Controller & Connection Manual

Xeryon drivers for ultrasonic stages

Revision 2.6 dd. 5/10/2021

Content

1. Introduction

Xeryon provides 5 types of controllers, all discussed in this manual. Where needed specifications are given per controller.

- The XD-A is a very small controller with housing (XD-A) or without (XD-A PCB), that can drive a single XLA.
- The XD-C is our most compact controller. It fits in the palm of your hand and can drive a single axis stage. This one comes in two versions, with housing (XD-C), or without (XD-C PCB) for a more compact OEM solution.
- The XD-M is the more advanced controller. It is available in a single-axis version (XD-M-1), but has the possibility to be daisy chained to create multi-axis systems with up to 6 stages (XD-M-2 → XD-M-6).
- The XD-19 is the rack mounted version of our most versatile controller specifically developed to fit in 19-inch server racks. Up to 12 stages can be connected and steered in this 2U high controller.
- The integrated controller is a controller that's specifically made for driving our XLA stages in open-loop mode. The controller is integrated into the XLA itself and therefore it makes the XLA open loop version very compact.

All of our controllers come with a user-friendly Windows interface and LabVIEW driver. More information on integrable software can be found on our website.

2. Controller overview

All drivers are delivered with a power adapter, USB cable and USB-stick with software to control the piezo stage(s).

1. XD-A & XD-A PCB: Compact driver for XLA

The XD-A controller is a compact controller PCB, especially made for the closed-loop version of the XLA micro-actuator. It has USB connectivity and closed loop control. Some of the analog and digital I/O is programmable.

Specifications:

Size:	50 x 50 x 30 mm
Power supply:	48 VDC
Output signal:	45 V (0 – 200 kHz)
Axis:	1
Control:	Open and closed loop
Communication:	USB-C 2.0, Digital IO, Analog IO, I2C, UART Rx, UART Tx
Motor/stage connector:	ZIF connector

2. XD-C & XD-C PCB: Compact driver for ultrasonic stages

The XD-C provides a complete solution for controlling Xeryon's ultrasonic stages. The controller reads the integrated encoder, generates and amplifies the driving signals and communicates with a host controller or PC through a simple ASCII protocol. The driver comes with a user-friendly Windows interface and LabVIEW driver to steer the stage in open and closed loop. Steering parameters can be tuned digitally via the user interface.

Specifications:

Size:	XD-C: 80 x 54 x 23 mm XD-C PCB: 50 x 50 x 30 mm
Power supply:	48 VDC
Output signal:	45 V (0 – 200 kHz)
Axis:	1
Control:	Open and closed loop
Communication:	XD-C: USB-C 2.0, RS232 on PCB XD-C PCB: USB-C 2.0, Digital IO, Analog IO, I2C, UART Rx, UART Tx
Stage connector:	Dsub 15 HD (female)

3. XD-M: Multi-axis driver for ultrasonic stages

The XD-M is a high-end plug and play piezo controller designed to control up to six ultrasonic piezo stages. The controller reads the integrated encoder of the piezo stage, generates and amplifies the driving signals and communicates with a host controller or PC through a simple ASCII protocol.

Specifications:

Size:	160 x 165 x 53 mm
Power supply:	48 VDC
Output signal:	45 V (0 – 200 kHz)
Axis:	Up to 6
Control:	Open and closed loop
Communication:	USB-B 2.0, RS232, Digital IO, Analog IO, RS422 (optional)
Stage connectors:	Dsub 15 HD (female)

4. XD-19: Multi-axis rack-mountable driver for ultrasonic stages

The XD-19 is a high-end plug and play piezo controller designed to control up to twelve ultrasonic piezo stages or actuators. The controller reads the integrated encoder of the piezo stage, generates and amplifies the driving signals and communicates with a host controller or PC through a simple ASCII protocol.

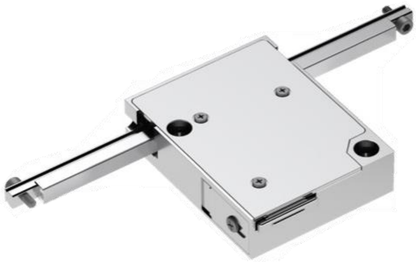
 

Specifications:

Size:	Height: 2U, depth: 221 mm
Power supply range:	100 – 240 VAC, 47 – 63 Hz
Output signal:	45 V (0 – 200 kHz)
Channels:	Up to 12
Control:	Open and closed loop
Communication:	USB-B, RS232, Digital IO, Analog IO, RS422 (optional)
Stage connectors:	Dsub 15 HD (female)

5. Integrated controller: Compact driver for XLA

The integrated controller is a very compact controller that's integrated into the stage. It is especially made for some versions of the XLA micro-actuator. It is very versatile since it can connect over USB-C, UART or a combination of analog and digital pins.



Specifications:

Size:	37 x 29 x 7 mm
Power supply:	12 VDC
Axis:	1
Control:	Open loop
Communication:	USB-C 2.0, Digital IO, Analog IO, UART Rx, UART Tx All available from the ZIF connector

3. Connections on the housing

On the different drivers, following in- and outputs can be found on the housing:

XD-A	
Actuator connector	ZIF-connector Contains the piezo and encoder signals for the XLA-series.
USB-C 2.0	This port is used for communication with the host controller or PC.
Screw-terminal	48 VDC
D-sub 15 HD	Placeholder for custom projects

XD-C PCB	
USB-C 2.0	This port is used for communication with the host controller or PC.
Screw-terminal	48 VDC
Stage connector	D-sub 15 HD (female) Contains the piezo and encoder signals for the XD-C series

XD-C	
Front panel	
USB-C 2.0	This port is used for communication with the host controller or PC.
Back panel	
Power plug	48 VDC
Stage connector	D-sub 15 HD (female) Contains the piezo and encoder signals for the XD-C series

XD-M	
Front panel XD-M-1 to XD-M-3	
No IO	
Front panel XD-M-4 to XD-M-6	
3 stage connectors	Dsub HD 15 (female) Contains power supply for the encoder, encoder signals and piezo signals.
Digital IO	Dsub HD 25 (female)
Back panel	
Power supply	DC Power jack, 48 VDC
Multiple stage connectors	Dsub HD 15 (female) Contains power supply for the encoder, encoder signals and piezo signals.
Virtual COM-port	USB-C 2.0
RS232	Dsub 9 (female)
Digital IO	Dsub HD 25 (female) for each pair of 3 stages
Analog IO	Dsub HD 15 (female) for each pair of 6 stages

XD-19	
Front panel	
No IO	
Back panel	
Power supply	100 – 240 VAC, 47 – 63 Hz
multiple stage connectors	Dsub HD 15 (female) Contains power supply for the encoder, encoder signals and piezo signals.
Virtual COM-port	USB-B
Digital IO	Dsub HD 25 (female) for each pair of 3 stages
Analog IO	Dsub HD 15 (female) for each pair of 6 stages

The piezo drive signals have an amplitude of 45 Vpp and a frequency range between 0 and 300 kHz, sufficient to drive Xeryon's ultrasonic linear and rotary stages.

- Pin layout of the stage connector (D-sub 15 HD female)

PIN #	SIGNAL	PIN #	SIGNAL
1	/	9	Encoder error
2	Encoder power (5V)	10	Piezo phase 3
3	Encoder ground	11	I - *
4	Piezo phase 2	12	A - *
5	Piezo phase 1	13	B - *
6	Index	14	/
7	A +	15	Piezo phase 4
8	B +	Shell	shield

- Analog IO

PIN #	SIGNAL	PIN #	SIGNAL
1	Analog input 1 stage 1	9	Analog input 2 stage 1
2	Analog input 1 stage 2	10	Analog input 2 stage 2
3	Analog input 1 stage 3	11	Analog input 2 stage 3
4	Analog input 1 stage 4	12	Analog input 2 stage 4
5	Analog input 1 stage 5	13	Analog input 2 stage 5
6	Analog input 1 stage 6	14	Analog input 2 stage 6
7	GND	15	5 V out
8	3,3 V out		

- Digital IO

PIN #	SIGNAL	PIN #	SIGNAL
1	Digital input 1 stage 1	14	Digital output 1 stage 1
2	Digital input 2 stage 1	15	Digital output 2 stage 1
3	Digital input 3 stage 1	16	Digital output 3 stage 1
4	GND	17	
5	Digital input 1 stage 2	18	Digital output 1 stage 2
6	Digital input 2 stage 2	19	Digital output 2 stage 2
7	Digital input 3 stage 2	20	Digital output 3 stage 2
8	GND	21	
9	Digital input 1 stage 3	22	Digital output 1 stage 3
10	Digital input 2 stage 3	23	Digital output 2 stage 3
11	Digital input 3 stage 3	24	Digital output 3 stage 3
12	GND	25	5 V out
13	3,3 V out		

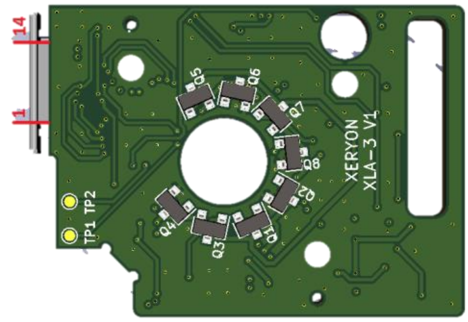
* The encoder in the XRT-U-XX-109 rotary stage is single ended and has thus no I - / A - / B – signal.

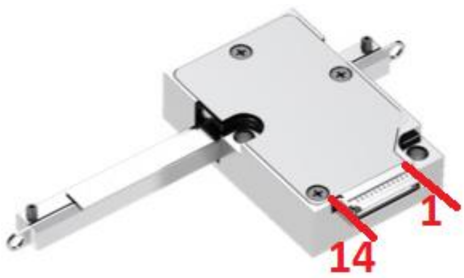
Different as well as single-ended encoder signals can be used with the XD-C → This is being taken care of by the driver.

Piezo 3 and piezo 4: connected to ground for XLS-1m CRTU-30m XRTU-40, and XRT-A-25.

Integrated controller for XLA	
Connector	ZIF-connector

The pinout for the ZIF-connector is shown below. We also have a breakout board available. This way you can plug-and-play with our XLA integrated controller. On our breakout board a USB-C connector is available, together with UART Rx and Tx. Also the digital and analog IO pins are accessible from that PCB.





Pin	Symbol	Function	In/Out	Pin	Symbol	Function	In/Out
1	+12V	+12V	In	2	+12V	+12V	In
3	DIR	Digital IO: Direction	In	4	SPE	Analog IO/PWM: Speed	In
5	LIM-	Digital IO: Left limit	Out	6	LIM+	Digital IO: Right limit	Out
7	Tx	UART Tx*	Out	4	Rx	UART Rx*	In
9	SWDIO			10	SWCLK		
11	GND		In	12	D-	USB negative data signal	In/Out
13	D+	USB positive data signal	In/Out	14	GND		In

*Rx and Tx work on 3.3V. If you want to connect with RS232, higher voltages are needed. In this case a voltage convertor (buffer) should be added.

Warning: Do not open the driver. In case of a damaged connector or cable, please contact Xeryon for repair or replacement.

4. Connections on the PCB

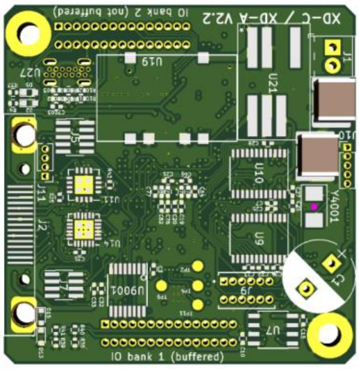
1. XD-A and XD-C controller PCB

Important: The XD-C and XD-A controller look identical, but they have different electronic components. The XD-A connects with the ZIF connector to the XLA micro-actuator. The XD-C connects with the D-Sub 15 connector to the Xeryon stages. The XD-C controller should never be connected to an XLA (micro-actuator) and the XD-A controller should never be connected to the XLS, XRT (stage). This can damage the controllers and the stages.

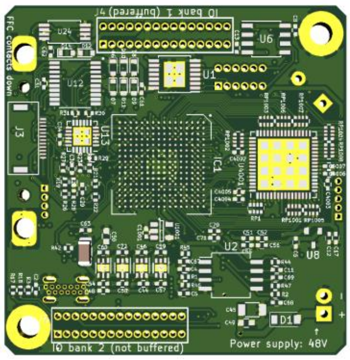
Summarized: The ZIF connector on the XD-C should not be used. The D-Sub connector on the XD-A should not be used.

All connections on the PCB can be connected to the controller housing with a dedicated connector on request by the costumer.

Top and bottom view (XD-C and XD-A)

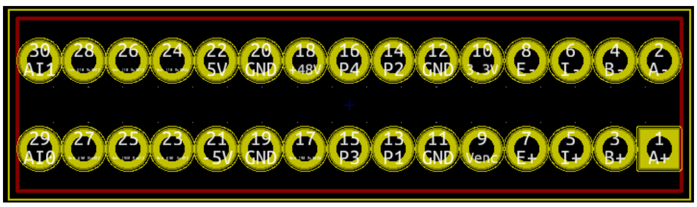


Top



Bottom

IO bank 1, buffered (XD-C and XD-A)

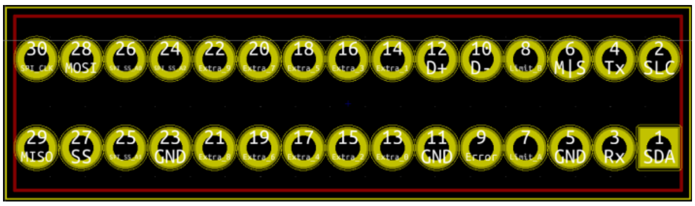


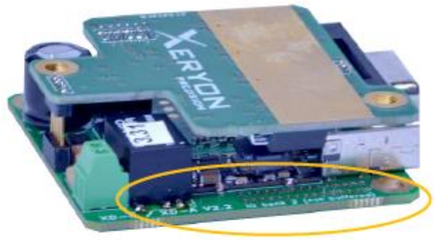
Pin	Symbol	Function	In/Out	Pin	Symbol	Function	In/Out
1	A+	Positive encoder signal A	In	2	A-	Negative encoder signal A	In
3	B+	Positive encoder signal B	In	4	B-	Negative encoder signal B	In
5	I+	Positive encoder index	In	6	I-	Negative encoder index	In
7	E+	Positive encoder error	In	8	E-	Negative encoder error	In
9	Venc	Encoder supply out	Out	10	3.3 V	3.3 V out	Out
11	GND	Ground	In	12	GND	Ground	In
13	P1	Piezo phase 1	Out	14	P2	Piezo phase 2	Out

15	P3	Piezo phase 3	Out	16	P4	Piezo phase 4	Out
17	-	Not connected	-	18	48 V	Power supply	In
19	GND	Ground	In	20	GND	Ground	In
21	-5 V	-5 V out	Out	22	5 V	5 V out	Out
23	DI0	Pulse / A / PWM*	In	24	DO0	Digital output 0	Out
25	DI1	Direction / forward / B*	In	26	DO1	Digital output 1	Out
27	DI2	Enable / backward*	In	28	DO2	Digital output 2	Out
29	AI0	Analog speed input*	In	30	AI1	Find index*	In

* for more details about these pins, see section 10: GPIO. Digital signals are 3.3 V logic and analog inputs are max 10 V.

IO bank 2, not buffered (XD-C and XD-A)





Pin	Symbol	Function	In/Out	Pin	Symbol	Function	In/Out
1	SDA	I2C data	In/Out	2	SLC	I2C clock	In/Out
3	Rx	UART Rx*	In	4	Tx	UART Tx*	Out
5	GND	Ground	In	6	M | S	Set as master or slave	In
7	Limit A	Passed position limit A	Out	8	Limit B	Passed position limit B	Out
9	Error	Error, fault	Out	10	D-	USB negative data signal	In/Out
11	GND		In	12	D+	USB positive data signal	In/Out
13	Extra 0		In	14	Extra 1		In
15	Extra 2		In	16	Extra 3		In
17	Extra 4		Out	18	Extra 5		Out
19	Extra 6	Index flag	Out	20	Extra 7	Motor on flag	Out
21	Extra 8	Position reached flag	Out	22	Extra 9	Index known flag	Out
23	GND	Ground	In	24	SPI A2	SPI slave address bit 2	Out
25	SPI A1	SPI slave address bit 1	Out	26	SPI A0	SPI slave address bit 0	Out
27	SPI SS	SPI slave select	In/Out	28	MOSI	SPI master out, slave in	In/Out
29	MISO	SPI master in, slave out	In/Out	30	SPI CLK	SPI clock	In/Out

*Rx and Tx work on 3.3V. If you want to connect with RS232, higher voltages are needed. In this case a voltage convertor (buffer) should be added.

5. Communication methods: an overview

A host computer or controller can communicate with the Xeryon controller via the USB configured as a virtual COM port, via RS232 (XD-M), via UART or using the digital and analog IO. For each type of method we have a specific section.

5.1. Communication over a virtual COM port, RS232 & UART

The baud rate is automatically detected by the driver and can be up to 115 200 baud. The protocol uses 8 data bits, 1 stop bit, no parity bit, no handshaking.

Format

A command line consists of maximum 16 characters followed by a 'new line' character (ASCII code 10). The command has the following fixed format:

X:DPOS=-12345678

- 1 character defining the axis, followed by a colon.
- 4 characters for the command.
- '=' sign separating the command from the corresponding value.
- Optional sign.
- Decimal value up to 8 decimal places (9 if the sign is omitted).
- Maximum total of 16 characters.

The characters have to be sent from left to right, in the example above starting with 'X' and ending with '8'. The command tags are in upper case. The instruction should be terminated with a 'new line' character (ASCII code 10). The driver processes the instruction immediately after receiving this 'new line' character.

Some instructions such as 'ZERO' and 'RSET' require no value. In that case, it is sufficient to send only the command itself, e.g. 'ZERO' followed by the 'new line' character.

Addressing axes on the XD-M or XD-19

To address an axis, put the axis name (1 letter followed by a colon) before the command. When no axis is specified, the command goes to the first axis (stage 1). In case of a single-axis system, no axis designation is required.

Standard axis names:

- XD-M: X Y Z A B C
- XD-19: A B C D E F G H I J K L

Multiple-axes system:

- Y:DPOS=-1000 → positioning of the Y-axis.
- X:RSET → resetting the X-axis.

Single-axis system:

- DPOS=-1000
- RSET

Value range

There are 9 characters reserved for the value including its sign. For signed values 8 decimal places are available, giving a range from -99 999 999 to +99 999 999. For positive numbers, the '+' sign can be omitted, increasing the positive range to 999 999 999. No spaces, commas or periods should be added to the numbers. Only integers are allowed.

- X:DPOS=-99999999
- X:DPOS=+99999999
- X:DPOS=999999999

Request a value

To request the value of a certain setting, put '=?' after the parameter for which you want to know the value, e.g. EPOS=? gives the controller a request for the encoder position. FREQ=? asks the controller for the current excitation frequency. In case of a multi-axes system put an axis tag in front of the command. e.g. X:STAT asks for the status word of axis X. This works best with INFO=0, otherwise the reply disappears in the constant flood of feedback data.

Units are as follows:

Type	Rotation stage	Translation stage	Resolution
Time, delays	ms		1 ms
Target position, step size	encoder units		1 encoder increment
Speed	deg/s (*)	µm/s	0.01 deg/s or 1 µm/s
Frequency	Hz		1 Hz

(*) Conversion factor of 100 required: e.g. enter SSPD=10000 for 100 deg/s.

Instruction set

"Controller commands" are commands that don't need to have a stage specified in front of it. "Stage commands" on the other hand are stage specific and the stage has to be specified. eg: INFO=0 and X:SSPD=1000

I. Driver configuration: stage selection (stage commands)			
Command	**Range**	**Mode**	**Explanation**
XRT1	 2, 3, 18, 19, 47, 49, 73, 109		Configure the driver for a XRTU-30 or XRTU-40 rotation stage. XRTU-40 with 3 µrad resolution: XRT1=2 XRTU-30 with 3 µrad resolution: XRT1=3 XRTU-40 with 19 µrad resolution: XRT1=18 XRTU-30 with 19 µrad resolution: XRT1=19 XRTU-40 with 49 µrad resolution: XRT1=47 XRTU-30 with 49 µrad resolution: XRT1=49 XRTU-40 with 73 µrad resolution: XRT1=73 XRTU-30 with 109 µrad resolution: XRT1=109
XRT3	 3, 19, 49, 73, 109		Configure the driver for a XRTU-60 rotation stage. XRTU-40 with 3 µrad resolution: XRT3=3 XRTU-30 with 19 µrad resolution: XRT3=19 XRTU-30 with 49 µrad resolution: XRT3=49 XRTU-40 with 73 µrad resolution: XRT3=73 XRTU-30 with 109 µrad resolution: XRT3=109
XRTA	109		Configure the driver for a XRTA rotation stage XRTA=109

XLS1	 1, 5, 78, 312, 1250		Configure the driver for a XLS-1 linear stage. XLS-1 with 1 nm resolution: XLS1=1 XLS-1 with 5 nm resolution: XLS1=5 XLS-1 with 78 nm resolution: XLS1=78 XLS-1 with 312 nm resolution: XLS1=312 XLS-1 with 1250 nm resolution: XLS1=1250
XLS3	 1, 5, 78, 312, 1250		Configure the driver for a XLS-3 linear stage. XLS-3 with 1 nm resolution: XLS3=1 XLS-3 with 5 nm resolution: XLS3=5 XLS-3 with 78 nm resolution: XLS3=78 XLS-3 with 312 nm resolution: XLS3=312 XLS-3 with 1250 nm resolution: XLS3=1250
XLA1	 78 312 1250		Configure the driver for a XLA1 linear stage. XLA1 with 78 nm resolution: XLA1 = 78 XLA1 with 312 nm resolution: XLA1 = 312 XLA1 with 1250 nm resolution: XLA1 = 1250
XLA3	 78 312 1250		Configure the driver for a XLA3 linear stage. XLA3 with 78 nm resolution: XLA3 = 78 XLA3 with 312 nm resolution: XLA3 = 312 XLA3 with 1250 nm resolution: XLA3 = 1250
II. Closed-loop motion (stage commands)			
Command	**Range**	**Mode**	**Explanation**
INDX	0, 1	Closed loop	Find the index. A value of 0 or 1 indicates the initial search direction. The controller sets off in the specified direction to search. When the stage reaches a mechanical limit (detected by position error > ELIM) it reverses the search direction. After finding the index, the stage is positioned at the index position. Some stages (e.g. XLS with 312 or 1250 nm resolution) have their physical index close to the end limits. For those stages a large encoder offset is used (ENCO), thus after finding the index location near the end limits, the stage is sent to the centre corresponding to the encoder offset.
HOME	-	Closed loop	Go to the home position. This equals DPOS=0
DPOS	26 bits	Closed loop	Set target position. Closed-loop control is used to reach and maintain the new position. The position is expressed in encoder units. Positive and negative values are allowed within the range of the stage.
STEP	26 bits	Closed loop	Move relative to the current position, over a specified distance. When already in closed loop, the current desired position is used as a reference. When before in open loop, the actual position (encoder value) is used as a reference. The command value specifies the step size in encoder increments. Positive values send the stage towards higher encoder values, negative values send the stage towards lower encoder values.

			Closed-loop control is used to reach and maintain the new position.
SCAN	-1,0,1	Closed loop	Continuously move with fixed speed. The speed is maintained by closed-loop control. A positive number sends the stage towards increasing encoder values, a negative number sends the stage towards decreasing encoder values. A zero value stops the stage.
SSPD	24 bits	Closed loop	Set speed. Used as scanning speed (SCAN command) and as target speed towards the next target position (DPOS and STEP). Unit is 1 µm/s or 0.01 deg/s. Default: 10000 (10 mm/s or 100 deg/s).
ACCE	16 bits	Closed loop	Set acceleration for speed profile. Expressed in m/s2. Default value: 10000
DECE	0-255	Closed loop	Set deceleration for speed profile, when approaching target position. Default value: 255
LLIM	26 bits	Open and closed loop	Set low-side soft end stop. Expressed in encoder units.
HLIM	26 bits	Open and closed loop	Set high-side soft end stop. Expressed in encoder units.
III. Open-loop motion (stage commands)			
Command	**Range**	**Mode**	**Explanation**
MOVE	-1,0,1	Open loop	Continuously move in open loop. Phase and amplitude influence the speed, but speed is not controlled. A positive number sends the stage towards increasing encoder values, a negative number sends the stage towards decreasing encoder values. A zero value stops the stage.
PHAS	16 bits	Open loop	Set the phase offset between the excitation signals. Can be used to control the speed in open loop. Input values 0-65535 correspond to a phase shift of 0-360°. Around 16384 the phase corresponds with a MOVE=1 direction, around 49152 (=-16384) it corresponds to a MOVE=-1 direction.
AMPL	16 bits	Open loop	Set amplitude for open-loop piezo excitation signals.
IV. Open- and closed-loop motion (controller commands)			
Command	**Range**	**Mode**	**Explanation**
STOP	-	Open and closed loop	Stop the stage.
CONT	-	Open and closed loop	Continue movement after a stop command.
V. Control and tuning parameters (stage commands)			
Command	**Range**	**Mode**	**Explanation**
FREQ	24 bits	Closed loop	Set the frequency of the excitation signals for zone 1. Unit is Hz. Default: 170000 (Hz).
FRQ2	24 bits	Open and closed loop	Set the frequency of the excitation signals for zone 2. Unit is Hz. Also used for scanning. Default: 170000 (Hz).

LFRQ	24 bits	Open and closed loop	Set the minimum piezo excitation frequency. Unit is Hz. Used as the lower boundary for finding the optimal frequency. Default: 165 kHz.
HFRQ	24 bits	Open and closed loop	Set the maximum piezo excitation frequency. Unit is Hz. Used as the upper boundary for finding the optimal frequency. Default: 175 kHz.
PROP	16 bits	Closed loop	Proportional control factor for zone 1. Default: 100.
PRO2	16 bits	Closed loop	Proportional control factor for zone 2. Default: 100.
ZON1	26 bits	Closed loop	Width of zone 1: +/- value around target position. Expressed in encoder units. Default: 100.
ZON2	26 bits	Closed loop	Width of zone 2: +/- value around target position. Expressed in encoder units. Default: 1000.
CFRQ	16 bits	Closed loop	Control frequency. Adapt this value to obtain stable closed-loop control. The optimal control frequency depends on the mass or inertia of the load. Default: 30000 (30 000 Hz) for zero load.
DUCO	1 bit	Closed loop	Amplitude is used in closed loop if set to 1. If set to 0, a fixed amplitude of 50% is used. Default: 1.
ELIM	20 bits	Closed loop	Limit on the position error used in closed-loop control. Expressed in encoder units. Default: 10000.
PTOL	16 bits	Closed loop	Position tolerance. When the stage is within +/- position tolerance of the desired position, the control is switched off and the 'position reached' flag is raised. Values are expressed in encoder units and should be in the range 0 – 65535. The range is applied symmetrically with respect to positive and negative position errors. e.g. PTOL=2 allows position errors between -2 and +2 encoder units. Default: 2. See also TOUT and PTO2.
PTO2	16 bits	Closed loop	Second position tolerance, similar to PTOL. Comes into action if first position tolerance PTOL fails within a timeout time TOUT. The default value is 10.
TOUT	16 bits	Closed loop	Set timeout time. To avoid that the stage keeps vibrating indefinitely around the desired position without 'landing', a timeout time can be set. The timer starts when the stage is near the desired position, within a distance of +/- PTO2. After passing the timeout time, PTO2 becomes the new position tolerance. The time is expressed in milliseconds. The default value is 50 (50 ms). Also check PTOL and PTO2.
VI. Signal shape and conditioning (stage commands)			
Command	**Range**	**Mode**	**Explanation**
ENBL	0-3	-	For XRTA only. Enable amplifiers. Bit 0 is for piezo signal 1, bit 1 for piezo signal 2. ENBL=3 enables both amplifiers, ENBL=0 disables both amplifiers. ENBL=1 enables only amplifier 1, ENBL=2 enables only amplifier 2.

COMP	12 bits	-	For XRTA only. Percentage of active error compensation. COMP=0 disables active error compensation. COMP=100 applies 100 % compensation, as set by the compensation values stored in memory. For other percentage values, the compensation is scaled accordingly. Maximum value: 4095.
ZERO	-	Open & closed loop	Force the piezo signals to zero volt.
MAMP	16 bits	Open and closed loop	Set maximum amplitude. The piezo excitation signals are limited to the corresponding voltages. MAMP=65535 sets them to the maximum voltage of 45 V. MAMP=36400 sets the maximum to 25 V. The relation is linear.
MIMP	16 bits	Closed loop	Set minimum amplitude for the piezo excitation signals. See MAMP for values.
PHAC	16 bit	Open & closed loop	Phase correction. Corrects an imbalance in the motor. Such imbalance may cause a rattling or scratching noise when the stage moves at low speed. Practical values are in the range of a few 1000, positive or negative. Default: 0 (no correction)
OFSA	12 bits	-	Offset on the piezo signals on piezo phase 1. OFSA=4095 corresponds to full scale (45 V), OFSA=0 produces no offset. The relation is linear.
OFSB	12 bits	-	Similar to OFSB, but for piezo phase 2.
FILP	8 bits	Open and closed loop	Filter speed for phase of piezo excitation signals. Default value: 1. Max. value: 255.
FILA	8 bits	Open and closed loop	Filter speed for amplitude of piezo excitation signals. Default value: 1. Max. value: 255.

VII. Directional settings (stage commands)			
Command	**Range**	**Mode**	**Explanation**
ENCD	1 bit	Open and closed loop	Set the encoder direction. Set the counting direction with respect to the A/B signals or sin/cos signals of the encoder. Flip this bit to swap left and right, or clockwise and counter-clockwise. Default value is 0.
ENCO	32 bits	Open and closed loop	Sets the encoder offset: distance between the index position and the desired zero position. In encoder units. Default value is 0.
ACTD	1 bit	Open and closed loop	Set the actuation direction. If not set correctly, the stage will move away from the desired position. Default value is 0.
PATH	1 bit	Closed loop	For rotation stages only. Selects whether the stage will follow the shortest path (PATH=1) to the target position or follow a linear approach, respecting high to low or low to high (PATH=0). Default: 1 for rotation stages, 0 for linear stages

VIII. Trigger outputs (stage commands)			
Command	**Range**	**Mode**	**Explanation**
TRGS	26 bits	Closed loop	Start of the trigger pulses, expressed in encoder units
TRGW	26 bits	Closed loop	Width of the trigger pulses, expressed in encoder units
TRGP	26 bits	Closed loop	Pitch of the trigger pulses, expressed in encoder units
TRGN	26 bits	Closed loop	Number of trigger pulses

IX. Communication (controller commands)			
Command	**Range**	**Mode**	**Explanation**
INFO	4 bits	-	Select type of info to be transmitted from the driver to the master (PC). 0: Stop broadcasting info automatically 1: SRNO, SOFT, STAGE, STAT, SYNC 2: SRNO, SOFT, STAGE, STAT, FREQ, OFRQ, SYNC, EPOS, DPOS, TIME 3: EPOS, DPOS, STAT 4: EPOS, STAT, DPOS, TIME 5: STAT, FREQ, OFRQ, EPOS, DPOS, TIME 6: FREQ, OFRQ, CURR 7: EPOS, STAT Default: 2 e.g. INFO=7 will alternatingly send EPOS & STAT values.
UART	0, 2400, 4800, 9600, 14400, 19200, 28800 38400, 57600, 76800, 115200	-	Set UART baud rate. To switch UART off: UART=0. To set the baud rate to 9600: UART=9600 The maximum baud rate is 155200. When UART is off, the UART can only be restarted by sending the UART command via USB.
POLI	1-65535	-	Set polling interval. Specifies the time between data updates. The interval is expressed in milliseconds. The default value is 97 (97 ms).
DLAY	16 bit	Closed loop	Sets the delay between the moment the stage reaches its target position and the moment the ‘position reached’ flag is raised. Expressed in milliseconds. Default: 100 (100 ms).
X. Manage settings (controller commands)			
Command	**Range**	**Mode**	**Explanation**
RSET	-	-	Reset the driver. All piezo signals go to zero and settings are reset to their saved value.
LOAD	-	-	Load settings from memory
SAVE	-	-	Save settings to memory
FACT	-	-	Reset to factory settings
GPIO	0-13	-	Select the preferred input mode using the GPIO command. For more details see the next section.
XI. Test (controller commands)			
Command	**Range**	**Mode**	**Explanation**
TEST	0-1	-	Test LED indicators (XD-M and XD-19). TEST=1 switches all indicators on. TEST=0 brings them back to their function.
XII. Integrated controller (for XLA open loop) specific commands			
Command	**Range**	**Mode**	**Explanation**

VOLT	16 bits	Open loop	Set the desired voltage level expressed in mV. Default value: 48000
DICF	1 bit	Open loop	Select a way to change direction. A value of "0" means that the direction can be controlled using the "MOVE" command (default). A value of "1" means that the direction can be controlled using the "DIR" pin.
SPCF	2 bits	Open loop	Select a way to control the speed. A value of "0" means that the speed can be controlled using the "SSPD" command (default). A value of "1" means that the speed can be controlled using a PWM signal on the "SPD" pin. A value of "2" means that the speed can be controlled using an analog signal on the "SPD" pin.

Info sent back from the controller

Information is sent back from the Xeryon controller to the master (PC) in ASCII format. The format is as follows:

1. One character identifying the axis, followed by a colon. This only applies to multiple-axes systems. For a single-axis system the axis identification is omitted.
2. Tag: Four characters describing the type of information
3. '=' sign separating the command from the corresponding value
4. Signed value associated with that information (sign + 8 decimal places). The message is terminated with a 'new line' character (ASCII code 10).

e.g. X:EPOS=+12345678

Different types of information:

For multiple-axis systems this information is being sent for every axis. First all data for axis 1, then all data for axis 2, … .

Tag	Explanation
SRNO	Serial number of the driver (hardware)
SOFT	Software version installed on the driver. e.g. 20103 → 2.1.3
[STAGE]	Type of stage (XLS1, XLS3, XRT1, XRT3, XLA1, XLA3, XRTA and its resolution e.g. XLS1=312
STAT	Status (see below)
FREQ	Excitation frequency currently in use
OFRQ	Optimal frequency as determined by FFRQ
CURR	Current consumed by the piezomotor
SYNC	Fixed value "12345678". Can be used for debugging communication issues.
EPOS	Encoder position
DPOS	Desired position
TIME	Time stamp: resolution 0,1 ms

The command INFO determines which information is sent back.

The Status Word contains 24 bits:

Status bit	Name	Explanation
0	Amplifiers enabled	XRTA only: Amplifiers for phase 1 and 2 enabled
1	End stop	Stage stopped by end stop
2	Thermal protection 1	Amplifier for phase 1 or 3 in thermal protection.
3	Thermal protection 2	Amplifier for phase 2 or 4 in thermal protection.
4	Force zero	Motor signals are currently forced to zero.
5	Motor on	The piezo motor is on.
6	Closed loop	The stage is currently in closed loop control.
7	Encoder index	Indicates whether the stage is positioned exactly at the encoder index.
8	Encoder valid	Indicates whether the encoder index has been passed and therefore the encoder value reflects the absolute position, not the relative position with respect to the startup position.
9	Searching index	Indicates whether the stage is currently searching the index position.
10	Position reached	Indicates whether the target position is reached (within tolerance limits).
11	Error compensation	Error compensation is on.
12	Encoder error	Indicates an error produced by the encoder.
13	Scanning	Indicates whether the stage is in a scanning mode.
14	Left end stop	Indicates that the left end stop is passed.
15	Right end stop	Indicates that the right end stop is passed.
16	Error limit	Indicates that the position error has reached the limit set by ELIM. This can indicate a collision or mechanical limit (end of stroke).
17	Searching optimal frequency	The driver is searching for the optimal excitation frequency of the piezo motor.
18-23	-	Not used

5.2. Communication using digital and analog IO

There are 4 different configurations for the use of the digital and analog IO pins. The first method is to control the position of the stage using pulses. Each pulse does a step (size) in a certain direction. The second method controls the position of the stage using an encoder-like signal. The two last methods control the speed of the stage. One option is to control the speed via an PWM input signal. The other method is using an analog input.

All of these methods are described more in detail below. To select the method you want, you have to use the “GPIO” command. This command can be send over USB or UART, like in section 5.1. s

The table below shows the specific command in order to enable a specific mode of control.

Command	Explanation
GPIO=0	Control via IO pins switched off. The controller will only react to text commands sent through USB or UART.
GPIO=2	Pulse and direction mode, with direction & enable pins.
GPIO=3	Pulse and direction mode, with forward & backward pins.
GPIO=4	A quad B input mode
GPIO=8	PWM control, with direction & enable pins.
GPIO=9	PWM control, with forward & backward pins.
GPIO=12	Analog control, with direction & enable pins.
GPIO=13	Analog control, with forward & backward pins.

The GPIO settings can be stored in memory using the SAVE command. That way, the GPIO mode will become active at powerup without having to first send the GPIO command via USB or UART.

The GPIO input and commands can be used together: the controller will react to both GPIO inputs and text commands. You don't have to go back to GPIO=0 to send text commands. You can send text commands also in the GPIO=2, 3, 4, … modes. But when going from GPIO input to text commands, first send a STOP command.

Pulse and direction mode

This mode is activated by the command GPIO=2 or 3.
GPIO=2 enables the input signals: pulse, direction, enable, index.
GPIO=3 enables the input signals: pulse, forward, backward, index

On each positive edge of the PULSE signal, the target position is incremented or decremented with a particular step size. The default step size is 1 (1 encoder unit). This step size can be changed with the command STPS, e.g. STPS=10.

The DIRECTION signal determines the direction: incrementing or decrementing the target position. The ENABLE signal enables the input, it has to be high in order to start moving.

An alternative to the DIRECTION and ENABLE signal is the FORWARD and BACKWARD signal. By setting one of them high, it's possible to select the direction of moving.

The INDEX signal is an analog input used as digital input. When going high (positive edge) the controller searches the index (3.3 V is sufficient, max. 10 V).

A quad B input

This mode is activated by the command GPIO=4
Input signals: A, B, enable, index
Encoder-like A quad B signal used as input to adapt the target position.

PWM control

This mode is activated by the command GPIO=8 or 9
GPIO=8 enables the input signals: PWM, direction, enable, index
GPIO=9 enables the input signals: PWM, forward, backward, index
The frequency of the PWM signal can be set by the command PWMF. PWMF=1000 sets the PWM frequency to 1000 Hz.

The speed is proportional to the pulse width. When the pulse width is 50 %, speed is set to 50 % of the speed set by the SSPD command. When the signal is all the time high, then 100 % of SSPD is selected. Speed can be controlled from 0 to 100 %.

The use of the direction, enable, forward and backward signals is the same as in pulse and direction mode.

Analog controls

This mode is activated by the command GPIO=12 or 13
GPIO=12 enables the input signals: speed, direction, enable, index
GPIO=13 enables the input signals: speed, forward, backward, index

The speed input is proportional to the voltage applied to the speed input pin. 10 V corresponds to 100 % of the speed set by the SSPD command.

The use of the direction, enable, forward and backward signals is the same as in pulse and direction mode.

6. Explanation of the control parameters

Xeryon's stages are primarily intended for closed-loop control and for this reason already have a position sensor integrated.

Control parameters have to be set according to the type of stage, load and customer-specific motion requirement. These parameters are pre-set by Xeryon upon delivery of the stage and controller. Nevertheless, it may be required that the user modifies these parameters when conditions change. More on this in "Tune your control parameters".

The most important control parameters are: excitation frequency (FREQ), proportional factor (PROP), control frequency (CFRQ) and positioning tolerance (PTOL).

The first parameter to set is the excitation frequency. This should correspond to the resonant frequency of the piezomotor driving the stage. Resonant frequencies differ slightly among piezomotors and therefore this parameter is tuned for each individual stage. Values close to the resonant frequency generate the highest force and speed, but setting it a few kHz above the resonant frequency often leads to a more relaxed control with better 'landing' characteristics. By using different frequencies for scanning and fine-positioning, the piezomotor can be tuned to work optimally in different scanning and positioning conditions.

It is not recommended to reduce the excitation frequency far below the pre-set frequency. This may lead to unstable scanning and positioning behaviour.

The proportional control factors are a second set of parameters that are used to tune the stage for a specific situation. Higher proportional factors let the controller react stronger and reduce positioning errors, but can also lead to instability or noisy operation when chosen too high. Lower proportional factors, on the other hand, will results in a more sluggish motion response with more overshoot.

The control frequency is important when the load on the stage (mass) is significantly increased. More information for each of these parameters is given in the instruction set (See "Tune your control parameters").

To optimise closed-loop control for both speed and accuracy, two zones are defined each with a different excitation frequency and proportional factor for both scanning and fine-positioning applications. The zones are defined symmetrically around the target position, with zone 1 being the area closest to the target and zone 2 the widest. The zones are set with the commands ZON1 and ZON2. Corresponding to these zones, there are also 2 excitation frequencies and 2 proportional factors. In between the zones the values for excitation frequency and proportional factor are interpolated:

- Positioning error < ZON1: FREQ & PROP
- Positioning error > ZON2: FRQ2 & PRO2
- ZON1 < positioning error < ZON2: interpolated values

	Zone 1 (close to target)	**Zone 2 (far from target)**
Set zone width	ZON1	ZON2
Set excitation frequency	FREQ	FRQ2
Set proportional factor	PROP	PRO2

Typically, in zone 1 (closest to the target position), the excitation frequency and proportional factor are both chosen higher. This gives a better ‘landing’ on the target position. For zone 2 (further away from the target position) the excitation frequency is chosen lower to increase speed. At the same time the proportional factor for zone 2 typically has to be chosen lower to avoid instability. Be aware that outside a certain frequency range, the motor will have very limited force (frequency too high) or feature unstable behaviour (frequency too low). A typical frequency difference between FREQ and FRQ2 is between 1 and 3 kHz for an XSU-1 motor and between 0.5 and 2 kHz for an XSU-3 motor. The proportional factors in zone 1 (PROP) are typically 2-3 times the value of the proportional factors in zone 2.

When the stage does not want to land on the target position, despite optimising frequency and proportional factor for zone 1, try to increase the positioning tolerances PTOL and PTO2. See the instruction set for more information.

During scanning motion, the controller only uses the parameters of zone 2 (FRQ2 and PRO2).

Homing procedures

All closed-loop stages contain a position encoder, also called a position sensor. This is a small component that is integrated in an actuator or a stage and constantly feeds back the position of the slider. Five different position sensor resolutions are offered: 1250 nm, 312 nm, 78 nm, 5 nm and 1 nm. We use optical sensors for the highest precision stages (78 nm, 5 nm and 1 nm) and inductive sensors for the medium precision stages (1250 nm and 312 nm) and for dusty environments.

The optical encoders have a physical index or reference mark, in the centre of the encoder strip. To find this index, the controller sets off in a specified direction to search. When the stage reaches a mechanical limit it reverses the search direction. When the index is found, the stage stops.

The inductive sensors contain the physical index position close to the end limit. The controller moves in a specified direction until the stage reaches a mechanical limit, where the physical index is located. For those stages a large encoder offset is used (ENCO), thus after finding the index location near the end limits, the stage is sent to the centre corresponding to the encoder offset.

The inductive sensors have no unique index or reference mark. Instead, these sensors give an index pulse each 1.28 mm. The controller slowly moves the stage in a specified direction until it reaches a mechanical limit. Then, it moves in the other direction and uses the first index pulse it passes as reference. With respect to this reference point, the zero position is defined by the parameter ENCO (in encoder units).

As a result it is important that nothing blocks the physical index of the stages.

7. Tuning the control parameters

As previously mentioned in ”Control”, the control parameters have to be set according to the type of stage and load. Each individual stage is tested by Xeryon and the parameters are pre-set for zero payload upon delivery of the stage and controller.

Nevertheless, it may be required that the user modifies these parameters when conditions change.

Adding mass to the stage

As soon as adding a mass of 100g or more, the MASS parameter should be adapted. For every 100g of mass you add, increase the MASS parameter with 100. The correlation is not 1-on-1, and stage dependant. Finding the optimal MASS parameters is usually obtained by trial-and-error.

MMAS is the software limit used for the Windows User Interface and the maximum MASS that can be set for the stage.

After changing the MASS parameters, the proportional parameters (PROP and PRO2) should also be adapted. A first good practice is too halve the values of PROP and PRO2.

Changing the dynamics

Would you like your stage to react faster or slower, the following parameters can be adapted to achieve this.

- SSPD is used to set the speed the stage will move from point to point or during a scan movement.
- ACCE defines the acceleration of the stage to the set speed in SSPD. The default value of 10000 means no acceleration limitation is taking into account (i.e. full acceleration).
- DECE defines the deceleration of the stage upon reaching its target. The default value of 255 means no deceleration limitation is taken into account (i.e. full deceleration).
- PROP & PRO2 are proportional factors used for the closed feedback loop. Both parameters are used for the two different zones (ZON1 and ZON2). Typically PROP is higher than PRO2. Increase them to get better positioning accuracy. Both PROP and PRO2 should always be changed according to the same ratio.

When the stage needs to move and react faster to get better positioning accuracy and less overshoot, increase the above mentioned parameters. Higher proportional factors let the controller react stronger and reduce positioning errors, but can also lead to instability or noisy operation when chosen too high.

8. Windows user interface

To provide the user with a quick way to interact with the driver and the connected stage, a Windows user interface is delivered with every controller. The use is simple and self-explanatory. It can be used for manual input and to run simple scripts.

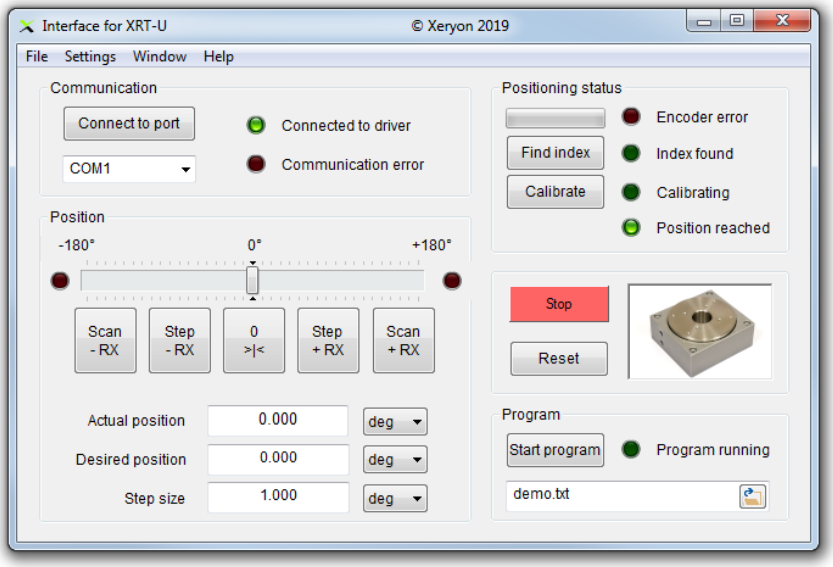
This user interface is not intended for interaction with other programs written in C, LabVIEW, MATLAB, etc. These programs should directly interact with the driver via the protocol described in previous sections. On request, code (C++, Python, LabVIEW, MATLAB) is provided to ease interfacing.

Remark: Before one can use the user interface "Xeryon_Dialog.exe", one has to install the driver installation files. Copy the "xd-c.inf" and "xd_c_win.cat" files from the USB-stick to a folder on your hard disk, preferably in the same folder as the user interface "Xeryon_Dialog.exe" file. Don't install the driver installation files from a USB-stick or network disk. Then, when both driver installation files are copied to your hard disk, install the files by a right mouse click on "xd-c.inf" and choose "Install". The installation can take a while. When installation is complete, a port number will be assigned to the controller. Start the user interface, select the correct port, click 'Connect to port'.

User interface for XD-A, XD-C PCB and XD-C

In case of a single axis system (one stage), select the correct graphical interface by setting GUI in config.txt to the following value:

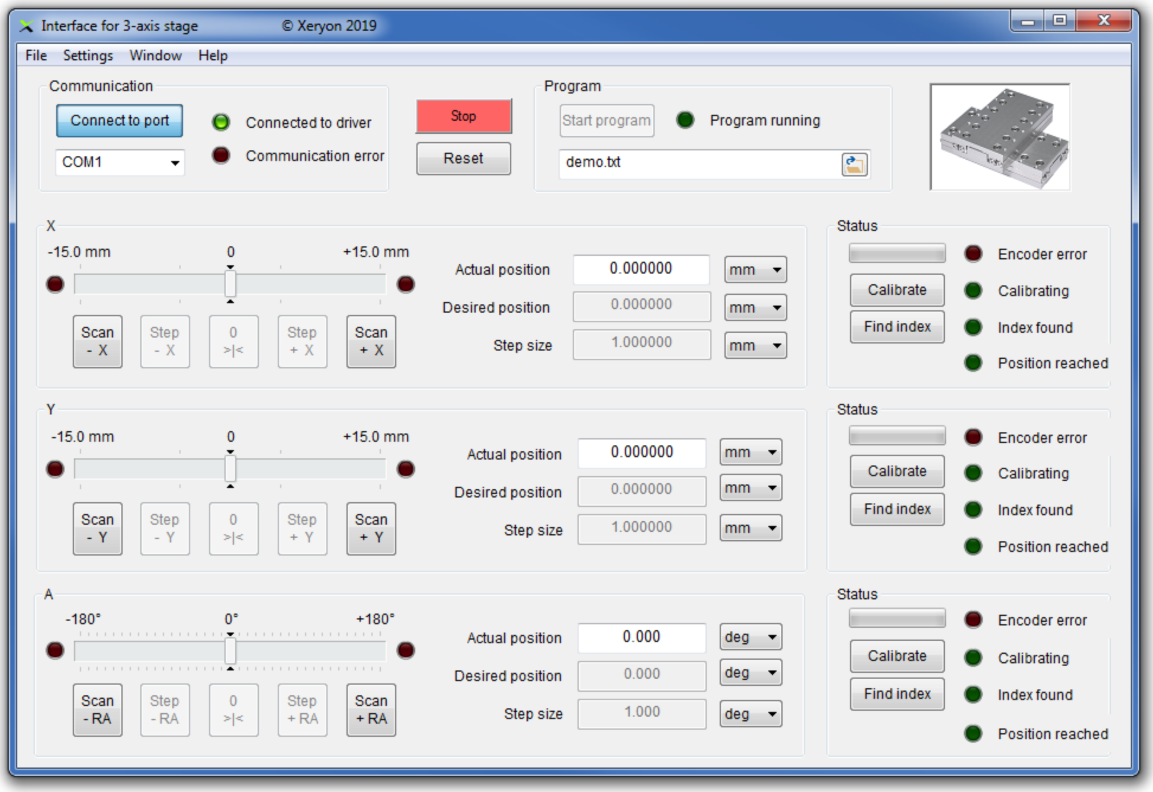
- XRTU-30: GUI=13
- XRTU-40: GUI=19
- XLS1 or XLS3: GUI=14
- XRTA: GUI=15
- XLA closed loop: GUI=21
- XLA open loop: GUI=22



User interface for XD-M

In the config.txt file, select the correct graphical interface:

- 2 axes in XY config.: GUI=17
- 2 independent axes: GUI=24
- 3 independent axes: GUI=20
- 4 independent axes: GUI=23



User interface for XD-19

The Windows Interface can handle a maximum of 4 axes. For controlling more axes, we refer to the Python interface.

Required files

The User Interface makes use of the following files:

- The executable of the User Interface: Xeryon_Dialog.exe
- A configuration file named “config.txt”. This file should not be edited by the user.
- A default settings file named “settings_default.txt”. The User Interface reads this file for initial settings at start-up. Replace or modify this file to alter the default settings. After saving, these values are stored on the driver.
- A settings file named “settings_user.txt”. The user can save and load alternative settings files via the menu. The filename is free to choose, but the file dialog window presents “settings_user.txt” as default filename.
- Several program files for which the name and content can be freely chosen. The file dialog window presents “demo.txt” as default filename.

Remark: config.txt and settings_default.txt have to be in the same folder as Xeryon_Dialog.exe.

The settings file and program files are composed of the same commands that are used to directly talk to the XD-C. An important difference is that the User Interface uses position data in degrees, millimetre etc., while encoder units have to be used when talking directly to the XD-C. The conversion is automatically made by the User Interface. Similar conversions are made for speed (deg/s or mm/s).

A few additional commands exist that affect the program flow and connection. These are not axis specific.

Command	Explanation
BAUD	Set the baud rate for communication.
DPOL	Delay used when polling for a 'position reached' signal after a new target position is set. When DPOL is too small, the Windows Interface may trigger on the 'position reached' status flag of the previous target position due to communication delay. In that case, a succeeding WAIT command will start the timer at the start of the movement instead of after the target has been reached.
HELP	Switch help on or off. HELP=1 switches the info tips on. HELP=0 switches the info tips off.
HALT	Stop the program. (Not to be confused by the STOP command for the driver.)
LABL	Label in the program used by REPT.
LOG	Start or stop logging of data. LOG=1 switches logging on. LOG=0 switched logging off. Data is stored in datalog.csv. When datalog.csv already exists, new data is appended.
MASS	Specifies the mass/inertia of the load on the stage. The User Interface calculates the optimal control parameters to obtain stable operation.
MMAS	Maximum mass that can be selected in the User Interface.
MPRO	Maximum proportional factor that can be selected in the User Interface.
MSPD	Maximum speed that can be selected in the User Interface.
PORT	Default port number to appear in the User Interface.
REPT	Repeat the above program a specified number of times. The first argument specifies the number of loops. The second argument specifies the label to jump to (label range 0 – 99). If the label does not exist, then the program jumps back to the first line. The REPT command should be placed at the end of the block to be repeated. Nesting of REPT blocks is allowed. Example: REPT=10 2 does 10 loops starting from label 2.
WAIT	Wait a specified time before proceeding to the next command. Time expressed in milliseconds. When WAIT follows a STEP or DPOS command, the timer is started when reaching the target position.

Remark: Comment text should be preceded by a percentage sign.

Example config file (config.txt)

This config file is written by Xeryon for your specific setup and should normally not be changed by the user.

```
GUI=19        % Version of graphical user interface
AXES=1 X      % Number of axes in the system and their names
XRT1=73       % Type of stage, e.g. XRT-U-40 with 73 µrad resolution
RANGE=360     % Range of the X-stage, e.g. 360 degrees
LEVEL=0       % User level (0-2)
CL=1          % Scan buttons for closed loop (1) instead of Move buttons for open loop (0)
```

Example settings file (settings_default.txt) – XD-C

```
INFO=2        % Select info
ZON1=0.1      % Set width of zone 1
ZON2=1        % Set width of zone 2
FREQ=178000   % Excitation frequency for zone 1
FRQ2=176000   % Excitation frequency for zone 2
HFRQ=185000   % Upper limit for excitation frequency
LFRQ=165000   % Lower limit for excitation frequency
PROP=500      % Proportional factor for zone 1
PRO2=100      % Proportional factor for zone 2
MPRO=120      % Maximum proportional factor
LLIM=-14      % Low-side soft end stop
HLIM=14       % High-side soft end stop
MASS=0        % Mass
MMAS=1000     % Maximum mass
SSPD=25       % Speed
MSPD=150      % Maximum speed
ELIM=30000    % Error limit
PTOL=5        % Positioning tolerance 1
PTO2=10       % Positioning tolerance 2
TOUT=300      % Timeout time 1
PHAC=-500     % Phase compensation
```

Example settings file (settings_default.txt) – XD-M

```
PORT=2        % Select COM-port 2 as default
INFO=2        % Select info, identical for all axes
X:ENCD=0      % Encoder direction for X-axis
Y:ENCD=1      % Encoder direction for Y-axis
X:FREQ=167000 % Piezo excitation frequency for X-axis
Y:FREQ=167000 % Piezo excitation frequency for Y-axis
X:SSPD=10     % Speed of X-axis
Y:SSPD=20     % Speed of Y-axis
X:PROP=3      % Proportional control factor for X-axis
Y:PROP=3      % Proportional control factor for Y-axis
X:LLIM=-28    % Lower position limit for X-axis
X:HLIM=28     % Upper position limit for X-axis
Y:LLIM=-28    % Lower position limit for Y-axis
Y:HLIM=28     % Upper position limit for Y-axis
X:MASS=100    % Load on X-axis
Y:MASS=50     % Load on Y-axis
X:PTOL=3      % Positioning tolerance in X-direction
Y:PTOL=5      % Positioning tolerance in Y-direction
```

Example program file (demo.txt)

```
SSPD=100      % Set speed to 100 mm/s or 100 degrees/s

DPOS=0        % Go to position 0

WAIT=100      % Wait 100 ms after arrival at position
LABL=2        % Set label 2

DPOS=60       % Go to position 60 mm or 60 degrees
WAIT=100
DPOS=120
WAIT=100
DPOS=180
WAIT=500
SSPD=10       % Set speed to 10 mm/s or 10 degrees/s
SCAN=1        % Move with constant speed in positive direction
WAIT=2000     % Wait for 2 s (while scan goes on)
SCAN=-1       % Move with constant speed in negative direction
WAIT=2000     % Wait for 2 s (while scan goes on)

REPT=3 2      % Repeat 3 times the code above, starting from label 2
STOP          % Stop stage
DPOS=0        % Finish in the centre
```

9. Python, MATLAB, LabVIEW and C++.

Interaction with the Xeryon controllers and connected stages is also possible through Python, MATLAB, LabVIEW and C++.

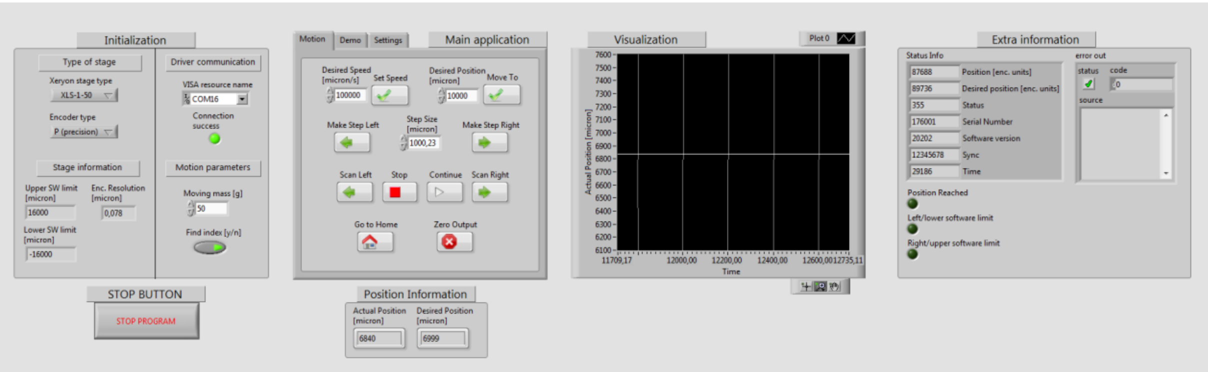
All libraries are available from our website under “Downloads”, with a sample program.

Python & MATLAB

These files are available in one folder. There is an example for both Python and MATLAB.
You can read more about our Python & MATLAB library on our website.

LabVIEW

A simple LabVIEW program is available for download. A screenshot of the interface for the XLS linear stage is shown below. You can use all the individual .vi’s to make your own program.
You can read more about our LabVIEW program on our website.



C++

We also have a C++ library available. This makes it very easy to control our stages using C++. You can read more about this library on our website.

10. Customer service

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- Phone: +32 (0)16 39 48 24
- Website: www.xeryon.com