5. SELECTION GUIDE FOR PIEZO MECHANISMS

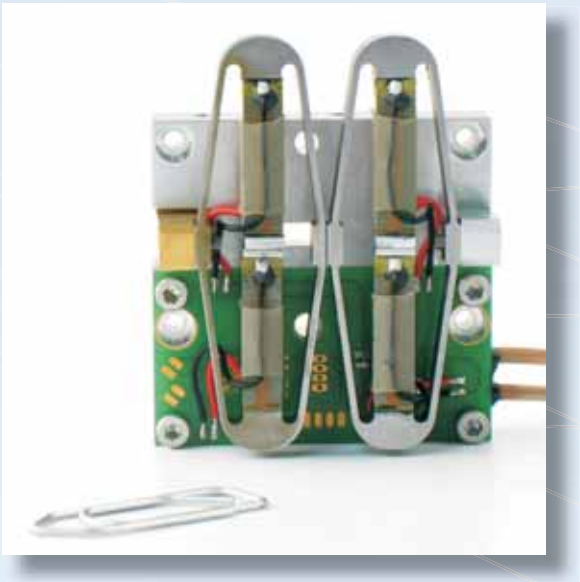
5.1 SELECTION GUIDE

Starting from standard Piezo Actuators, several mechanisms can be designed in order to control several degrees of freedom. Basically, all the APA® series can be used to build mechanisms providing several degrees of freedom. These mechanisms can integrate position sensors (Strain Gauges and Eddy Current Sensors) for closed loop control. The long travel mechanisms use an incremental magnetic sensor (MAG) based on the Hall effect.

- X: X guided stage with reduced out-of-plane Y and Z displacements,
- XY: XY stage with reduced out-of-plane Z displacement,
- XYZ: Scanner including three translations,
- OPP: Objective piezo positioner,
- FPS: Fast Piezo Shutter,
- RSPA/LSPA/LSPS: Rotary & Linear Stepping Piezo Actuator & Stage.

Please do not hesitate to take a look at our web site, where you can download:

- The technical data sheet,
- The mechanical interface drawing,
- The 3D edrawings file.



ACTUATOR SERIE	MECHANISM
APA XS	XY, TT, DTT, SPA, SPS
APA S	XY, TT
APA SM	X, OPP, SPA
APA M	TT, XY, XYZ, FPS
APA ML	XY

MECHANISM	SENSOR OPTION
X	SG, ECS
XY	SG, ECS
XYZ	SG, ECS (SG for Z axis)
TT	SG, ECS
DTT	SG, ECS
OPP	SG, ECS
FPS	SG
SPA, SPS	MAG

■ Table 5.1: Selection possibilities of piezo mechanisms ▶

■ Figure 5.1: View of two stacked X120S stages

5.2 X PIEZOELECTRIC STAGES

The piezoelectric stages X60S / X120S are single axis linear guided stage that can be equipped with Strain Gauges for a very fine positioning mode. Parasitic rotations (along X and Y axis) are very limited. The moving frame can be custom designed (attachment points, holes...) and 2 stages can be stacked for XY motion. Two X60S and X120S stages can be stacked to get a 2 degree-of-freedom (XY) mechanism.

REFERENCES	UNIT	X60S	X120S
Item Code		V-XS60	V-XS120
Notes		Preliminary data	Preliminary data
Sensors option		SG	SG
Active axis		TX	TX
Max. No-load displacement [Tx]	µm	55	115
Max. out of plane Z displacement	µm	0,50	0,50
Max. parasitic Z rotation	µrad	-	-
Max. parasitic X Y rotations	µrad	3	3
Voltage range	V	-20 ... 150	-20 ... 150
Stiffness	N/µm	1,82	0,33
Heigth (Z axis)	mm	12	12
Dimensions (X & Y axis)	mm	30*30	30*30
Resolution	nm	0,6	1,2
Mass	g	70	70
Unloaded resonance frequency (in the actuation's direction)	Hz	600	1200
Response time	ms	0,83	0,42
Capacitance (per electrical port)	µF	1,55	1,55
Mechanical interfaces (payload)		4 M3 threaded holes on [] 17*17	4 M3 threaded holes on [] 17*17
Mechanical interfaces (frame)		4 Ø 3.5 mm holes on [] 17*17	4 Ø 3.5 mm holes on [] 17*17
Electrical interfaces		2 PTFE insulated AWG30 wires 100 mm long with Ø1 banana plug	2 PTFE insulated AWG30 wires 100 mm long with Ø1 banana plug

■ Table 5.2: Characteristics of the X60S & 120S stages

Other stages based on APA® from the XS, SM, M and ML series can be defined.

5.3 XY PIEZOELECTRIC STAGES

The piezoelectric stage XY200M has a large stroke along the X and Y axis and is able to bear load up to 3 kg. Applications include Atomic Force or Scanning Tunneling Microscopes and mask positioning. This stage is based on APA200M and display a high stiffness. The stage can be equipped with Strain Gauges (SG) or Eddy Current Sensors (ECS option) for a very fine positioning mode. Parasitic rotations (along X, Y and Z rotation) are very limited. The moving frame can be custom designed (attachment points, holes...). The compact XY25XS stage is well suited to integrated devices for fiber, lens or detector positioning, micro scanning, pixel shift, dithering...

■ Figure 5.2: View of the XY25XS stage

REFERENCES	UNIT	XY25XS	XY200M
Item Code		V-XYXS25	V-XYM200
Notes		-	-
Sensors option		SG, ECS	SG, ECS
Active axis		TX, TY	TX, TY
Max. No-load displacement [Tx, Ty]	µm	25	200
Max. out of plane Z displacement	µm	0,50	1,00
Max. parasitic Z rotation	µrad	50	240
Max. parasitic X Y rotations	µrad	10	50
Voltage range	V	-20 ... 150	-20 ... 150
Stiffness	N/µm	2,50	0,59
Heigth (Z axis)	mm	20,0	22,0
Dimensions (X & Y axis)	mm	50*50	100 *100
Resolution	nm	2,5	2,0
Mass	g	80	180
Unloaded resonance frequency (in the actuation's direction)	Hz	3000	580
Response time	ms	0,17	0,86
Capacitance (per electrical port)	µF	0,50	6,30
Mechanical interfaces (payload)		1 Ø 17 mm hole + 4 Ø1.8mm on Ø 20 mm	3 Ø 2.7 mm holes on [] 38
Mechanical interfaces (frame)		4 Ø 2.8 mm holes on [] 45	4 Ø 4.5 mm holes on [] 84
Electrical interfaces		2 RG178B/U coaxial cables with Harwin connectors	2 RG178B/U coaxial cables with Harwin connectors

■ Table 5.3: Characteristics of the XY stages

Other stages based on APA® from the XS,S, SM, ML and L series can be defined.

The technical information on this leaflet is not contractual and can be changed without prior notice.

■ Figure 5.3: View of the XYZ200M stage

5.4 XYZ PIEZOELECTRIC STAGES

The piezoelectric stage XYZ200M has a large stroke along the X, Y and Z axis and is able to bear load up to 3 kg.
Applications include Confocal microscopy, mask positioning and inspection. This stage is based on APA200M and display a high stiffness. The stage can be equipped with Strain Gauges or Eddy Current sensors (ECS option) for a very fine positioning mode. Parasitic rotations (along X, Y and Z rotation) are very limited. The moving frame can be custom designed (attachment points, holes...). This mechanism requires the Push-pull option on the first two channels of the driver.

REFERENCES	UNIT	XYZ200M
Item Code		V-XYZM200
Notes		-
Sensors option		SG, ECS
Active axis		TX, TY, TZ
Max. No-load displacement [Tx, Ty]	µm	200
Max. Z displacement [Tz]	µm	200
Max. parasitic Z rotation	µrad	240
Max. parasitic X Y rotations	µrad	50
Voltage range	V	-20 ... 150
Stiffness	N/µm	0,59
Heigth (Z axis)	mm	49,0
Dimensions (X & Y axis)	mm	100*100
Resolution	nm	2,0
Mass	g	540
Unloaded resonance frequency (in the actuation's direction)	Hz	380
Response time	ms	1,32
Capacitance (per electrical port)	µF	6,30
Mechanical interfaces (payload)		objective interface max 4/55*1.36 (to be specified)
Mechanical interfaces (frame)		4 Ø 4.5 mm holes on [] 84
Electrical interfaces		2 RG178B/U coaxial cables with Harwin connectors

■ Table 5.4: Characteristics of the XYZ stage

Other stages based on APA® from the XS, S, SM, ML and L series can be defined.

5.5 TILT TRANSLATORS TT FOR ΘX-Z MOTION

The tilt translator TT is a Tilt stage based on 2 APA®. With the TT60SM, two types of motion can be generated:

- a Piston Z motion (translation) when the two actuators are simultaneously actuated,
- a Tilt ΘX motion when the two actuators are actuated in opposite phase.

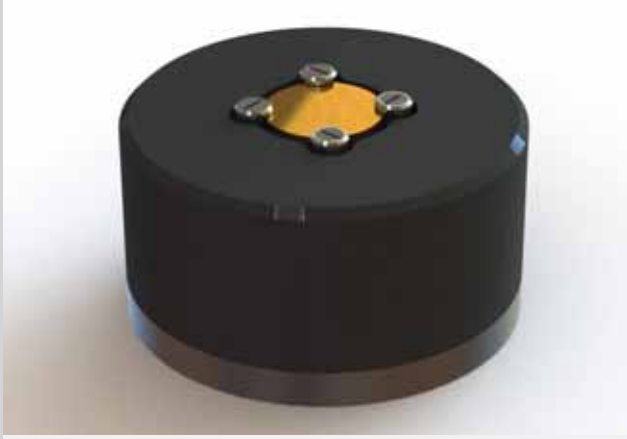
The tilt translator mechanism TT60SM can be equipped with Strain Gauges or Eddy Current Sensors for closed loop operation. If only the tilt motion is required, then only one channel is necessary. The TT60SM mechanism requires the Push-pull option on the driver.

■ Figure 5.4: View of the Tilt Translator TT60SM

REFERENCES	UNIT	TT60SM
Item Code		V-TTSM60
Notes		Preliminary Data
Sensors option		SG, ECS
Active axis		TZ, RX
Max. No-load displacement [Tz]	µm	50,0
Angular displacement [Rx]	mrad (+/-)	11,30
Voltage range	V	-20 ... 150
Stiffness	N/µm	2,00
Height (Z axis)	mm	35,0
Diameter	mm	Ø55mm
Vertical Resolution [Tz]	nm	0,5
Angular resolution [Rx]	µrad	0,1
Mass	g	141
Unloaded resonance frequency (in the actuation's direction)	Hz	400
Response time	ms	1,25
Capacitance (per electrical port)	µF	1,55
Mechanical interfaces (payload)		Flat surface Ø25.4mm (1")
Mechanical interfaces (frame)		4 M3 threaded holes on Ø48mm
Electrical interfaces		Actuators connection: 1.5m wire with Lémo FGG.00.303.CLAD22 connector -SG option: 1.5m wire with Lémo FGG.00.304.CLAD22 connector -ECS option: 1m wire with Radiall R113081000W connector

■ Table 5.5: Characteristics of the tilt translator systems

Other double tilt system based on APA® from the XS, S, SM, M, ML and L series can be defined.



■ Figure 5.5: View of the Double Tilt Translator DTT35XS

5.6 DOUBLE TILT TRANSLATOR DTT FOR Z-ΘX-ΘY MOTION

The double tilt translator DTT is based on 2 pairs of APA35XS. Three types of motion can be generated:

- A vertical Z motion (translation) when the two pairs of APA35XS are simultaneously actuated,
- A Tip & Tilt ΘX and/or ΘY motion up to +/- 2 mrad, when the two actuators of a pair are actuated in opposite phase.

The double tilt translator mechanism can be equipped with strain gauges or Eddy Current sensors to operate in closed loop. For driving the two tilts (Tip Tilt) motion, only two channels are necessary (with the Push-pull mode from the 75 family of drivers).

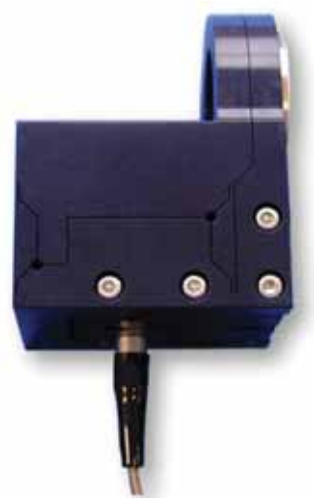
REFERENCES	UNIT	DTT35XS
Item Code		V-DTTXS35
Notes		Preliminary Data
Sensors option		SG, ECS
Active axis		RX, RY, TZ
Max. No-load displacement [Tz]	µm	35,0
Max. Angular displacement [Rx, Ry]	mrad (+/-)	2,80
Voltage range	V	-20 ... 150
Stiffness	N/µm	2,00
Heigth (Z axis)	mm	24,0
Diameter	mm	Ø45mm
Vertical Resolution [Tz]	nm	0,4
Angular resolution [Rx, Ry]	µrad	0,03
Mass	g	53,0
Unloaded resonance frequency (in the tilt direction)	Hz	2800
Response time	ms	0,2
Capacitance (per electrical port)	µF	0,50
Mechanical interfaces (payload)		Flat surface Ø 12.7mm (1/2")
Mechanical interfaces (frame)		Cylinder Ø 43mm or 4 M3 threaded holes on Ø30
Electrical interfaces		Actuators connection: 1.5m wire with Lémo FGG.00.303.CLAD22 connector -SG option: 1.5m wire with Lémo FGG.00.304.CLAD22 connector -ECS option: 1m wire with Radiall R113081000W connector

■ Table 5.6: Characteristics of the DTT35XS

Other double tilt system based on APA® from the XS, S, SM, M, ML and L series can be defined.

5.7 OBJECTIVE PIEZO POSITIONNER OPP120SM

The objective piezo positionner OPP120SM uses the amplified piezo actuators from CEDRAT TECHNOLOGIES's standard range of actuators and an additional guiding for a vertical and accurate movement of the objective. The APA® achieves the trade-off between stroke and stiffness and is therefore well suited to rapid confocal microscopy. The interface with the objective can be customised. The piezo mechanism can integrate an eddy current proximity sensor (ECS option).



■ Figure 5.6: View of the OPP120SM

REFERENCES	UNIT	OPP120SM
Item Code		V-OPPSM120
Notes		-
Sensors option		SG, ECS
Active axis		TZ
Max. No-load displacement [Tz]	µm	140
Max. parasitic rotations [Rx, Ry]	µrad	25
Voltage range	V	-20 ... 150
Resolution	nm	14
Stiffness	N/µm	0,71
Heigth (Z axis)	mm	50,0
Dimensions	mm	65 * 40
Mass	g	180
Unloaded resonance frequency (in the actuation's direction)	Hz	600
Response time	ms	0,83
Loaded resonance frequency (in the actuation's direction) load = 50 g	Hz	440
Loaded response time	ms	1,14
Capacitance (per electrical port)	µF	3,15
Mechanical interfaces (payload)		objective interface max M25*0.75 (to be specified)
Mechanical interfaces (frame)		microscope interface (max M25*0.75) to be specified
Electrical interfaces		1 RG178B/U coaxial cable

■ Table 5.7: Characteristics of the OPP120SM

Other mechanisms based on APA® from the SM, M and L series can be defined.

■ Figure 5.7: View of the FPS200M (courtesy of EMBL)

5.8 FAST PIEZO SHUTTERS FPS200M, FPS400M & FPS900M

The Fast Piezo Shutters (FPS) are mechanisms moving a jaw that open and close a slit. Width of slits up to 1.1 mm can be opened and closed in less than 10ms. Other features include high repeatability, low jitter, long life time...

Design of FPS series is based on APA200M, APA400M and APA900M actuators. The moving jaw is made of tungsten to offer very high X-Ray stop. FPS has been qualified by EMBL at ESRF Grenoble. FPS shutters are used by synchrotron facilities all around the word.

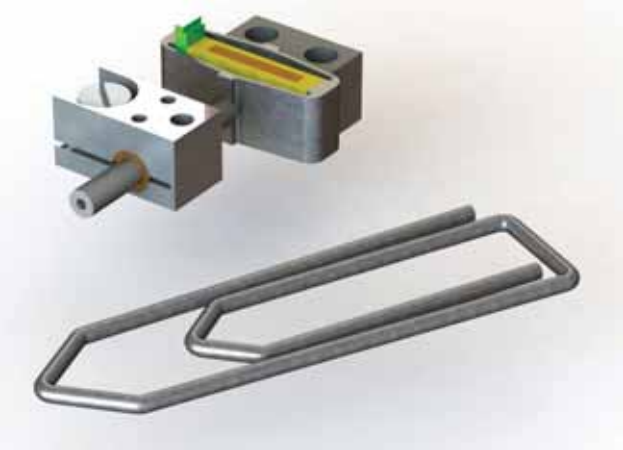
REFERENCES	UNIT	FPS200M	FPS400M	FPS900M
Item Code		V-FPSM200	V-FPSM400	V-FPSM900
Notes		-	-	-
Sensors option		SG	SG	SG
Active axis		TX	TX	TX
Max. No-load displacement (Tx)	µm	400	800	1600
Max. beam diameter	mm	0,3	0,7	1,1
Voltage range	V	-20 ... 150	-20 ... 150	-20 ... 150
Stiffness	N/µm	3,17	0,10	0,02
Heigth (Z axis)	mm	21,0	21,0	23,0
Dimensions (X & Y axis)	mm	60 * 44	60 * 44	60 * 44
Mass	g	150	150	150
Unloaded resonance frequency (in the actuation's direction)	Hz	850	430	248
Aperture & closing time	ms	2,00	4,00	10,00
Capacitance (per electrical port)	µF	3,15	3,15	3,15
Mechanical interfaces (payload)		4 slits (width 0.6 mm)	4 slits (width 0.6 mm)	4 slits (width 0.6 mm)
Mechanical interfaces (frame)		4 holes Ø 2.7mm on [] 24*38 mm	4 holes Ø 2.7mm on [] 24*38 mm	4 holes Ø 2.7mm on [] 24*38 mm
Electrical interfaces		2 RG178B/U coaxial cables	2 RG178B/U coaxial cables	2 RG178B/U coaxial cables

■ Table 5.8: Characteristics of the FPS

Other mechanisms based on APA® from the SM, M and L series can be defined.

5.9 LINEAR STEPPING PIEZO ACTUATOR LSPA

Linear Stepping Piezoelectric Actuators (LSPA) are linear piezoelectric motors for micro/ nano positioning applications benefiting from the APA® heritage. They operate by accumulation of small steps (see 2.6). Between each step, the motor is locked into position and does not need to be powered.
When the long stroke is performed, it can also be operated in a deformation mode 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. This LSPA can be supplied with CEDRAT TECHNOLOGIES's standard compact driver SPC45 or with standard Linear Amplifiers CA45 or LA75. Other Custom Linear Stepping Piezo Actuators can be designed based on various APA®.



■ Figure 5.8: View of the LSPA35XS

REFERENCES	UNIT	LSPA30UXS	LSPA35XS	LSPA40SM
Item Code		V-LSPAUXS30	V-LSPAXS35	V-LSPASM40
Notes		-	Preliminary data	Preliminary data
Base		APA30uXS	APA35XS	APA40SM
Mastered motions		TX	TX	TX
Max. No-load displacement	mm	6	10	20
Holding force without cunsomption	N	0,8	3	15
Max speed	mm/s	70	30	20
Max step size	µm	44	14	6
Max driving force	N	0,3	1	5
Typical max loading	gr	15	30	200
Typical working frequency	Hz	1600	2100	3100
Typical stepping mode resolution	µm	1	1	1
Deformation stroke	µm	30	55	52
Linear resolution	nm	0,3	0,55	0,5
Stiffness	N/µm	0,11	0,49	3,73
Capacitance	µF	0,05	0,25	1,55
Voltage range	V	-20 ... 150	-20 ... 150	-20 ... 150
Typical Lifetime	cycles	1000000	1000000	1000000
Heigth	mm	5,6	12	14
Width	mm	8,8	16	32
Length	mm	19,15	30	45
Mass	g	1,9	5	18
Unloaded resonance frequency (in the actuation's direction)	Hz	2200	2800	4100
Mechanical interfaces (payload)		1 x M2 dep. 3	"M2 dep. 3 + 2x diam1.05 dep. 1"	"M3 dep. 5 + 2x diam2.05 dep. 1"
Mechanical interfaces (frame)		2 x diam 1.8 holes	2 x diam 2.4 holes	2 x diam 3.4 holes
Electrical interfaces		2 PTFE insulated AWG30 wires 50mm long with Ø 1 bananaplug	2 PTFE insulated AWG30 wires 50mm long with Ø 1 banana plug	2 PTFE insulated AWG30 wires 50mm long with Ø 1 banana plug

■ Table 5.9: Characteristics of the Linear Stepping Piezo Actuators

■ Figure 5.9: View of the LSPS35XS stage

5.10 LINEAR STEPPING PIEZO STAGE LSPS

The Linear Stepping Piezo Stages LSPS are based on the Linear Stepping Piezo Actuator's (SPA) principle (see 2.6). It provides with:

- A long stroke, high speed & blocking at rest
- A micro/nano positioning resolution
- A guided motion & Robustness
- Compactness & Easy Interfaces

LSPS stages can be driven with SPC45 driver or a linear amplifier from the LA75 family. Open and closed loop versions are available.
Custom Stages can be designed with smaller or bigger APA®.

REFERENCES	UNIT	LSPS35XS	LSPS40SM
Item Code		V-LSPSXS35	V-LSPSSM40
Notes		Preliminary data	Preliminary data
Base		APA35XS	APA40SM
Mastered motions		TX	TX
Max. No-load displacement	mm	10	20
Holding force without cunsomption	N	3	20
Max speed	mm/s	30	10
Max step size	µm	37,5	20
Max driving force	N	1	10
Typical max loading	gr	70	400
Typical working frequency	Hz	800	500
Typical stepping mode resolution	µm	1	1
Deformation stroke	µm	55	52
Linear resolution	nm	0,55	0,52
Stiffness	N/µm	0,49	3,73
Capacitance	µF	0,25	1,55
Voltage range	V	-20 ... 150	-20 ... 150
Out of plane	µm	6	10
Z rotation	µrad	0,3	0,5
X Y rotation	µrad	0,3	0,5
Typical Lifetime	cycles	1000000	1000000
Sensors option		MAG	MAG
Heigth	mm	15	20
Width	mm	30	50
Length	mm	30	50
Mass	g	30	90
Unloaded resonance frequency (in the actuation's direction)	Hz	900	1330
Mechanical interfaces (payload)		4 x M2 deep. 6	"4 x M2 deep. 4 + 4 x M3 deep. 4"
Mechanical interfaces (frame)		4 x diam 2.4 holes	4 x diam 3.4 holes
Electrical interfaces		8 pins ERNI connector	8 pins ERNI connector

■ Table 5.10: Characteristics of the Linear Stepping Piezo Stage LSPS

5.11 ROTARY STEPPING PIEZO ACTUATORS RSPA

Rotary Stepping Piezoelectric Actuators (RSPA) are rotary piezoelectric motors with 360° revolutions. They operate by accumulation of small steps (see 2.6).
This motor technology provides:

- Extreme Compactness
- High rotational speed & blocking at rest
- Nano resolution
- More than 1 million cycles

The motor is locked in position when it is not powered.
RSPA can be supplied with CEDRAT TECHNOLOGIES's standard compact drivers SPC45 or with standard Linear Amplifiers CA45 or LA75. Custom Stepping Piezo Actuators can be designed based on various APA®.

■ Figure 5.10: View of the RSPA30XS

REFERENCES	UNIT	RSPA30UXS	RSPA35XS
Item Code		V-RSPAUXS30	V-RSPAXS35
Notes		Preliminary data	Preliminary data
Base		APA30uXS	APA35XS
Mastered motions		RZ	RZ
Max. No-load displacement	rad	∞	∞
Holding torque without cunsomption	Nmm	4	30
Max speed	rpm	65	20
Max step size	mrad	6,8	3,5
Max driving torque	Nmm	1,3	10,0
Typical max loading	gr	15	30
Typical working frequency	Hz	1000	600
Typical stepping mode resolution	mrad	0,1	0,1
Capacitance	µF	0,05	0,25
Voltage range	V	-20 ... 150	-20 ... 150
Typical Lifetime	cycles	1000000	1000000
Heigth	mm	10	18
Diameter	mm	12	20
Mass	g	3	8
Unloaded resonance frequency (in the actuation's direction)	Hz	1363	835
Mechanical interfaces (payload)		2mm diameter x 4mm long with 1mm width flatted shaft	3mm diameter x 4mm long with 1mm width flatted shaft
Mechanical interfaces (frame)		4 diam 1.8 holes	4 diam 2.2 holes
Electrical interfaces		2 PTFE insulated AWG30 wires 50mm long with Ø 1 banana plug	2 PTFE insulated AWG30 wires 50mm long with Ø 1 banana plug

■ Table 5.11: Characteristics of Rotatory Stepping Piezo Actuators RSPA