values	Max. values
Notes			x : number of channel		
Function			Switching power stage		
Max. number of channels			2		
Cooling			Forced air		
Option			RS422 communication		
Negative supply voltage	Standard environment	V	-20	-20,0	-24,0
Positive supply voltage	Standard environment	V	150	150,0	156,0
Input voltage	Standard environment	V	TTL signal / CMOS		
Min. output voltage	Standard environment	V	-20	-20	-24,0
Max. output voltage	Standard environment	V	150	150	156,0
Max. output current		A	3,00	3,00	3,30
Max. output load capacitance		µF	400	360,0	440,0
Loaded Output bandwidth	Standard load	Hz	8065	7258	8871
Input impedance		kOhms	10	9,5	10,5
Mass		g	500	-	-
Dimensions		mm	14F wide, 3H high		

\*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 bandwidth (-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

<b>Quasistatic excitation</b>	: AC voltage between -20 and 150 V at 1 Hz
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<b>Standard load</b>	: Actuator APA from series S or SM : 1.55 µF (load test may be different)

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#### 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

## **ANNEX 5 : 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.***