

# **Programming manual for Piezo Ultrasonic Controller**

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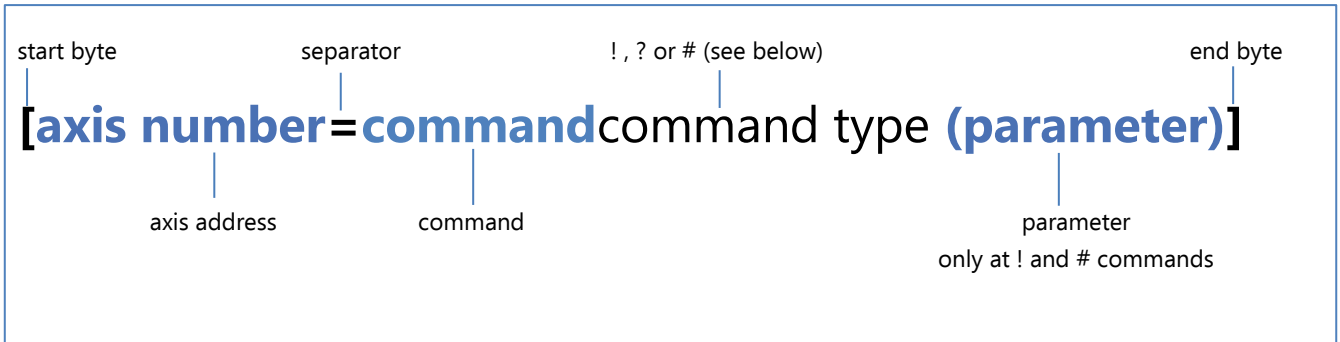
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# 1 Command structure

In order to communicate with the WSB ZPiezo, WSB PiezoS or WSB PiezoDrive controllers via one of the interfaces, the WS protocol must be used. How this is structured, and which commands are available is described in the following chapter.

## 1.1 Structure of a send command

A command sent to the electronics in the WS protocol consists of the following components.



Except for the separator and the start and end bytes, the individual modules are explained in more detail. Basically, there are three different types of commands in the WS protocol:

- 1) Set parameter (!)
- 2) Read parameter (?)
- 3) Check error register (#) – after setting of a parameter

<b><u>The write command !</u></b>	[1=Command!Parameter]	
<b><u>The read command ?</u></b>	[1=Command?]	→ Response
<b><u>Write command with error check #</u></b>	[1=Command#Parameter]	→ Response

## 1.2 Structure of the response

If a response is requested by a sent command, the electronics send back a string that looks like this.

**[axis number = parameter]**

The structure is schematically identical to a send command. The desired information is hidden behind the placeholder 'parameter'.

## 2 Commands and Explanations

### 2.1 General Commands

#### 2.1.1 Error Register – ERR

Command	Type	Parameter	Response	Unit
<b>ERR</b>	?	<i>none</i>	<i>hexadecimal</i> ↪ Error code (s. <a href="#">Error Codes</a> )	

Get the error code of the last occurred error that has not been read out yet and reset the error register to 0. Only the last error is stored.

Example: [0=ERR?] → [0=0x0000]

#### 2.1.2 Firmware Version – VN

Command	Type	Parameter	Response	Unit
<b>VN</b>	?	<i>none</i>	<i>text</i> ↪ Firmware version number	

Get the version of the firmware installed on the controller unit.

Example: [0=VN?] → [0=01.015]

#### 2.1.3 Name – APPN

Command	Type	Parameter	Response	Unit
<b>APPN</b>	?	<i>none</i>	<i>text</i> ↪ Controller name	

Get the name of the controller unit.

Example: [0=APPN?] → [0=PiezoDrive]

#### 2.1.4 Firmware Date – APPD

Command	Type	Parameter	Response	Unit
<b>APPD</b>	?	<i>none</i>	<i>text</i> ↪ Firmware date	

Get the date of the firmware installed on the controller unit.

Example: [0=APPD?] → [0=07/22/2024]

#### 2.1.5 Reset – Reset

Command	Type	Parameter	Response	Unit
<b>Reset</b>	!	<i>none</i>	<i>none</i>	

Perform a reset of the firmware.



No responses will be sent right before and after the reset of the firmware. New commands just can be sent without waiting for any kind of confirmation.

Example: [0=Reset!]

## 2.2 Axis Commands

### 2.2.1 Status – STAT

Command	Type	Parameter	Response	Unit
<b>STAT</b>	?	<i>none</i>	<i>hexadecimal</i> ↪ Axis status	

Get the current status of an axis.

Responses can be interpreted using the following bit values:

Bit	Meaning	Hex value
0	Movement direction (0: down, 1: up)	0x00000001
1	Reserved	0x00000002
2	Motor currently running (movement)	0x00000004
3	Axis referenced	0x00000008
4	Software lower limit	0x00000010
5	Software upper limit	0x00000020
6	Hardware lower limit	0x00000040
7	Hardware upper limit	0x00000080
8	Reserved	0x00000100
9	Reserved	0x00000200
10	Hardware lower limit reached once	0x00000400
11	Hardware upper limit reached once	0x00000800
12	Motor power on	0x00001000
13	Motor driver currently enabled	0x00002000
14	Device is motorized	0x00004000
15	Reserved	0x00008000
16	Closed loop active	0x00010000
17	Closed loop sensor connected	0x00020000
18	Closed loop signal present	0x00040000
19	Reserved	0x00080000
20	Reserved	0x00100000
21	Reserved	0x00200000
22	Trigger features enabled	0x00400000
23	Axis locking state	0x00800000
24	Reserved	0x01000000
25	Reserved	0x02000000
26	Reserved	0x04000000
27	Reserved	0x08000000
28	Reserved	0x10000000
29	Reserved	0x20000000
30	Reserved	0x40000000
31	Reserved	0x80000000

Example: [1=STAT?] → [1=0x**00477000**]

→ **0000 0000 0100 0111 0111 0000 0000 0000**

### 2.2.2 Position – POS

Command	Type	Parameter	Response	Unit
<b>POS</b>	?	<i>none</i>	<i>decimal</i> ↪ Position	mm

Get the current position of an axis.

Example: [1=POS?] → [1=25.00000]

### 2.2.3 Move Absolute (mm) – MPOS <sup>1)</sup>

Command	Type	Parameter	Response	Unit
<b>MPOS</b>	?	<i>none</i>	<i>decimal</i> ↪ Axis Target Position	mm
	#, !	<i>decimal</i> ↪ Target position (including decimal places)	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	mm

Set an absolute target position and execute a movement to this destination with the currently configured velocity and acceleration.

Example: [1=MPOS?] → [1=0.000000]

Example: [1=MPOS#2.5] → [1=0x0000]

### 2.2.4 Move Absolute (nm) – Ma <sup>1)</sup>

Command	Type	Parameter	Response	Unit
<b>Ma</b>	?	<i>none</i>	<i>decimal</i> ↪ Axis Target Position	nm
	#, !	<i>decimal</i> ↪ Target position	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	nm

Set an absolute target position and execute a movement to this destination with the currently configured velocity and acceleration.

Example: [1=Ma#250000] → [1=0x0000]

### 2.2.5 Move Relative (mm) – RPOS <sup>1)</sup>

Command	Type	Parameter	Response	Unit
<b>RPOS</b>	#, !	<i>decimal</i> ↪ Relative distance (including decimal places)	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	mm

Set a relative target position and execute a movement to this destination with the currently configured velocity and acceleration.

Example: [1=RPOS#1.0] → [1=0x0000]

### 2.2.6 Move Relative (nm) – Mr <sup>1)</sup>

Command	Type	Parameter	Response	Unit
<b>Mr</b>	#, !	<i>decimal</i> ↪ Relative distance	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	nm

Set a relative target position and execute a movement to this destination with the currently configured velocity and acceleration.

Example: [1=Mr#1000] → [1=0x0000]

<sup>1)</sup> Polling requests can be used to determine whether a movement is finished (s. [Is On Target – PO](#)). The valid position range depends on the system (hardware limits) and on the configured lower and upper software limits:

- [Software Limit Lower \(mm, dec\) – SLPOS](#) and
- [Software Limit Upper \(mm, dec\) – SUPOS](#).

### 2.2.7 Stop – BR

Command	Type	Parameter	Response	Unit
<b>BR</b>	#, !	<i>none</i>	000A on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

Stop an axis.

Example: [1=BR#] → [1=0x000A]

### 2.2.8 Is On Target – PO

Command	Type	Parameter	Response	Unit
<b>PO</b>	?	<i>none</i>	<i>decimal</i> ↪ Movement status on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

Get the current movement status of an axis.

This command can be used for polling requests during a movement to determine when it is finished and then synchronize following commands.

Responses can be interpreted using the following bit values:

<b>Value</b>	<b>Meaning</b>
0	On target, movement finished
1	Not on target, movement ongoing

Example:

[1=MPOS#2.5] → [1=0x0000] → move absolute to position 2.5 mm  
 [1=PO?] → [1=0] → Check: on target? → On target, movement finished  
 [1=PO?] → [1=1] → Check: on target? → Not on target, movement ongoing

### 2.2.9 Set Position Counter to 0 – PR <sup>2)</sup>

Command	Type	Parameter	Response	Unit
<b>PR</b>	#, !	<i>none</i>	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

Set the current position of an axis to its new 0 position.

Example: [1=PR#] → [1=0x0000]

### 2.2.10 Set Position Counter – Ps <sup>2)</sup>

Command	Type	Parameter	Response	Unit
<b>Ps</b>	#, !	<i>decimal</i> ↪ Position	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	nm

Set the current position of an axis to a new one.

Example: [1=Ps#1000000] → [1=0x0000]

<sup>2)</sup> The current value of the position counter will be set to the new 0 and interpreted accordingly. This means, an absolute movement to position 0 nm moves to the last position at which the position counter has been set to 0 (e.g. set position counter 0 at 1000000 nm, position 0 moves to the original 1000000 nm).

Adjustments of the position counter affect the configured lower and upper software limits:

- [Software Limit Lower \(mm, dec\) – SLPOS](#) and
- [Software Limit Upper \(mm, dec\) – SUPOS](#).

### 2.2.11 Reference Drive – REF

Command	Type	Parameter	Response	Unit
<b>REF</b>	?	<i>none</i>	<i>decimal</i> ↪ Last found reference of axis	mm
	#, !	<i>none</i>	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

While a reference drive is ongoing, polling requests can be used to determine when it is finished (see [Is On Target- PO](#)).

Example: [1=REF?] → [1=0.000000]

Example: [1=REF#] → [1=0x0000]

### 2.2.12 Hardware Limit Lower – HL

Command	Type	Parameter	Response	Unit
<b>HL</b>	#, !	<i>none</i>	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

Search the lower hardware limit of an axis.

Example: [1=HL#] → [1=0x0000]

While a hardware limit search is ongoing, polling requests can be used to determine it is finished (see [Is On Target- PO](#)).



### 2.2.13 Hardware Limit Upper – HU

Command	Type	Parameter	Response	Unit
<b>HU</b>	#, !	<i>none</i>	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

Search the upper hardware limit of an axis.

Example: [1=HU#] → [1=0x0000]

While a hardware limit search is ongoing, polling requests can be used to determine when it is finished (see [Is On Target- PO](#)).

### 2.2.14 Velocity – VPOS

Command	Type	Parameter	Response	Unit
<b>VPOS</b>	?	<i>none</i>	<i>decimal</i> ↪ Velocity	$\frac{\text{mm}}{\text{s}}$
	#, !	<i>decimal</i> ↪ Velocity	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	$\frac{\text{mm}}{\text{s}}$

Set or get the velocity of an axis.

Example: [1=VPOS?] → [1=100.0000]

Example: [1=VPOS#50.0000] → [1=0x0000]

### 2.2.15 Acceleration – APOS

Command	Type	Parameter	Response	Unit
<b>APOS</b>	?	<i>none</i>	<i>decimal</i> ↪ Acceleration	$\frac{\text{mm}}{\text{s}^2}$
	#, !	<i>decimal</i> ↪ Acceleration	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	$\frac{\text{mm}}{\text{s}^2}$

Set or get the acceleration of an axis.

Example: [1=APOS?] → [1=300.0000]

Example: [1=APOS#200.0000] → [1=0x0000]

### 2.2.16 Deceleration – DPOS

Command	Type	Parameter	Response	Unit
<b>DPOS</b>	?	<i>none</i>	<i>decimal</i> ↪ Deceleration	$\frac{\text{mm}}{\text{s}^2}$
	#, !	<i>decimal</i> ↪ Deceleration	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	$\frac{\text{mm}}{\text{s}^2}$

Set or get the acceleration of an axis.

Example: [1=DPOS?] → [1=300.0000]

Example: [1=DPOS#200.0000] → [1=0x0000]

### 2.2.17 Software Limit Lower (mm, dec) – SLPOS <sup>4)</sup>

Command	Type	Parameter	Response	Unit
<b>SLPOS</b>	?	<i>none</i>	<i>decimal</i> ↪ Software-limit position	mm
	#, !	<i>decimal</i> ↪ Software-limit position (including decimal places)	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	mm

Set or get the lower software limit of an axis.

Example: [1=SLPOS?] → [1=-55.000000]

Example: [1=SLPOS#-50.000000] → [1=0x0000]

<sup>4)</sup> Adjustments of the lower software limit affect the valid value range of absolute and relative movements:

- [Move Absolute \(mm\) – MPOS](#),
- [Move Absolute \(nm\) – Ma](#) and
- [Move Relative \(mm\) – RPOS](#),
- [Move Relative \(nm\) – Mr](#).

### 2.2.18 Software Limit Upper (mm, dec) – SUPOS <sup>5)</sup>

Command	Type	Parameter	Response	Unit
<b>SUPOS</b>	?	<i>none</i>	<i>decimal</i> ↪ Software-limit position	mm
	#, !	<i>decimal</i> ↪ Software-limit position (including decimal places)	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	mm

Set or get the upper software limit of an axis.

Example: [1=SUPOS?] → [1=65.000000]

Example: [1=SUPOS#60.000000] → [1=0x0000]

<sup>5)</sup> Adjustments of the upper software limit affect the valid value range of absolute and relative movements:

- [Move Absolute \(mm\) – MPOS](#),
- [Move Absolute \(nm\) – Ma](#) and
- [Move Relative \(mm\) – RPOS](#),
- [Move Relative \(nm\) – Mr](#).

### 2.2.19 Axis Direction– LR

Command	Type	Parameter	Response	Unit
<b>LR</b>	?	<i>none</i>	<i>decimal</i> ↪ Direction state	
	#, !	<i>decimal</i> ↪ Direction state	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

Set or get the direction of an axis. Responses can be interpreted using the following values:

<b>Value</b>	<b>Meaning</b>
0	Direction not inverted
1	Direction inverted

An inversion of an axis direction interchanges the direction of positive and negative movements.

### 2.2.20 Control Loop – SVO

Command	Type	Parameter	Response	Unit
<b>SVO</b>	?	<i>none</i>	<i>decimal</i> ↪ Status	
	#, !	<i>decimal</i> ↪ Status	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

Get or set the current state of the control loop of an axis.  
Responses can be interpreted using the following values:

<b>Value</b>	<b>Meaning</b>
0	Control loop off
1	Control loop on

### 2.2.21 Motor output (open loop) – EW

Command	Type	Parameter	Response	Unit
<b>EW</b>	?	<i>none</i>	<i>decimal</i> ↪ read value	
	#, !	<i>decimal</i> ↪ Motor output	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

Configure the motor output of an axis and read its output values.

Example: [1=EW?] → [1=0.0] → read motor output

[1=SVO#0] → set motor in open loop modus (see chapter SVO)

Example: [1=EW#1000] → [1=0x0000] → set motor output

### 2.2.22 Velocity Drive – Sc

Command	Type	Parameter	Response	Unit
<b>Sc</b>	#, !	<i>Decimal</i> ↪ Velocity	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	$\frac{\text{nm}}{\text{s}}$

Set the velocity for a constant movement of an axis and start it. A positive movement direction is the default direction while a negative movement direction can be configured by appending a minus (-) sign in front of the velocity parameter. A velocity of 0 stops the axis.

Example: [1=Sc#100000] → [1=0x0000] → positive movement direction

Example: [1=Sc#-100000] → [1=0x0000] → negative movement direction

Example: [1=Sc#0] → [1=0x0000] → stop movement

### 2.2.23 Store Configuration Parameter – ff

Command	Type	Parameter	Response	Unit
<b>ff</b>	#, !	<i>None</i>	0 on success, error code (s. <a href="#">Error Codes</a> ) otherwise	

Store the configuration parameter of an axis in the non-volatile memory to be applied automatically during the boot process of the firmware.

Example: [1=ff#] → [1=0x0000]

### 3 Error Codes

Error Code (Hex)	Meaning
0000	Success, no error
0001	Unknown command
0002	Invalid parameter syntax
0003	Command is too long
0005	Unallowable move attempted on unreferenced axis, or move attempted with servo off
0007	Position out of limits
000A	Controller was stopped by command
000F	Invalid axis identifier
0010	Unknown stage name
0011	Parameter out of range
0017	Illegal axis
0018	Incorrect number of parameters
001A	Parameter missing
001B	Soft limit out of range
001C	Motion error while axis in motion
001D	Maximum current exceeded error while axis in motion
001E	Maximum motor output error while axis in motion
001F	Axis has no reference sensor
0020	Axis has no limit switch
0021	The connected stage has driven into a limit switch
0022	Command not allowed for selected stage(s)
0028	No joystick configured
002D	Referencing failed
002E	Reference mode is on
0031	Move to limit switch failed
0032	Attempt to reference axis with referencing disabled
0034	Motion still in progress
0035	Dynamic motion still in progress
0036	Unknown parameter
0038	Password invalid
003C	Protected parameter
004F	Set open loop value not allowed
0054	Motor is off

## 4 Motion commands

This list contains all commands of the WS protocol. The entries from the columns Command, Type and Parameters are copied in exactly this syntax for the desired command.

No.	Command	Type			Parameter (at ! and # only)	Unit	Explanation
		!	?	#			
1	ERR		•		-	-	Error Register
2	VN		•		-	-	Firmware Version
3	APPN		•		-	-	Name
4	APPD		•		-	-	Firmware Date
5	Reset	•			-	-	Reset
6	STAT		•		-	-	Status
7	POS		•		-	mm	Position
8	MPOS		•		-	mm	Move Absolute (mm)
		•		•	Target position		
9	Ma	•		•	Target position	nm	Move Absolute (nm)
10	RPOS	•		•	Relative distance	mm	Move Relative (mm)
11	Mr	•		•	Relative distance	nm	Move Relative (nm)
12	BR	•		•	-	-	Stop
13	PO		•		-	-	Is On Target
14	PR	•		•	-	-	Set Position Counter 0
15	Ps	•		•	Position	nm	Set Position Counter
16	REF		•		-	mm	Reference Drive
		•		•	-	-	
17	HL	•		•	-	-	Hardware Limit Lower
18	HU	•		•	-	-	Hardware Limit Upper
19	VPOS		•		-	$\frac{\text{mm}}{\text{s}}$	Velocity
		•		•	Velocity		
20	APOS		•		-	$\frac{\text{mm}}{\text{s}^2}$	Acceleration
		•		•	Acceleration		
21	DPOS		•		-	$\frac{\text{mm}}{\text{s}^2}$	Deceleration
		•		•	Deceleration		
22	SLPOS		•		-	mm	Software Limit Lower (mm, dec)
		•		•	Software-limit position		
23	SUPOS		•		-	mm	Software Limit Upper (mm, dec)
		•		•	Software-limit position		
24	LR		•		-	-	Axis Direction
		•		•	Direction state		
25	SVO		•		-	-	Control Loop
		•		•	Status		
26	EW		•		-	-	Motor output (open loop)
		•		•	Motor output		
27	Sc	•		•	Velocity	$\frac{\text{nm}}{\text{s}}$	Velocity Drive
28	ff	•		•	-	-	Store Configuration Parameter

## 5 Customer Service

In case of any questions, complaints or suggestions please contact Xeryon, Belgium.

For technical support: [support@xeryon.com](mailto:support@xeryon.com)