

XY PIEZO STAGES H E R I T A G E

C O M P A C T - D Y N A M I C - P R E C I S E



HERITAGE IN SPACE, ELECTRO-OPTIC SYSTEMS & SCIENTIFIC INSTRUMENTATION

CEDRAT TECHNOLOGIES (CTEC) piezo stages and their associated controllers are widely used in space, electro-optic systems and scientific instrumentations.. Most of all the models are customized products developed under client technical specifications. They are not available as Commercially Off The Shelves (COTS) solutions except when it is clearly mentioned in the description paragraphs below. Those stages are embedded in Electro Optic surveillance systems (infrared & visible cameras, FLIR, POD,...), Space Satellites (optical communication,...) scientific instrumentations (Synchrotrons, Telescopes, Microscopes,...), production machine etc... Their excellent dynamic performance, reliability and compactness make them ideal for the following mechatronic functions & applications:

- Image resolution enhancement (micro-scanning)
- Image & line of sight stabilization
- Shakers
- Mask positioning
- SEM & AFM microscopy
- Optical tweezers

The XY stage is the most common mechanism that constitutes a translation device, on two (and sometimes three by adding a Z vertical axis) perpendicular axis. Most of our XY stages are based on a push pull electrical & mechanical symmetric configuration which provides with outstanding performances like centering position at rest (power off), thermomechanical compensation, high stiffness and resonant frequency in compact size.

All the stage models can be equipped with Strain Gages (SG) sensors option to obtain accurate positioning performances with the related controllers in [OEM](#) or in [Powered rack](#) version.

In the table below you will see a recap of the products developed at CTEC and further detail in the following paragraphs:

	UNIT	XY25XS	XY95ML	XY100SZ10M	XY120S-TC
Stroke (x,y) peak to peak	µm	25	95	100	120
Stroke (z) peak to peak	µm	-	-	8	-
Resonance frequency	Hz	3 000 ⁽¹⁾	1 215 ⁽¹⁾	328 ⁽²⁾	992 ⁽¹⁾
Capacitance per axis	µF	0.5	40	2.9	1.55
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	UNIT	XY200M	XYZ200M	XY300M	XY400M	XY500M
Stroke (x,y) peak to peak	µm	200	200	300	400	500
Stroke (z) peak to peak	µm	-	200	-	-	-
Resonance frequency	Hz	580 ⁽¹⁾	380 ⁽¹⁾	286 ⁽³⁾	275 ⁽¹⁾	340 ⁽⁴⁾
Capacitance per axis	µF	6.3	6.3	5.8	6.3	20
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⁽¹⁾ Unloaded
⁽²⁾ With 125 g payloadwith
⁽³⁾ 44 g payload
⁽⁴⁾ With 45 g payload



Fig. 1 : XY25XS-SG

1. XY20XS AND XY25XS MODELS

1.1. DESCRIPTION

The XY20XS and XY25XS stages were developed for improving the image resolution of infrared (IR) cameras. The image resolution enhancement is obtained thanks to an image oversampling algorithm (developed by our customer) that is coupled to a micro-scanning pattern (performed by the stage). The role of the stage is to shift either a lens or a detector, it means shifting the image relatively to the sensor's pixels, by a fraction of the pixel size, following a precise pattern.

The XY20XS and XY25XS are the most popular XY stages from CTEC. Several thousands of units have been produced over the last 20 years, and every model has been customized to meet our customers' requirements in terms of optical, mechanical and electrical interfaces. The table below shows few models that have been produced so far at CTEC:

1.2. APPLICATIONS

Micro-scanning / pixel shift / dithering inside infrared (IR) camera for image resolution enhancement, LOS (line of sight) stabilization.

1.3. ENVIRONMENTAL CONDITIONS

- **Average operating temperature range:** -40 °C to +70 °C.
- **Shocks and vibrations levels according to customer's specifications.**

PARAMETER	UNIT	XY25XS (STANDARD)
Stroke on X and Y axis (peak to peak)	µm	25
Unloaded resonance frequency	Hz	3 000
Capacitance per axis	µF	0.5
Dimensions	mm	50 x 50 x 16
Total mass	g	<80

Table a : Performances of XY25XS



PARAMETER	UNIT	XY20XS			XY25XS			
Lens diameter	mm	22	17	14	80	22	36	26
Payload mass	g	6	4.5	1	-	4.4	50	32

2. XY95ML

2.1. DESCRIPTION

The XY95ML stage is based on 4 APA95ML actuators arranged by pair along each axis in push pull configuration. This stage aims at generating high frequency micro vibrations (few hundreds Hz) on a centered payload to submit it to a large spectrum of acceleration over 2 axes. This 2 axes shaker can be used either for lab testing equipment or production processes.

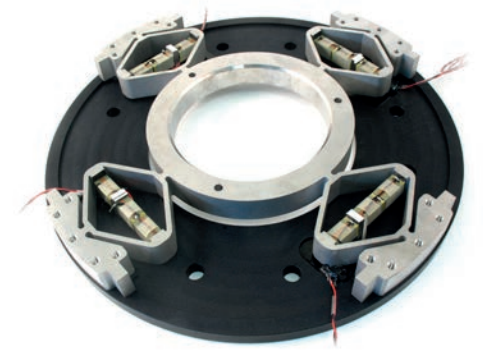


Fig. 2 : XY95ML

2.2. APPLICATIONS

Multi-axis shakers.

PARAMETER	UNIT	XY95ML
Stroke on X and Y axis (peak to peak)	µm	95
Unloaded resonance frequency	Hz	1 215
Capacitance per axis	µF	40
Dimensions	mm	Height: 45 Ø:300
Total mass	g	5 400g

Table b : Performances of XY95ML

3. XY100SZ10M ROSETTA

3.1. DESCRIPTION

The ROSETTA satellite was launched in 2004 by an Ariane-5 G+ launcher, in order to study Comet 67P/Churyumov-Gerasimenko. One of its ten instruments, MIDAS, uses an XY100SZ10M 3 axes piezo electric stage in the scanning mechanism of its on-board Atomic Force Microscope (AFM). The mechanism ensures the nano-resolution scanning motion of the AFM under a severe environment. After 10 years of travel in space, the instrument successfully operated, showing its ability to both provide with high accuracy motion and withstand severe environmental conditions.

3.2. APPLICATIONS

Nano-resolution scanning motion of an Atomic Force Microscope (AFM) in space environment.

3.3. ENVIRONMENTAL CONDITIONS

- **Thermal – vacuum:** -20 / 75 °C
- **Random vibration:** 40 grms – Payload 100 gr
- **Lifetime:** 1e6 cycles full stroke.
- **Radiations ESCC n° 22900**
- **Outgassing PSS 01-702**
- **ESD ESCC n° 23800**
- **Micro-section examination ESCC n° 23400**

PARAMETER	UNIT	XY100SZ10M ROSETTA
Stroke on X and Y axis (peak to peak)	µm	100
Stroke on Z axis (peak to peak)	µm	8
Loaded resonance frequency (125g payload)	Hz	328
Capacitance per axis	µF	2.9
Dimensions	mm	100 x 100 x 25
Total mass	g	470

Table c : Performances of XY100SZ10M Rosetta

4. XY120S-TC

4.1. DESCRIPTION

The XY120S-TC stage is based on 2 APA120S actuator and is integrated into an optical communication transceiver based on laser fiber system. The invar frame allows the non-symmetrical 2 APA120S configuration to be less sensitive to thermomechanical behavior, it means very low mechanical position bias due to atmospheric temperature variation. This piezo stage performs a fast-tracking function (60 microns at 250 Hz) that constantly and finely adjust the point to point laser communication between the emitter and the receiver of Free Space Optics modules installed on cell towers or building rooftop.

4.2. APPLICATIONS

Free space optics, optical wireless broadband, telecommunications, fast-tracking, laser fiber alignment

4.3. ENVIRONMENTAL CONDITIONS

- **Operating temperature:** -40 °C to 85 °C.

PARAMETER	UNIT	XY120S-TC
Stroke on X and Y axis (peak to peak)	µm	100
Unloaded resonance frequency	Hz	328
Capacitance per axis	µF	2.9
Dimensions	mm	50 x 50 x 8
Total mass	g	65

Table d : Performances of XY120S-TC

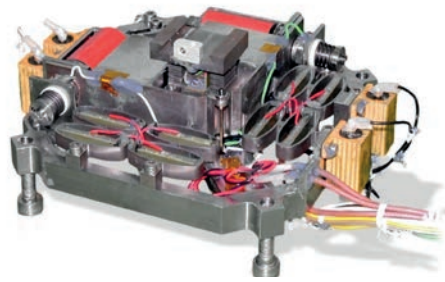


Fig. 3 : XY100SZ10M Rosetta

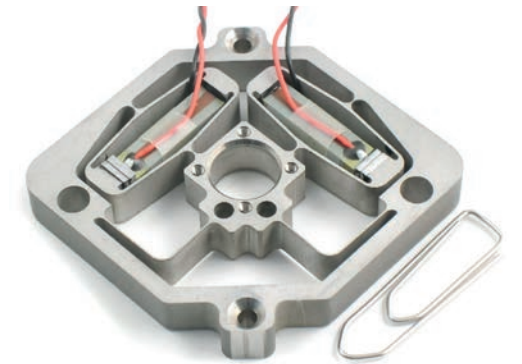


Fig. 4 : XY120S-TC

5. XY200M

5.1. DESCRIPTION

The XY200M stage is a standard stage derived from a former space design project. The commercially off the shelves (COTS) XY200M stage has a push pull configuration based on 4 APA200M actuators.

5.2. APPLICATIONS

Mask positionning, SEM & AFM microscopy, optical tweezers, scanning.

5.3. ENVIRONMENTAL CONDITIONS

The Space designed XY200M, called XY200M-space, has followed a space evaluation program according to ECSS standards (European Space Agency standards).

- **Thermal – vacuum:** -20 / 75 °C
- **Random vibration:** 20 grms – Palyoad 100 gr
- **Lifetime:** 1e6 cycles full stroke.
- **Radiations ESCC n° 22900**
- **Outgassing PSS 01-702**
- **ESD ESCC n° 23800**
- **Micro-section examination ESCC n° 23400**

PARAMETER	UNIT	XY200M
Stroke on X and Y axis (peak to peak)	µm	200
Unloaded resonance frequency	Hz	580
Capacitance per axis	µF	6.3
Dimensions	mm	100 x 100 x 22
Total mass	g	450

Table e : Performances of XY200M

6. XYZ200M

6.1. DESCRIPTION

The XYZ200M stage is composed of a COTS XY200M stage with an additional vertical Z axis based on 3 APA200M actuators driven in parallel. The motion range is 200 microns over the 3 orthogonal axis and the position accuracy is obtained with the control of the feedback signal from Strain Gages Sensor integrated on each axis.

6.2. APPLICATIONS

Confocal microscopy, mask positioning, inspection.

6.3. ENVIRONMENTAL CONDITIONS

- **Operating temperature:** -20 °C to +60 °C.

PARAMETER	UNIT	XYZ200M
Stroke on X and Y axis (peak to peak)	µm	200
Stroke on Z axis (peak to peak)	µm	200
Unloaded resonance frequency	Hz	380
Capacitance per axis	µF	6.3
Dimensions	mm	100 x 100 x 49
Total mass	g	540

Table f : Performances of XYZ200M



Fig. 5 : XY200M



Fig. 6 : XYZ200M

7. XY300M

7.1. DESCRIPTION

The XY300M stage has been designed to move a lens, either for infrared (IR) or visible imager, over 300 microns stroke along 2 axes to perform the stabilization of the line of sight of Land, Naval or Airborne Electro Optic Systems (EOS). This stage is based on 4 APA400M with SG sensor inside mounted in push pull configuration. The inner stage PCB includes robust & shielded connectors as well as a SG sensor conditioner to avoid SG feedback signal attenuation or distortion in long distance cable connection between the stage and the related controller box (CCBu40).

7.2. APPLICATIONS

Micro-scanning, infrared (IR) camera resolution improvement., line of sight stabilization, tracking.

7.3. ENVIRONMENTAL CONDITIONS

- **Operation temperature:** -40°C/+70°C

8. XY400M

8.1. DESCRIPTION

The XY400M stage has been initially developed and delivered to LESIA laboratory for the [PicSat CubeSat project](#). The project aims at monitor stars luminosity variations. The stage keeps an optical fiber centered in the telescope focal point.

The stage was designed from the existing XY200M, by using APA400M actuators instead of APA200M, in order to increase the stroke from 200 µm to 400 µm. A COTS model is available.

8.2. APPLICATIONS

Optical fiber alignment, focal point stabilisation

8.3. ENVIRONMENTAL CONDITIONS

- **Space environment.**
- **Quasistatic acceleration :** 13 G.
- **Random vibrations:** 13 G rms.



Fig. 10 : XY300M-SG-SV



Fig. 7 : XY300M with CCBu40



Fig. 8 : XY400M

PARAMETER	UNIT	XY300M
Stroke on X and Y axis (peak to peak)	µm	300
Loaded resonance frequency (44g payload)	Hz	286
Capacitance per axis	µF	5.8
Dimensions	mm	95 x 95 x 24.2
Total mass	g	458

Table g : Performances of XY300M

PARAMETER	UNIT	XY400M
Stroke on X and Y axis (peak to peak)	µm	400
Unloaded resonance frequency	Hz	275
Capacitance per axis	µF	6..3
Dimensions	mm	97.6 x 97.6 x 27
Total mass	g	500

Table h : Performances of XY400M

9. XY500M

9.1. DESCRIPTION

The XY500M stage has been designed to move an infrared (IR) imager or Focal Plan Array (FPA), over 400 microns stroke along 2 axes to perform both Field Of View (FOV) scanning and stabilization of the line of sight in Airborne Electro Optic Systems (EOS). This stage is based on 4 APA400MML with SG sensor inside mounted in push pull configuration. The inner stage PCB includes robust & shielded connectors as well as a SG sensor conditioner to avoid SG feedback signal attenuation or distortion in long distance cable connection between the stage and the related controller box (CCBu40).

9.2. APPLICATIONS

Infrared (IR) detector FOV scanning, optical tracking, line of sight stabilization.

9.3. ENVIRONMENTAL CONDITIONS

- **Temperature range:** -45 °C to 65 °C.

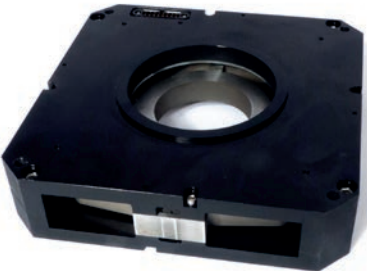


Fig. 9 : XY500M

PARAMETER	UNIT	XY500M
Stroke on X and Y axis (peak to peak)	µm	500
Loaded resonance frequency (44g payload)	Hz	340
Capacitance per axis	µF	20
Dimensions	mm	120 x 120 x 29.5
Total mass	g	938

Table i : Performances of XY500M

CEDRAT TECHNOLOGIES (CTEC) offers off-the-shelf mechatronics products including piezoelectric & magnetic actuators, motors, mechanisms, transducers and sensors with corresponding drivers & controllers. These mechatronics products are used for scientific and industrial applications requiring functions such as: micro and nano positioning, generation of vibrations, micro-scanning, fast & precise motion control, active control of vibrations, and energy harvesting

Most of the products are available in OEM versions for low cost and high volume industrial applications. CTEC also offers services including, design, R&D under contract and training

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CTEC is a SME located in Meylan, Inovallée, the French Innovation Valley near Grenoble. CTEC is recognised as a highly innovative company and has received several awards

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