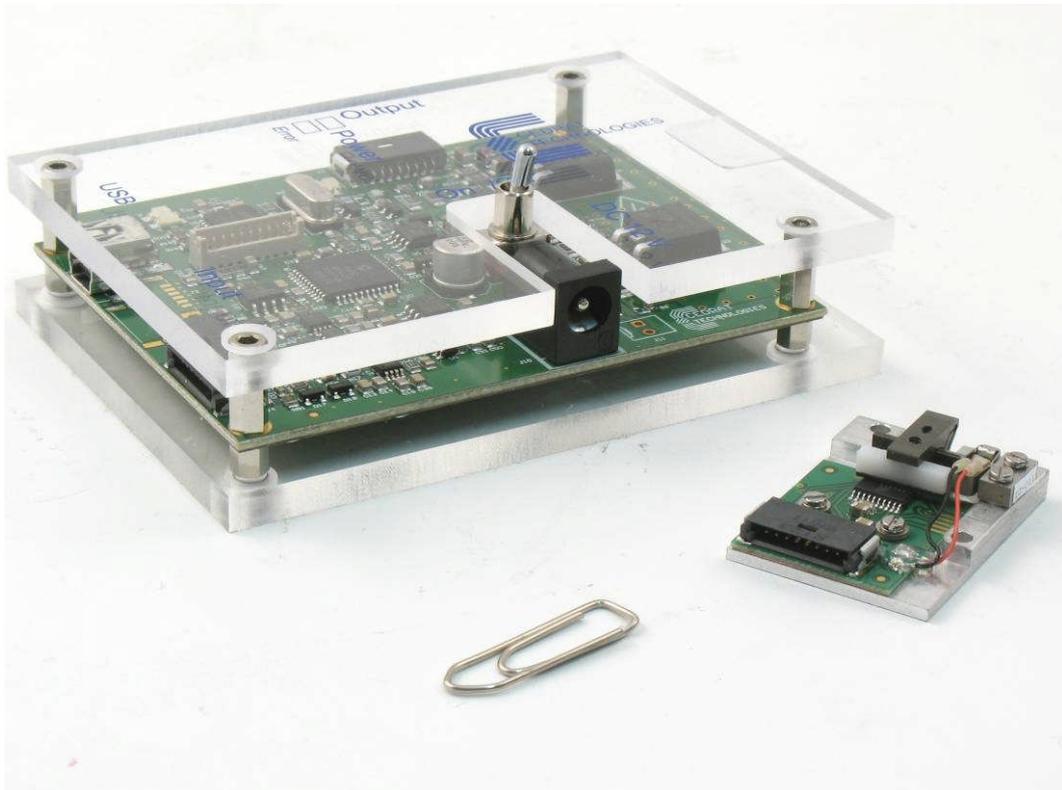


LSPA30uXS Developer's Kit

PRODUCT AND WARRANTY INFORMATION



Version : 2.1.0

CAUTION: READ BEFORE OPENING

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

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

High voltage is present in this product.

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

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

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

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

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1. GENERAL

Piezoelectric Actuators from CEDRAT TECHNOLOGIES SA consists in a wide range of actuators, divided in four categories:

- Multilayer actuators, that are not mechanically prestressed,
- Parallel prestressed actuators, that are mechanically prestressed multilayer actuators and offer mechanical interfaces,
- Amplified piezo actuators, which use an elastic amplifier to both prestress the multilayer actuator and amplify the displacement.
- Piezoelectric Motor, using Cedrat Technologies actuators to perform millimetric stroke.

Piezoelectric Actuators must be handled carefully. Lifetime of Piezoelectric Multilayer actuators is not limited by wear. They can perform millions of cycles without loss of performance provided they are operated under suitable conditions.

The lifetime of a Piezoelectric Multilayer Actuators is a function of many combined parameters; the most influencing being the applied voltage, the temperature and the humidity. For maximum lifetime, operating voltage should be minimized, especially when they are used in static conditions.

The mechanical installation or the induced moments under operation by the mechanism are the main sources of failure.

2. STEPPING PIEZO ACTUATOR PRINCIPLE

Stepping Piezoelectric Actuators are classified as Inertial Stepping Motors (ISM). These motors have the particularity to be based on a single actuator, making the electronic command and control easier.

Stepping Piezoelectric Actuators (SPA) are formed of only four parts (Figure 1): the well-established Amplified Piezoelectric Actuator (APA[®]), a front mass, a clamp and a rod.

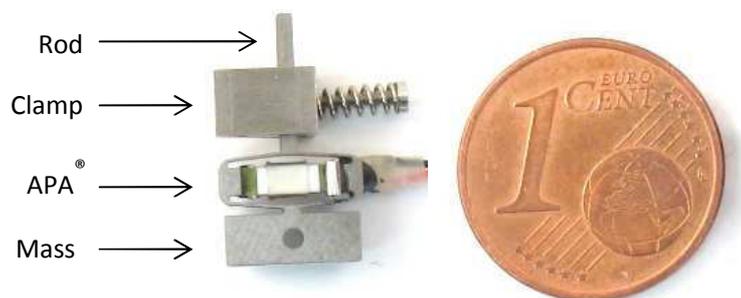


Figure 1 SPA30uXS components

SPA operates by accumulation of small steps, using inertial mode, impact forces and stick-slip effects: Typically, a slow APA[®] actuation generates a slow motion of the mass while the rod sits in the clamp. A fast APA[®] actuation induces a fast motion of the rod slipping in the clamp. This allows getting steps, which gives a long stroke, called the stepping mode (M_1). Between each step the actuator stays naturally locked in position. Figure 2 shows the stepping mode principle for fixed clamp and fixed mass configurations. The load can be fixed on different positions leading to two different motor capabilities thanks to different modes. In a first configuration offering nano positioning, the load can replace the mass or can be fixed to the mass. So when the long stroke (M_1) is performed, the motor can be also operated in a deformation mode (M_2) for a fine adjustment. In this case, the stroke is proportional to the applied voltage, which leads to a nanometre resolution and a high bandwidth (limited by motor blocked force). In a second configuration, the load is fixed on the moving rod. In this case, the advantage is a high stiffness, but fine mode is no more available.

The proposed kit uses as standard configuration the fixed mass configuration. However, developers have the possibility to experiment the other configuration using the “Extracted configuration” (see § **Erreur ! Source du renvoi introuvable.**).

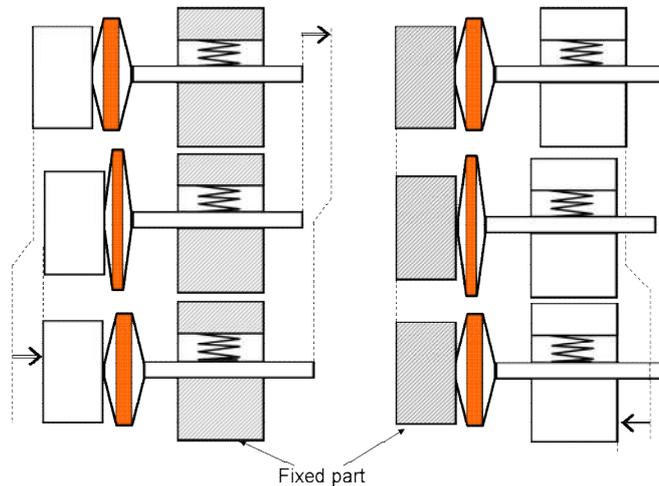


Figure 2 Working principles for 2 different configurations

The long stroke stepping mode (M_1) is produced by step accumulation with an appropriate 0-150V voltage pattern. The short stroke deformation mode (M_2) is produced by deformation of the APA®, which is simply proportional to the voltage excitation between -20 to $+150$ V. Only one amplifier channel per SPA is required.

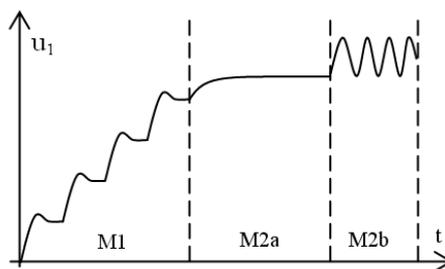


Figure 3 SPA stepping mode (M_1) and deformation mode (M_2)

Compared to a piezo stack of the same size, an APA presents a typically 20 to 100 times larger compliance and a four to ten times larger stroke. The larger compliance of the APA leads to a 5 to 10 lower resonance frequency (at constant mass) and so a 5 to 10 times smaller current demand than the same piezo capacitance in a stack.

The large deformation stroke of the APA is also an advantage. It provides a useful deformation stroke mode (M_2). It also contributes in getting good speed in long stroke mode (M_1): larger steps per cycle compensate a lower step frequency.

These expected advantages provided by the APA into an ISM stepping piezoelectric motor have been experimented in several prototypes, and especially SPA30uXS.

3. DESCRIPTION OF THE LSPA30UXS DEVKIT

The SPA30uXS kit is made of different sub-systems:

1. A LSPA30uXS, coupled with an incremental sensor on the holding platform
2. A SPC45 driver
3. An AC-DC converter for SPC45 power
4. Two adapted cables
5. USB cable

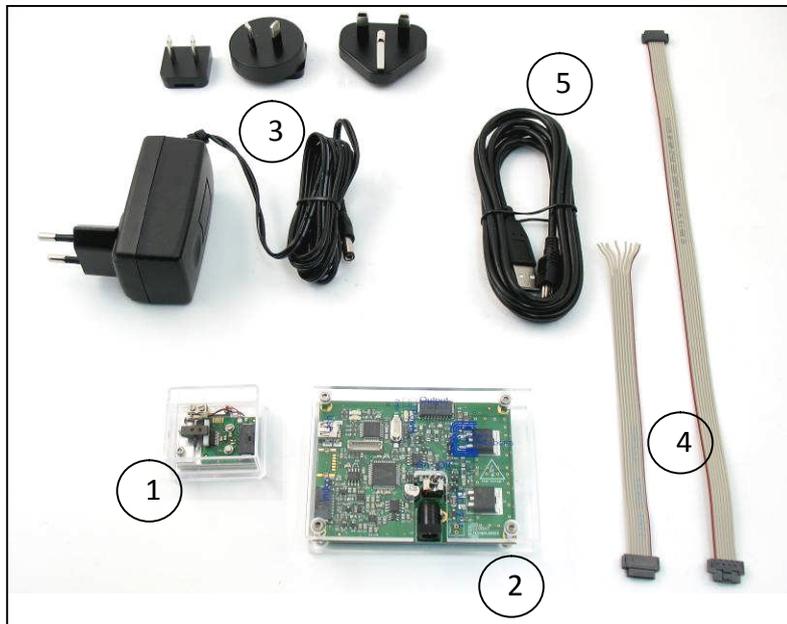


Figure 4 SPA30uXS kit components

3.1. SPA30UXS PLATFORM DESCRIPTION

3.1.1. Overall presentation

The SPA30uXS motor is presented on an holding platform. This one includes the motor, but also an incremental magnetic sensor and the associated connecting board. The whole view of the platform is presented on Figure 5. Each component is described further.

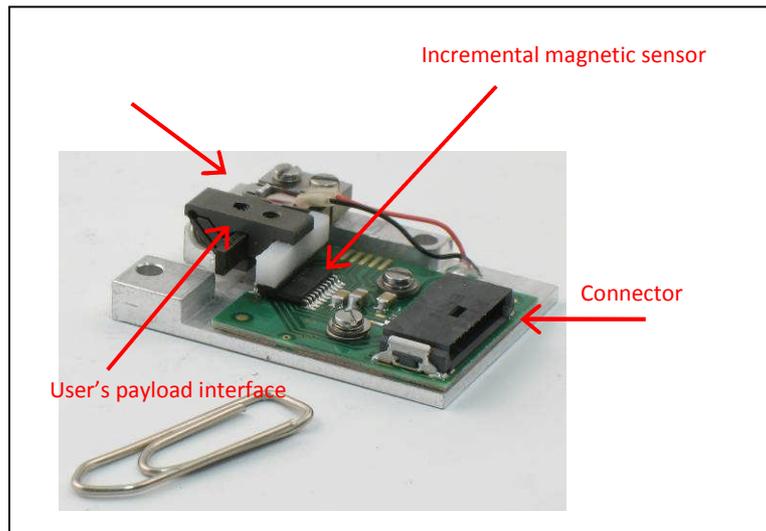


Figure 5 SPA30uXS platform description

3.1.2. LSPA30uXS motor

The LSPA30uXS motor is presented in its mobile clamp configuration (see § 2). It gives a 3.4mm stroke, fully covered by the sensor for closed-loop configurations. Offering a M2 fixing hole, integration of user's payload is easy. Be sure to refer to § 3.1.7 in order to suit with integration and loading recommendations. Figure 6 proposes a close-up of the mobile clamp, with user's payload interface.

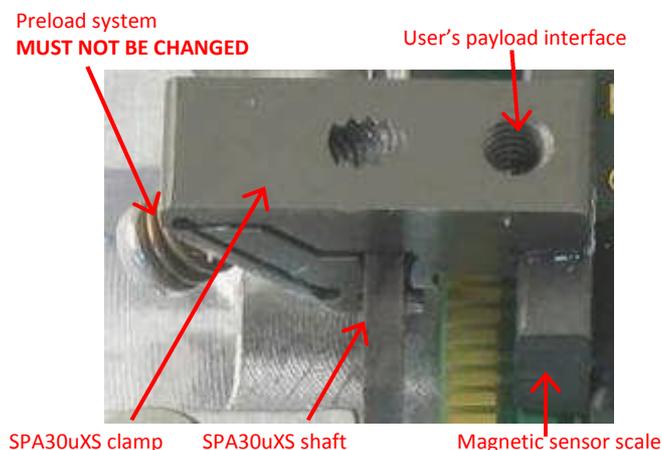


Figure 6 Mobile part details

3.1.3. Incremental magnetic sensor

The integrated incremental magnetic sensor gives the possibility to reach 1.95µm resolution in motion. The sensor is powered with a 5V voltage. Two output TTL channels (Channel A and B) are available in order to be decoded to

produce a count up pulse or a count down pulse. The decoding operation is done by the proposed driver SPC45 (see §7.4).

3.1.4. Connecting board

The connecting board presents the interface with the actuator in one hand, and with the sensor, in the other hand. The detail of the pin configuration is given in Figure 7.

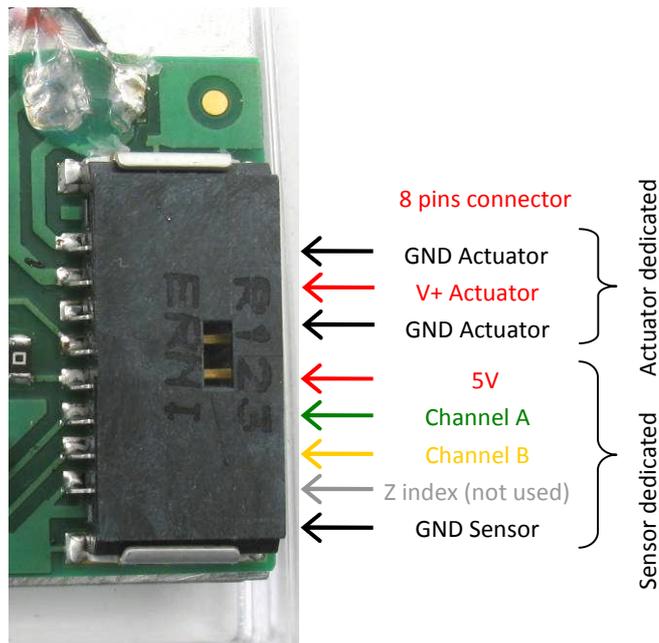


Figure 7 LSPA30uXS connector details

3.1.5. Possible configurations

The LSPA30uXS offers the possibility to be set-up in several different configurations. The first one is the Delivery configuration (Figure 8). In this case, the motor is not able to be connected inside the box.

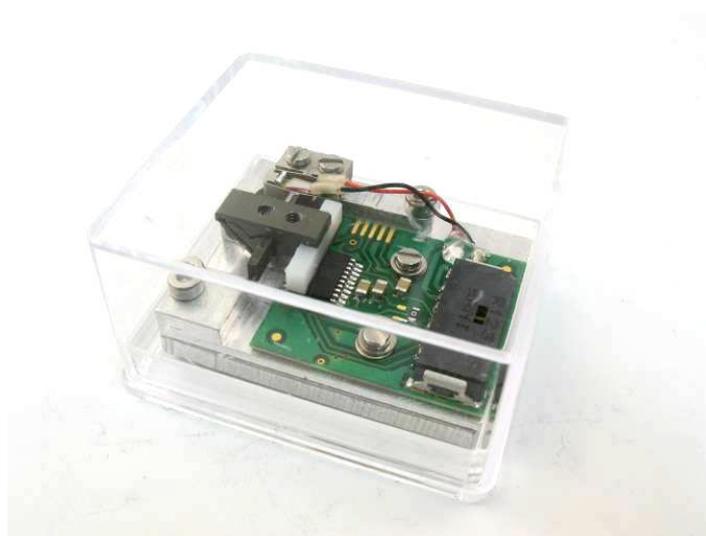


Figure 8 Delivery configuration

The Demo configuration (Figure 9) allows the user to test the motor in a very basic way. Using the supplied software and the USB cable, you are able to obtain a very first feedback of the behaviour of the motor.



Figure 9 Demo configuration

In order to be integrated into user's test bench, the LSPA30uXS platform can be removed from the Demo configuration by removing two M2 screws, identified on Figure 10. The associated mechanical interfaces and dimensions are presented in § 3.1.6.

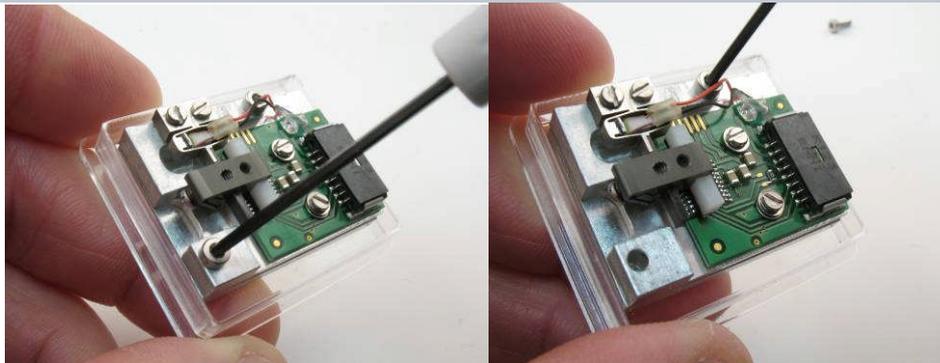
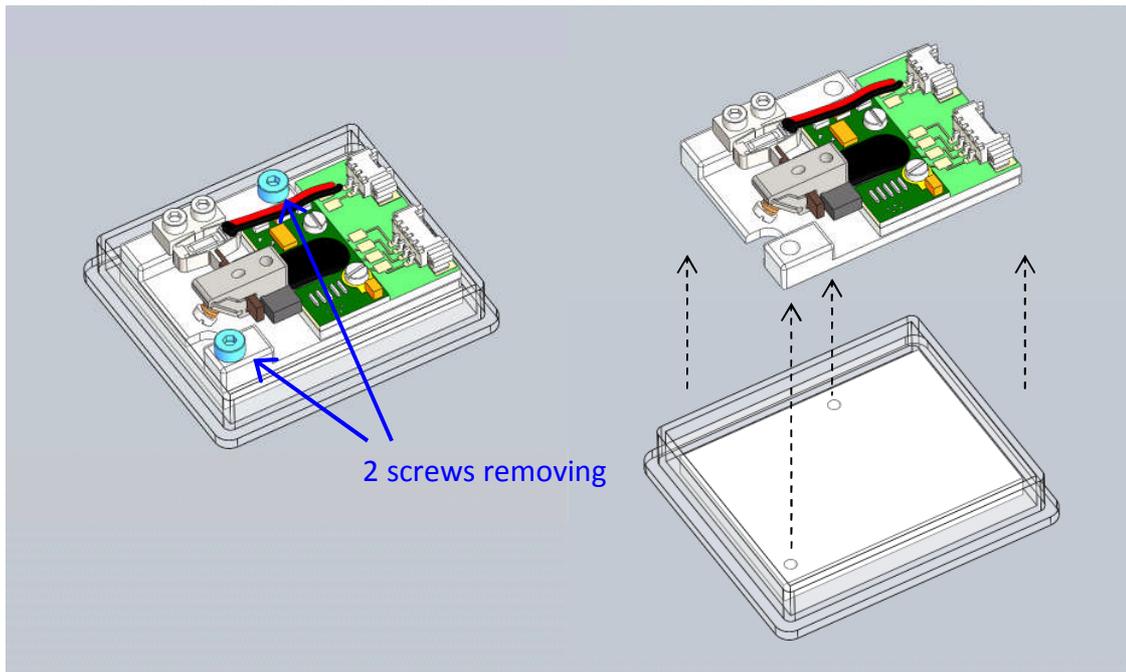


Figure 10 "On-site" configuration, from Demo configuration

The last available configuration accessible with the LSPA30uXS platform is the "Extracted configuration". In this case, the motor can be removed from the platform.

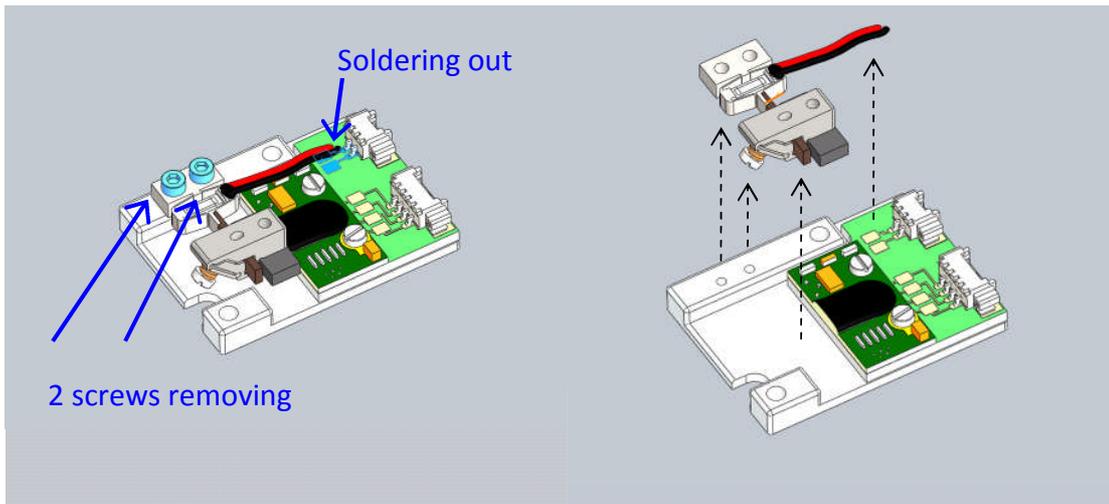


Figure 11 "Extracted" configuration, from "On-site" configuration

IMPORTANT: The LSPA30uXS mobile part is composed of a preload system (screw + spring). This preload is set up during factory verification and must not be changed. Any intervention on the preload screw would disable product warranty.

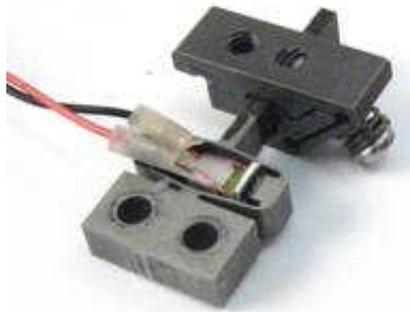


Figure 12 Extracted motor, without sensor magnetic scale

3.1.6. Mechanical integration

The LSPA30uXS platform dimensions are provided in the following figure. Mobile part of the motor is presented in blue. Fixed part is in orange color.

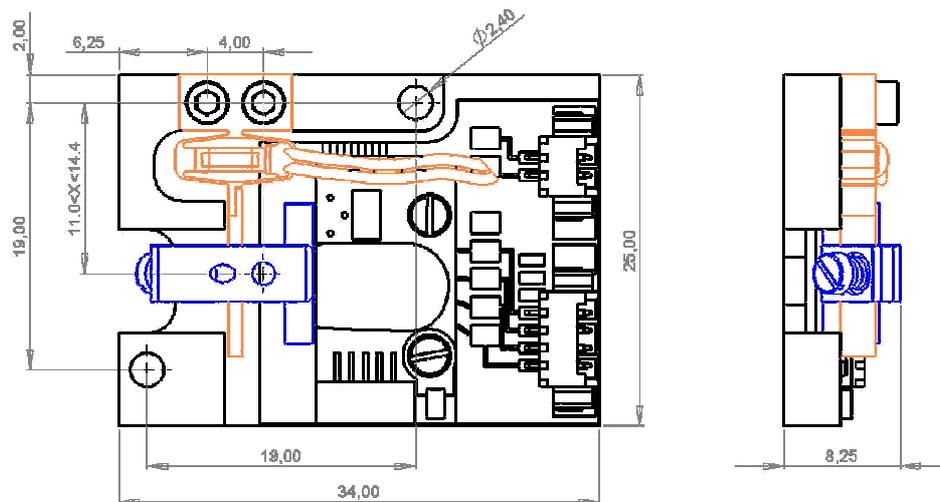


Figure 13 Motor platform dimensions

3.1.7. LSPA30uXS loading acceptance

In order to keep the performances in an acceptable range, we recommend not exceeding a 5 grams loading. The torque that can be applied is also limited in order to keep the friction geometry stable. By the way, the applied torque should not exceed **0.08mNm** (corresponding to 5 grams positioned in the user's payload hole).

Any higher loading would impact performances and lifetime. For higher loading, external guiding, such as bearing, has to be implemented.

Warning! During the load assembly on the clamp, be sure not to apply a higher torque than the motor can support.

3.1.8. How to assemble the load to the mobile part?

Place the motor on the "zero" mechanical stop, using software (see §6).

Put the load on the mobile part. Hold the mobile part using a manual clamp when screwing the M2 screw to assemble the load to the mobile part (see Figure 14). This operation is needed to avoid high constrain torque that can disassemble the motor (see example on Figure 15).

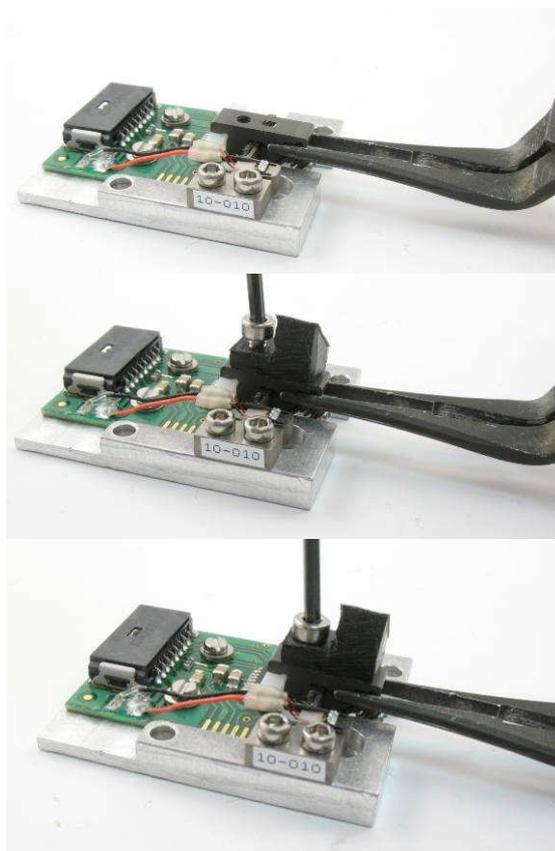


Figure 14 Example for load assembling using manual clamp and screw driver

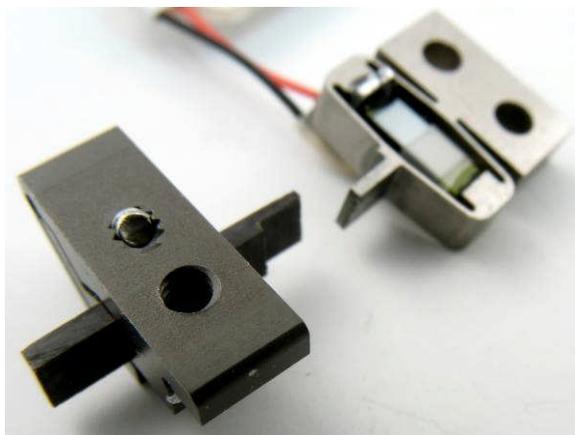


Figure 15 Example of motor failure due to incorrect handling

3.1.9. LSPA30uXS position tolerance

The LSPA30uXS is an actuator and does not include self guiding solution.

3.2. SPC45 DESCRIPTION

The Stepping Piezo Controller SPC45 is the driver board of the LSPA30uXS. It includes control functions, digital and analogue interfaces, and serial

communication ports. The SPC45 is powered with the provided standard AC/DC adapter (24Vdc). Description of the SPC45 interfaces is given on Figure 16.

WARNING! Be careful when plugging a cable to the SPC45 board. Connection of the input cable to the output connector (or reciprocally) could lead to severe damaging of the electronics. Always verify your connections before switching on the electronics.

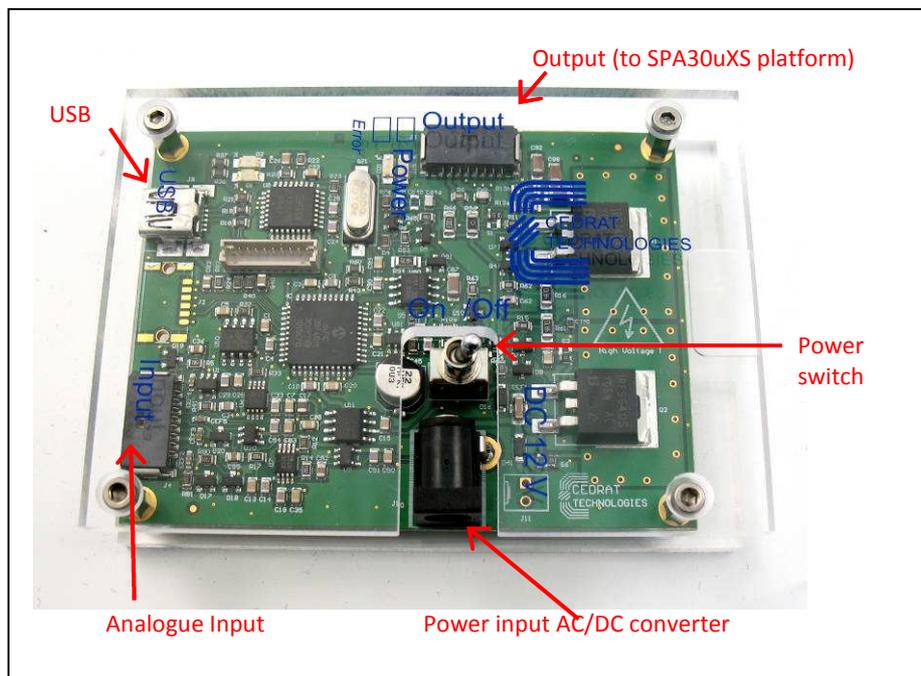


Figure 16 SPC45 description

Input and output of the board are physically given on Figure 17 and Figure 18 and detailed on Table 1.

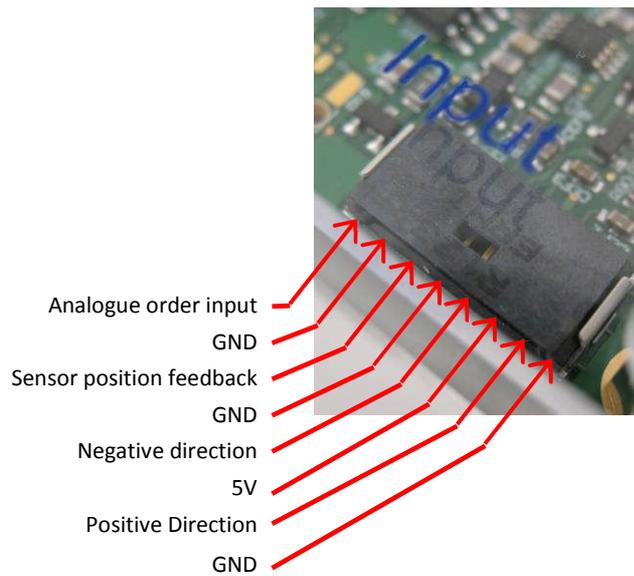


Figure 17 Input connector details

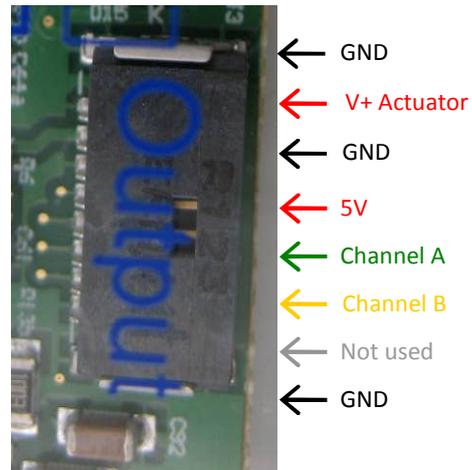


Figure 18 Output connector details

Number	Description	Range	Nature
IN08	Analogue order input	[0 : 5] V	In
IN07	GND	-	-
IN06	Sensor position feedback	[0 : 5] V	Out
IN05	GND	-	-
IN04	Negative	TTL (0 or 5V)	In
IN03	5V	-	Out
IN02	Positive	TTL (0 or 5V)	In
IN01	GND	-	-
OUT01	GND Actuator	-	-
OUT02	V+ Actuator	[0 : 110] V	Out
OUT03	GND Actuator	-	-
OUT04	5V	-	Out
OUT05	Channel A	TTL (0 or 5V)	In
OUT06	Channel B	TTL (0 or 5V)	In
OUT07	Z index	TTL (0 or 5V)	Not used
OUT08	GND sensor	-	-

Table 1 SPC45 port description

Please notice that connector reference are the following one: ERNI 8b RA 1,27

Cables used are cables 1,27 mm ERNI Minibridge, 8 points.

3.3. LSPA30UXS KIT PERFORMANCES

The performances presented in the following table are results of tests performed with no load, in lab conditions. Additional payload may have consequences on performances.

References	Unit	LSPA30uXS DevKit
Notes		-
Sensor		MAG
Base		APA30uXS
Stroke	mm	3.4
Stiffness	N/ μ m	0.108
Max speed	mm/s	30
Typical Holding force at rest	N	0.8
Typical actuation force	N	0.2
Sensor resolution	μ m	1.952
Capacitance	μ F	0.052
Height	mm	8.25
Base size	μ m	25x34
Mass	gr	8.1
Max input current (incl. Driver) @12V	A	0.4
Holding current	A	0

4. ENVIRONMENT COMPATIBILITIES

Stepping Piezo Actuator has a few heritages from various environment compatibilities. Vacuum compatibility can be achieved via some precautions, with or without sensor. Strong magnetic fields compatibility and cryogenic use may also be investigated with the LSPA30uXS. Please contact us to get further information about the LSPA30uXS potentialities.

5. GRAPHICAL USER INTERFACE OF THE SPC45

The Graphical User Interface (GUI) is built to give the user the opportunity to control the system, in open or closed-loop, but also to give feedback about system state.

5.1. SOFTWARE INSTALLATION

This paragraph describes the different instructions to connect the SPC45 driver and to install the software.



Do not connect the USB driver on the PC before installing the software.

The installation is simple: Updated software SPC45 may be downloaded from Cedrat Technologies website. Please check:

<http://www.cedrat-technologies.com/en/mechatronic-products/soft-download.html>

It includes the installation of the drivers to dialogue with the SPC45 and the installer for the application software. It contains the autonomous application too.

5.1.1. Required equipments

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

- Change “,” in “.” in the regional configuration of your PC if it is not the case. (Settings/ Controls Panel / Regional and language Options / Customize / Decimal symbol).
- Software is optimized for 1600x900 screen resolution.

5.1.2. First time installation

- The operator has to run the “setup.exe”, following the given instructions.

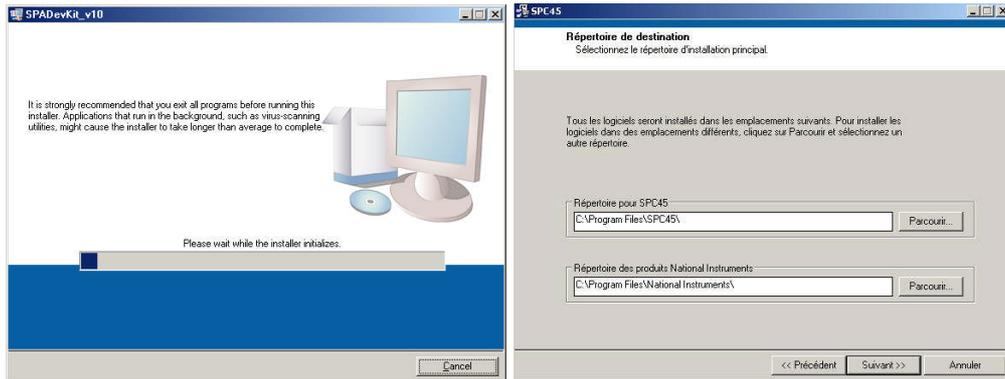


Figure 12 Destination directory

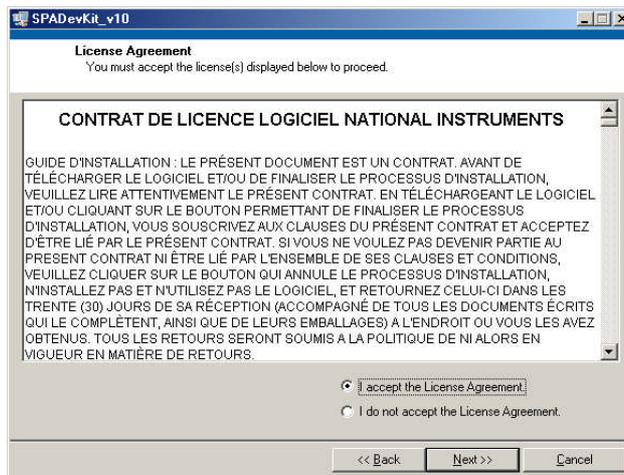


Figure 13 License Agreement

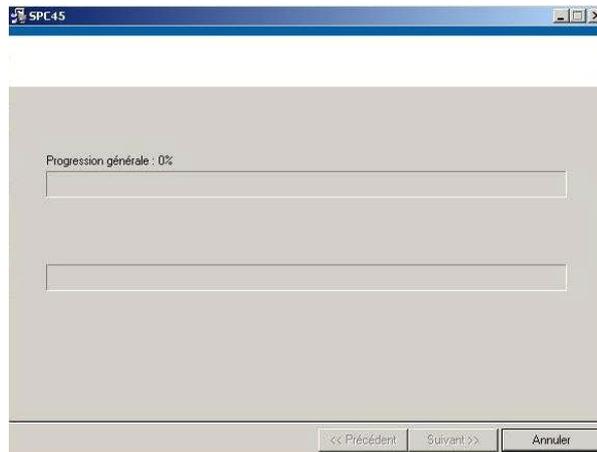


Figure 14 Starting Installation

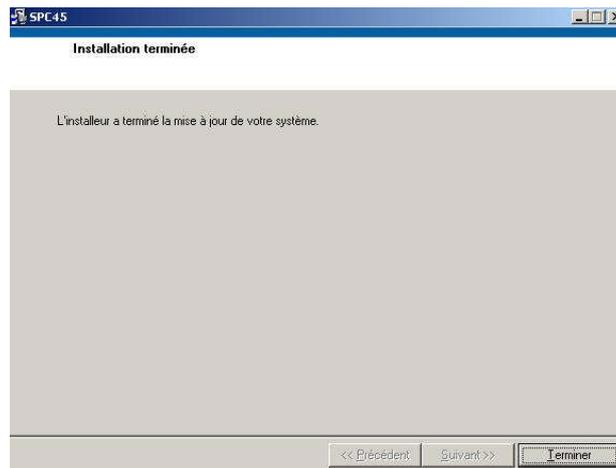


Figure 15 Installation finish

- After this installation is finished, another driver is installed automatically. The system shall be **restarted**.
- Connect your PC with the SPC45 by USB cable and power on the driver.
- Now the operator can run the software “SPC45.exe”

5.2. OVERALL DESCRIPTION

The control software interface is made of a few boxes.

The first one concerns the choice of the working mode of the system. Some modes need additional parameters definition, which are detailed further.

The second box corresponds to the parameters feedback from the system, and especially position.

The communication channel is automatically detected when the software starts.

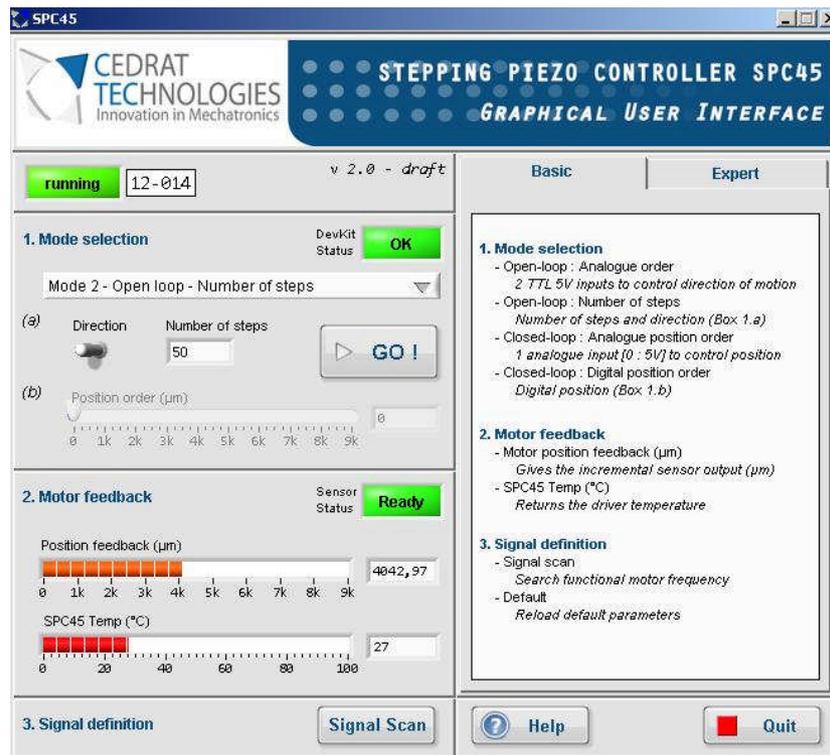


Figure 16 Graphical User Interface SPC45

5.2.1. Communication

Before running the GUI, please plug the SPC45 driver, power it and connect the driver to the computer using provided USB cable.

The port COM is automatically detected by the software. If the communication is well established, the Running indicator turns green.

Running

If the driver is not available, not plugged, or not powered, the communication fails and status indicates “offline”. An additional warning message appears (Figure).

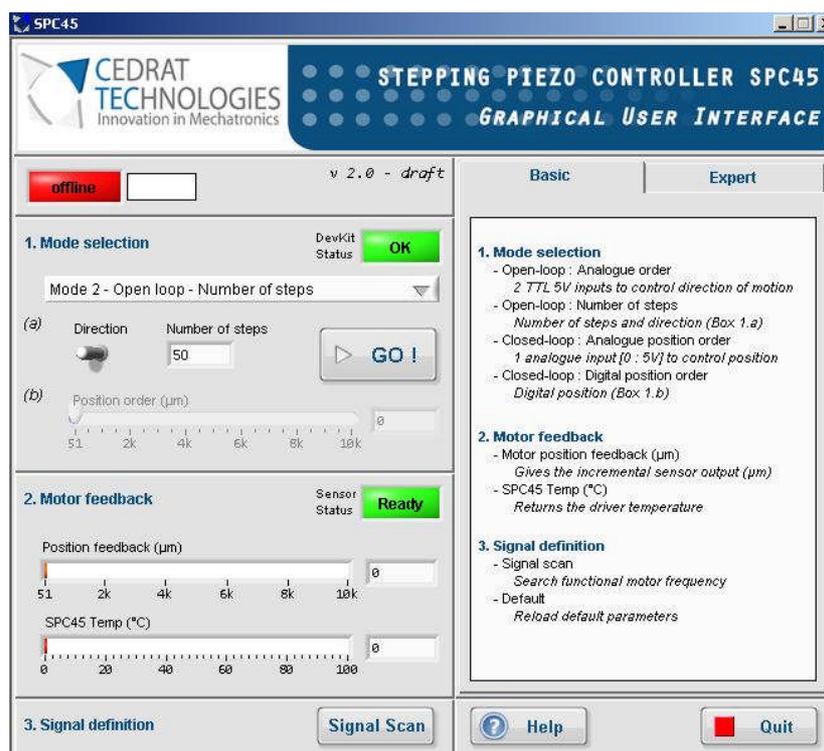


Figure 17 Waiting message

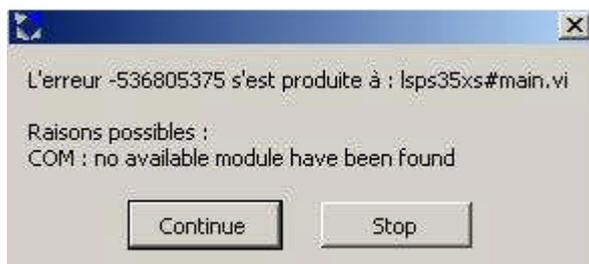
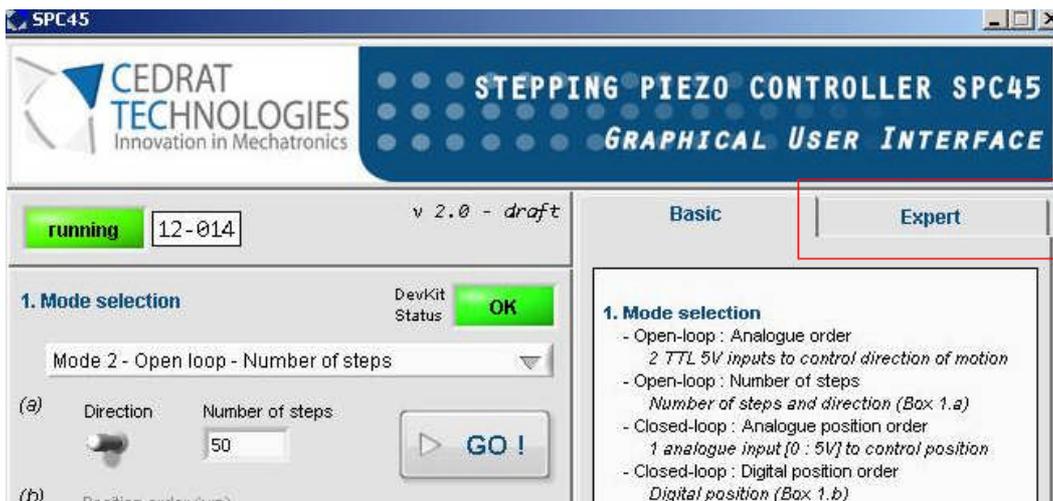


Figure 18 Communication error

If this problem occurs, you have to restart the software ensuring to connect the USB cable correctly and to power ON the SPC45 before launching the SPC45.exe.

5.2.2. Load configuration

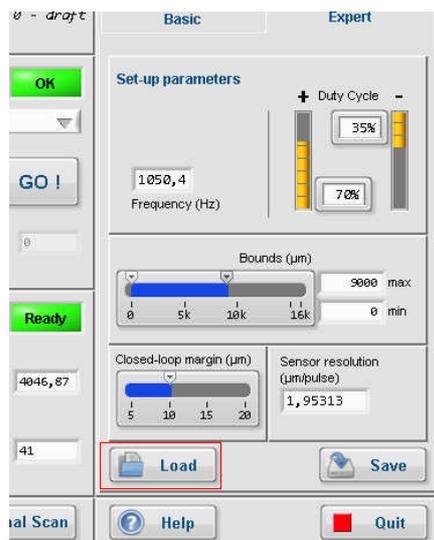
The Graphical User Interface SPC45.exe can be used for several products from Cedrat Technologies. Consequently, it is needed to load the default configuration for of your system item. For that, go into the “Expert” mode:



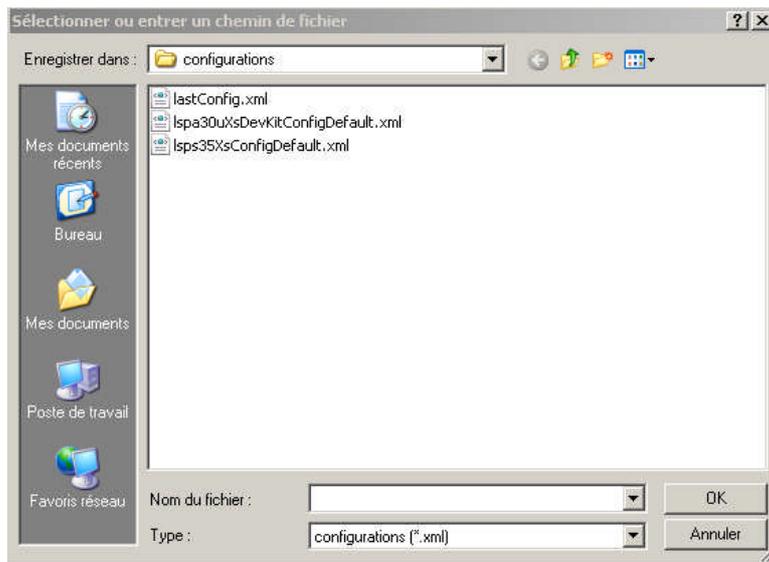
Click “OK” on the warning message



Click on “Load”:



Select and Open the file “xxxxConfigDefault” corresponding to your product:



The GUI is now configured for your product. Leave the expert mode by clicking back on “Basic”:



The GUI is ready to be used with your product.

5.2.3. Mode choice

The user interface allows the user to choose the working mode. Each of them is detailed further.

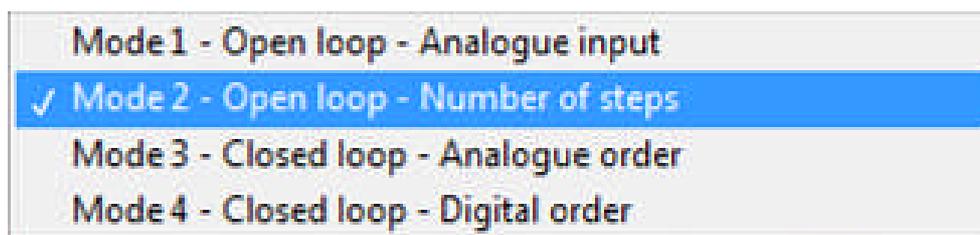


Figure 19 Mode choice

5.2.3.1. Mode 1: Open-loop: Analogue input

Especially designed for demo purpose, this mode allows using two TTL (0-5V) inputs, in order to control the direction of the system motion. Please refer to Figure 16 to see input positions (Positive and Negative direction).

5.2.3.2. Mode 2: Open-loop: Number of steps order

This mode gives the possibility to send to the system an order as a specific number of steps in the chosen direction. The software updates and monitors automatically the position feedback.

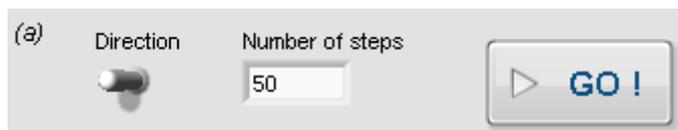


Figure 20 Direction and number of step definition

Enter Number of desired Steps, select direction and Run the motion. After the motion, the position feedback is automatically updated (see §5.2.4).

5.2.3.3. Mode 3: Closed-loop: Analogue position

The “Closed-loop Analogue position” mode is available when a sensor is detected by the driver SPC45. This detection is done when the driver is turned on. If sensor is not detected, the Red LED on SPC45 driver lights.

The input range is [0 ; 5] V. The system automatically reaches the desired position.

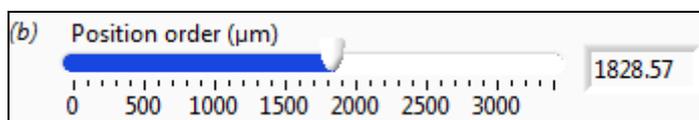


Figure 21 Digital closed-loop order

5.2.3.4. Mode 4: Closed-loop: Digital position

The “Closed-loop Digital order” mode is only available when a sensor is detected by the driver SPC45. This detection is done when the driver is turned on. If sensor is not detected, the Red LED on SPC45 driver lights.

The desired position (μm) is selected using the input bar cursor or the Digital control. Then run the system motion using RUN button. The Position feedback (μm) is automatically updated after the motion.

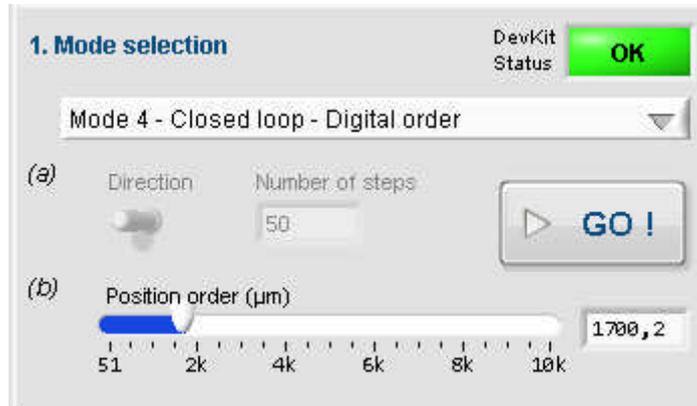
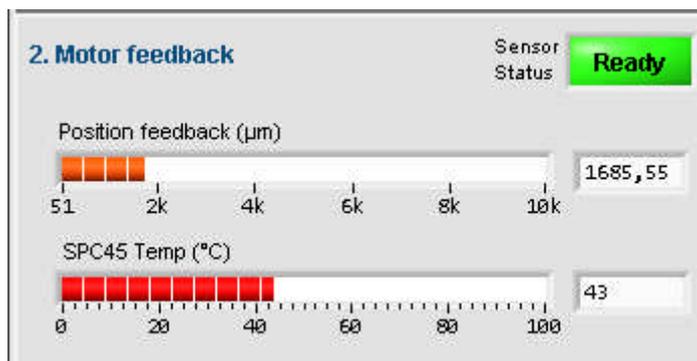


Figure 22 Closed-loop interface

If Mode 4 is the only mode unavailable, please refer to § 5.1.1 to change regional configuration.

5.2.4. System Feedback

The user interface gives a feedback. This includes the position and driver temperature. During “Open-loop: Analogue input” mode and “Closed-loop: Analogue order” mode, system status update is done 5 times per second. This would also update values from Maintenance sheet (see §8).



5.2.5. Signal definition

The signal definition box (#3) is composed of two buttons. The first one, called “Signal scan”, allows the driver to look for a convenient input signal. This is done

automatically, and takes a few seconds. If closed-loop mode is used, the system takes place to the previous position order as soon as the “Signal scan” is finished. Note that this function may not give useful feedback, especially if loading is not correct and/or mechanical stops are strongly involved. Load the default configuration if the system seems to be inefficient after the Signal Scan. (§5.2.2)



Figure 23 Signal definition box

5.2.6. Missing sensor

If you are not using the provided sensor, or if there is connection problem, the SPC45 driver is not able to return position feedback from sensor. The GUI indicates a “sensor missing” message, next to the Position feedback indicator.



Figure 24 Sensor status

5.3. OPERATING THE SYSTEM WITHOUT GUI

Mode 1 and 3 (Analogue modes) are fully usable without GUI. For other modes: the SPC45 driver is commanded using serial digital inputs. Listing of the serial commands needed to communicate with the SPC45 driver may be furnished. Please contact us to get further information.

6. OPERATION OF THE SPC45

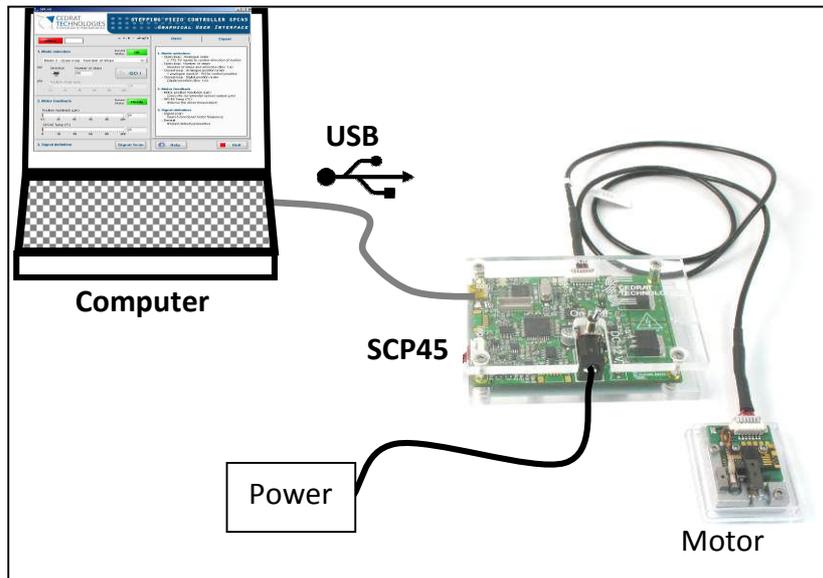
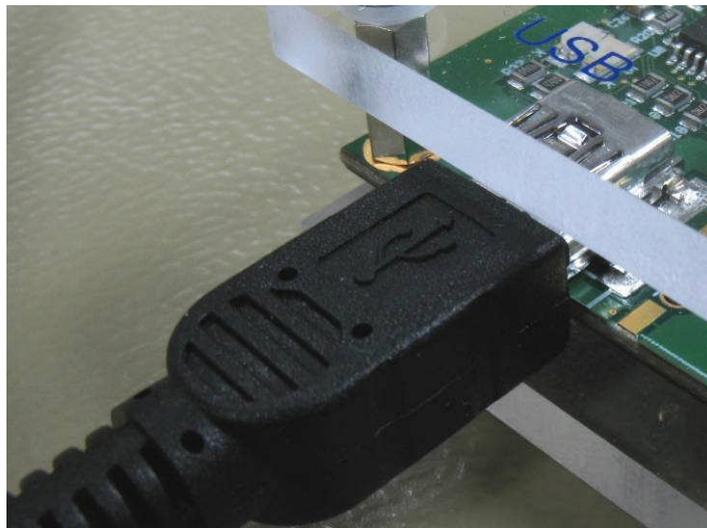


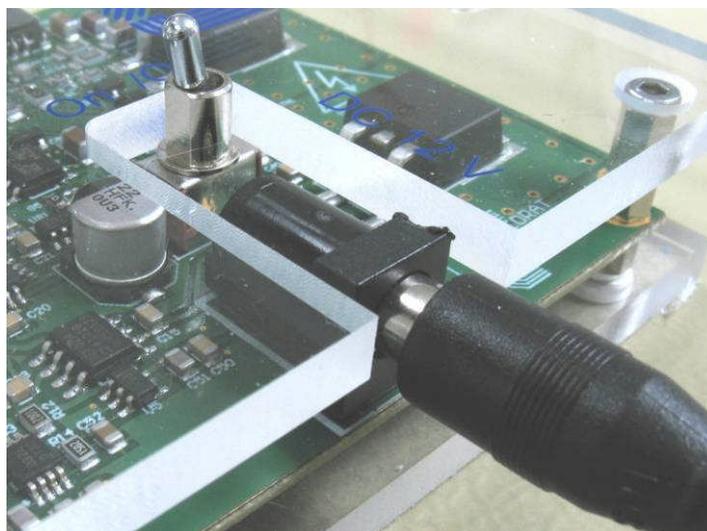
Figure 25 Standard configuration

6.1.1. Procedure:

- (01) Check the content of the delivery. If any component is missing, please contact Cedrat Technologies.
- (02) Plug the SPC45 driver to the motor platform using the provided standard cable.
- (03) Plug the SPC45 driver to a computer using the provided USB cable.



(04) Plug the power adapter to the driver SPC45. Turn on the Power switch.



(05) Launch SPC45.exe. Please refer to § 5.1 to get information about software installation.

(06) Wait for the communication between the computer and the driver is settled.

(07) Choose the desired control mode (Open-loop - Number of steps order OR Closed-loop – Digital order). Note that the two other modes are unusable without analogue input, so they are not convenient in “plug-and-play” configuration.

(08) Please refer to § 5.2.3.2 and § 5.2.3.4 to obtain information about these modes way-of-working.

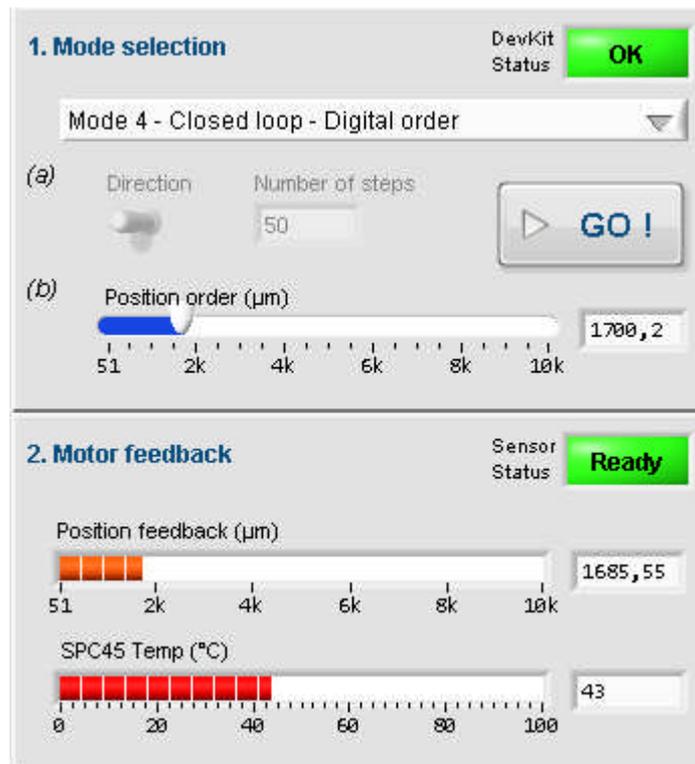


Figure 26 Software interface

7. EXPERT MODE

This part details information about possibilities offered to expert, who wants to dedicate the system configuration to their own application. By the way, expert may adapt the system to fit their own mechanism specification.

Do not try to change any of the following parameters if you are not sure to use the system in the correct way.

All of the possibilities described here are accessible by activating the “Expert Mode” tab on the GUI. When clicking on it, the following message informs you to refer to this part of the User’s Manual.



7.1. SYSTEM COMMAND SIGNAL DEFINITION

The LSPA and LSPS systems are using a specific waveform to generate the motion. This waveform has been settled to allow users to load the system with small loadings. For other loadings, “Signal Scan” function (see §5.2.5) allows driver SPC45 to look for an adapted input signal. However, expert may manually improve the signal definition to improve system performances.

The user interface gives the expert the possibility to change the parameters of the system input signal. The main rule of the frequency change is explained by Figure 27. With load, the optimal frequency decreases. According to user’s payload, the signal frequency may have to be changed.

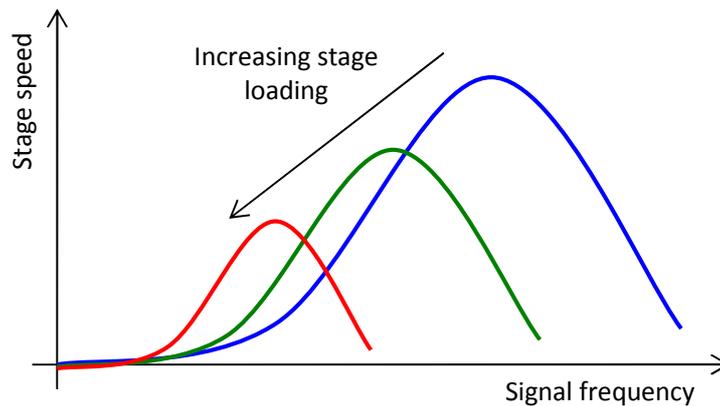


Figure 27 Example of signal frequency influence on speed for several loadings

The Graphical User Interface allows to impact on the signal frequency. It consists in indicating directly the desired signal frequency to the controller.

Two others parameters accessible are Duty cycle for each direction. Figure 28 shows the impact of signal duty-cycle variation on system speed. It can be seen that optimal values are reached for approximately 35% and 70%. These values are set as default values.

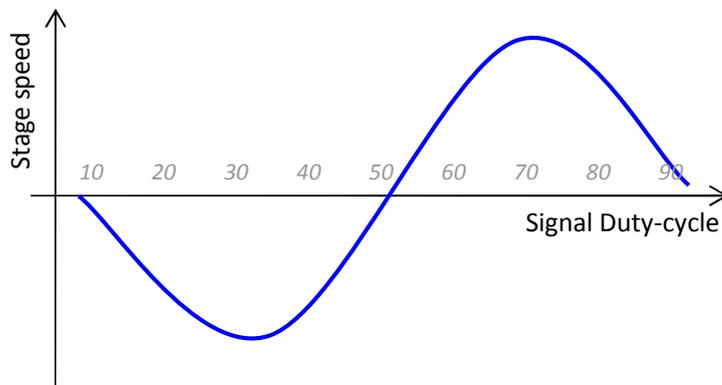


Figure 28 Duty-cycle influence principle on system speed

The user interface is presented in Figure 29

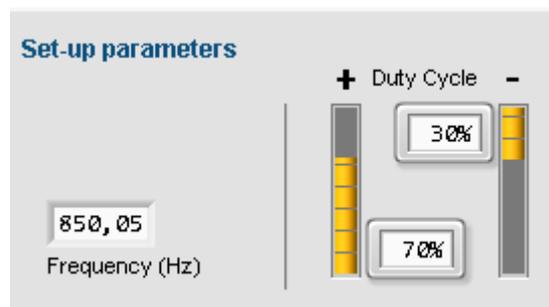
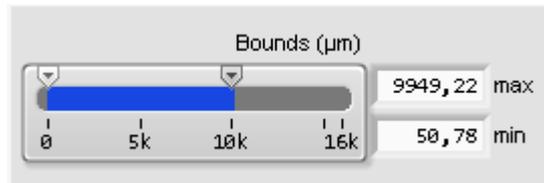


Figure 29 Signal Expert definition

7.2. DEFINE BOUNDS

It is possible to define numeric bounds for the system. This option can be used in order to limit the motion of the system in a given window. The bounds will only be taken into account in “Mode 4 – Closed loop – Digital Order”



7.3. CLOSED-LOOP MAX ERROR

WARNING! Changing the value of the maximum positioning error might lead to unstable control.

The closed-loop mode is done by an on/off control. While the error, defined as the difference between the position order and the position feedback is bigger than the max error, motion is performed. Figure 30 (a) explains this principle.

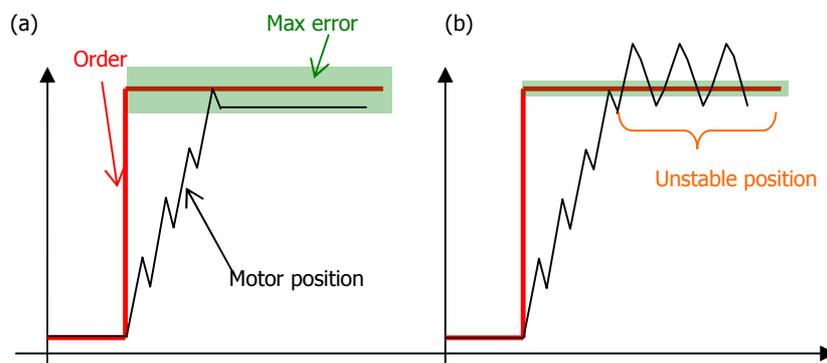


Figure 30 Closed-loop principle and instability risk

The main drawback of this control solution is the instability created by the discrete behaviour of the controller. Indeed, once the maximum error is below standard step size, the system may have major difficulties to reach the desired position. Figure 30 (b) presents an example of this situation.

The maximum error may be changed using the following cursor (see figure 31), available at the front panel of the Expert tab.

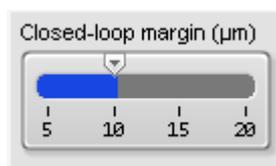


Figure 31 Max error setting

7.4. OTHER INCREMENTAL SENSOR INTEGRATION

WARNING! When the sensor is changed, if the closed-loop control is unstable or direction of motion reversed, this might result from the inversion of the channels. Swap the channels connections and try again.

The driver SPC45 allows interacting with any incremental sensor, using two 5V-TTL-Logic signals. Provided sensor gets a 1.95 μm resolution. This gain, defined as the standard value is visible on the GUI (see fig 32). It has no reason to be changed as long as the provided sensor is used.

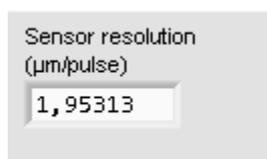


Figure 32 Sensor resolution setting

However, user's test bench may already have its own incremental sensor. In this case, sensor resolution can be changed in order to fit considered sensor resolution.

7.5. "LOAD" OF "SAVE" CONFIGURATION

It is possible to load or save a given configuration thanks to the buttons "Load" and "Save".



7.6. REVERSING MOBILE PART

Description of the Stepping Piezo Actuator explains the possible configurations. The standard one using mobile clamp is settled in the LSPA30uXS DevKit as basic configuration. The other one, with mobile actuator, is also achievable using the LSPA30uXS.

In this case, extracted version of the motor is needed. Please refer to **§Erreur ! Source du renvoi introuvable.** to get information.

Once the motor is free from platform and sensor scale, the clamp can be screwed to the ground, leading to the mobile actuator configuration.

WARNING! When integrating the motor into specific test bench, mechanical stops have to be placed in order to avoid any risk for the mobile part to go out of the shaft!! It is not possible to replace the shaft into the mobile part once it is disassembled!

Typical signal frequency in mobile actuator configuration has to be higher than in mobile clamp. By the way, typical admissible frequency can be settled to 2300Hz, without any load.

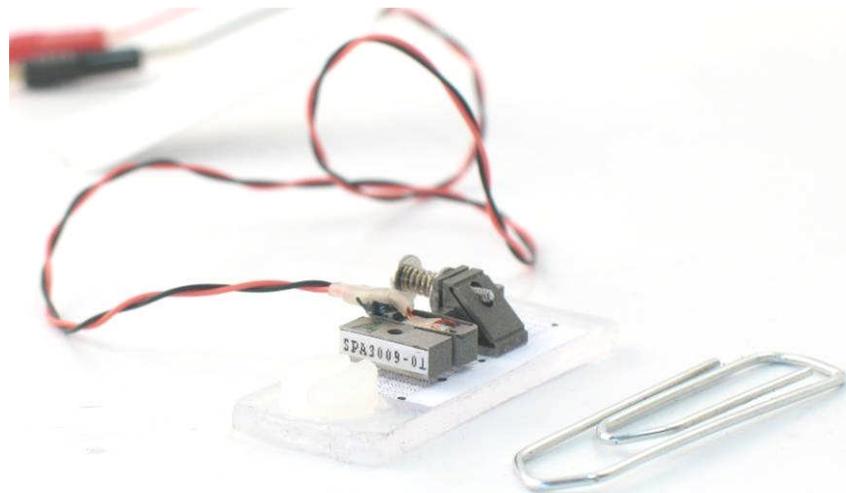


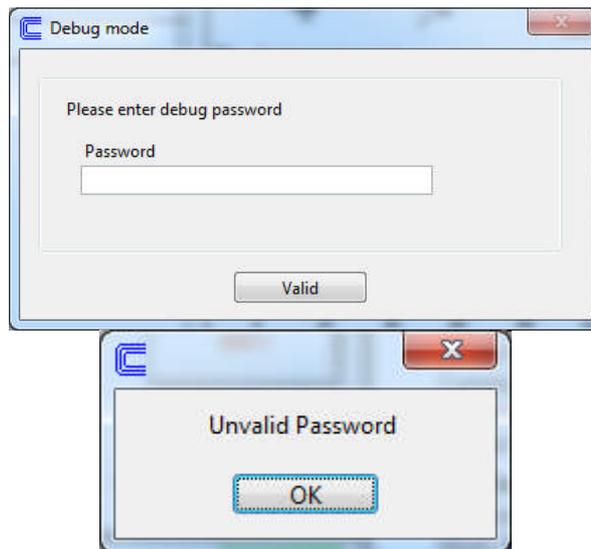
Figure 19 Mobile actuator configuration (fixed clamp) on MRI compatible test bench

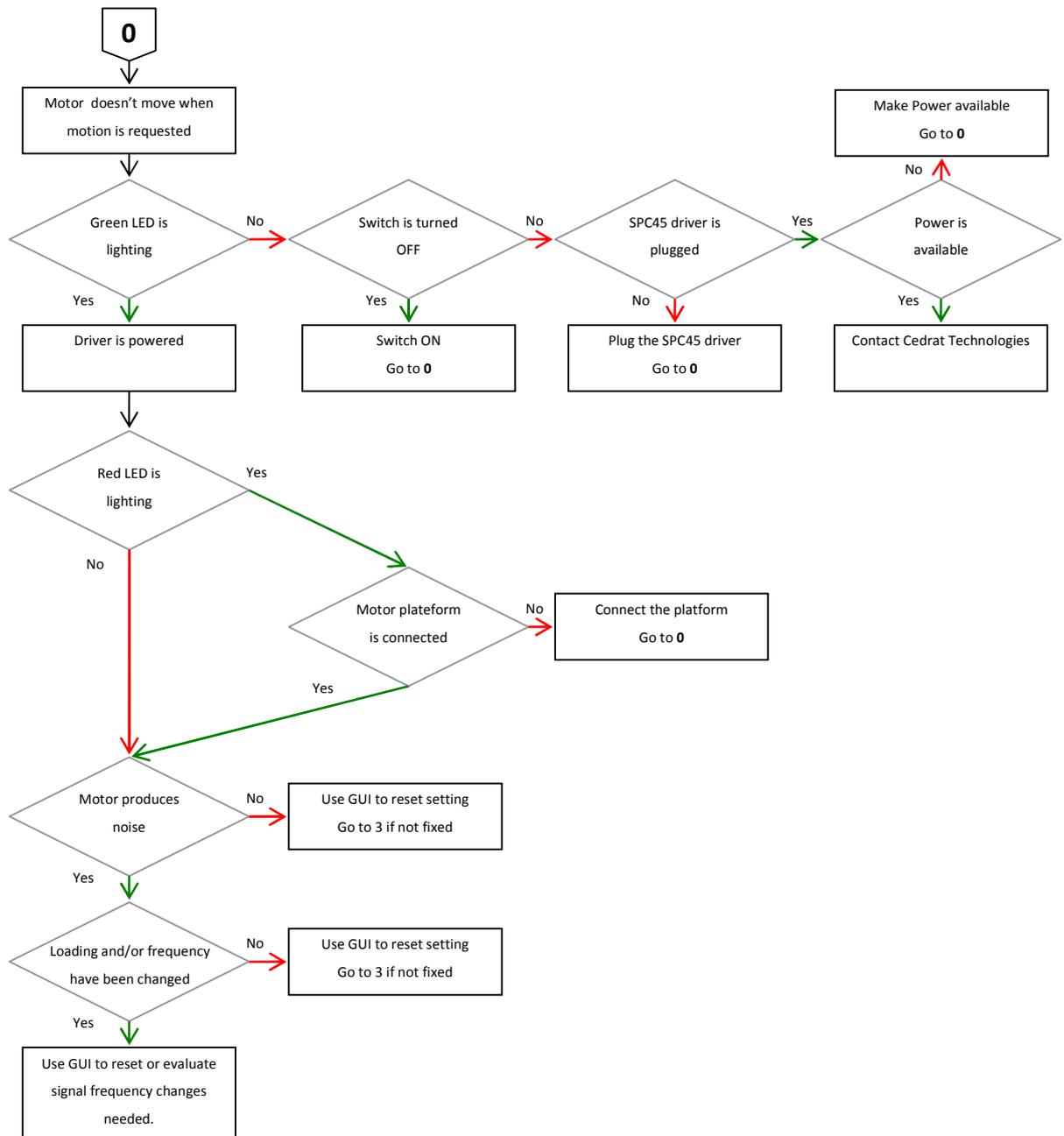
8. TROUBLE SHOOTING FORM

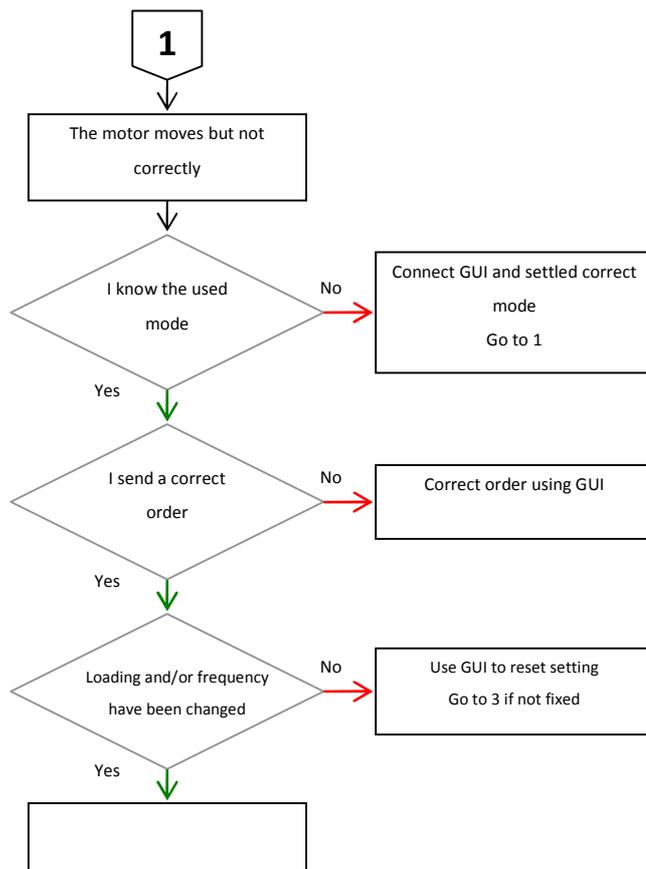
Error diagnostic may be helped using the following graphs. Please identify your problem and refer to associated protocol.

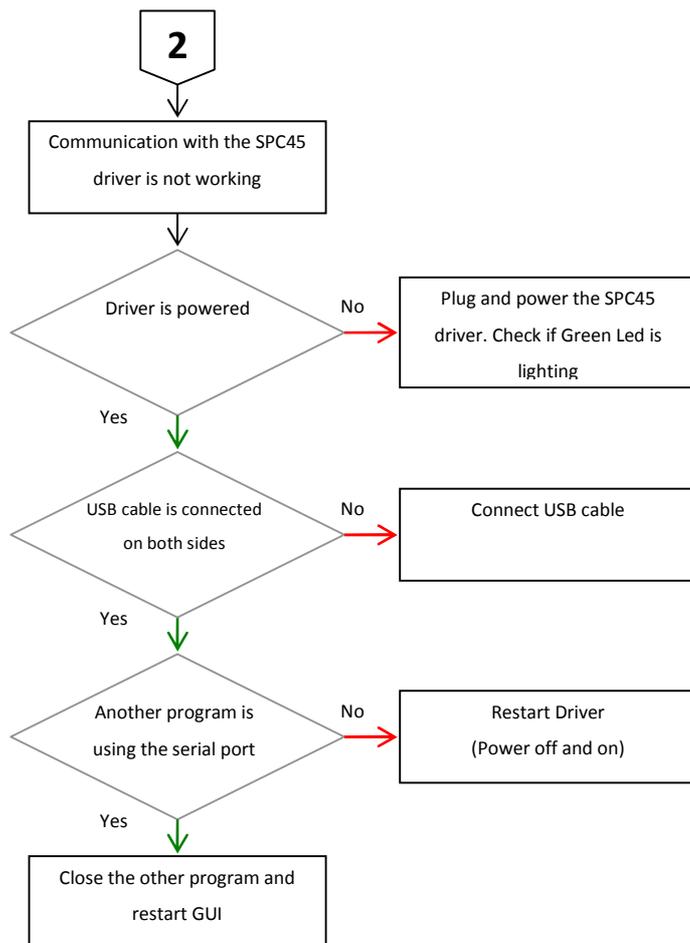
Problem	Protocol
The motor doesn't move when motion is requested	0
The motor moves but not correctly	1
Communication with the SPC45 driver is not working	2
My problem is not fixed	3

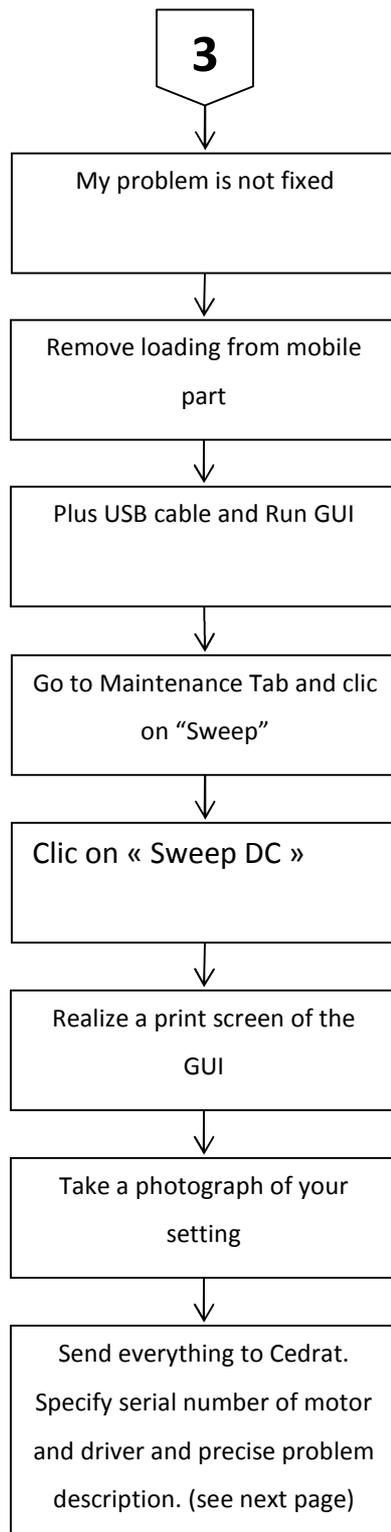
For advanced debugging, Maintenance Tab includes information about motor. This Tab is locked by a password. Please contact Cedrat Technologies if you meet problems and want to unlock this Tab.











If you don't find the solution to your problem using the proposed trouble shooting form, please contact your vendor with the following information:

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

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

Problem description: Please describe here the problems

9. WARRANTY CONDITIONS AND EXCEPTIONS

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

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

In addition, this warranty will not apply if the LSPA30uXS DevKit or SPC45 Driver are subjected to any of the following:

improper handling, including, but not limited to, shocks and abrasions
improper installation, including, but not limited to, excessive mechanical forces and moments, failure to use the standard electrical and mechanical interfaces
excessive voltage, including, but not limited to, peak values outside the recommended operating range, DC values applied for excessive time periods
inappropriate environmental conditions, including, but not limited to, high temperatures or high humidity

10. INSPECTION UPON RECEIPT

This product has been inspected and shown to operate correctly at the time of shipment.

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.

