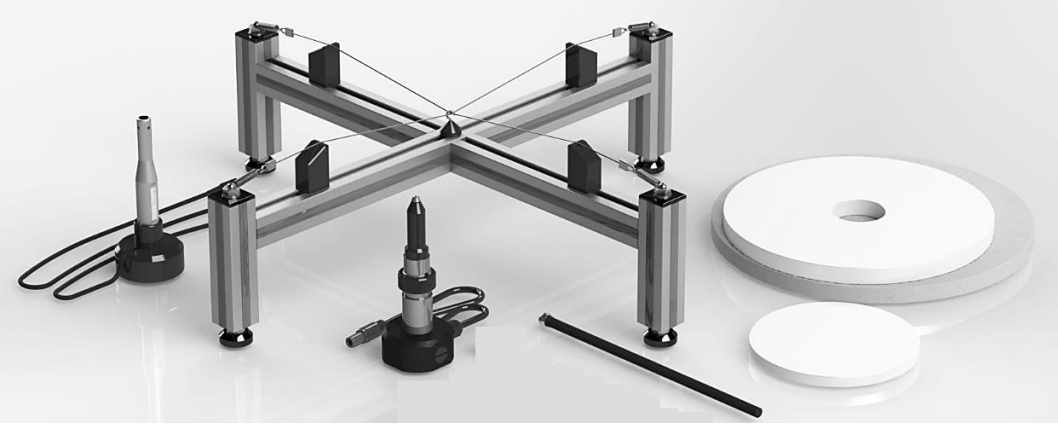
SONELASTIC
Advanced Impulse Excitation Technique

Installation and Operation Manual

SX-PD

Adjustable support for discs and rings



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SX-PD

Adjustable support for discs and rings

Manufactured by:

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1. Introduction

ATCP Physical Engineering equipment and products have been projected and manufactured to provide a long-lasting and top-rated performance. This Installation and Operation Manual contains all necessary information regarding the use and maintenance of SX-PD Support.

Carefully read this manual before using the support. Improper use may damage the product and affect its performance.

2. Definitions

Impulse Excitation Technique: The Impulse Excitation Technique is a non-destructive technique to determine the elastic moduli and damping of materials by the resonance frequencies of test specimens. ASTM E1876 is the main standard related to the Impulse Excitation Technique.

Resonance frequencies: Specimen natural frequencies of vibration.

Elastic modulus: Elastic modulus or Young's modulus is defined as the slope of the stress-strain curve at the elastic region, as described by Hooke's Law. The elastic modulus determined by Impulse Excitation Technique is also termed as dynamic elastic modulus.

Damping: Damping is the phenomenon by which mechanical energy is dissipated in dynamic systems. It is directly linked to the presence of defects and to the material microstructure.

3. Application and features

SX-PD Support is an apparatus to support specimens for non-destructive characterization of Young's modulus and damping of materials by the Impulse Excitation Technique, in agreement with ASTM E1876 and correlated standards. SX-PD Support was developed to be used alongside Sonelastic® Systems.

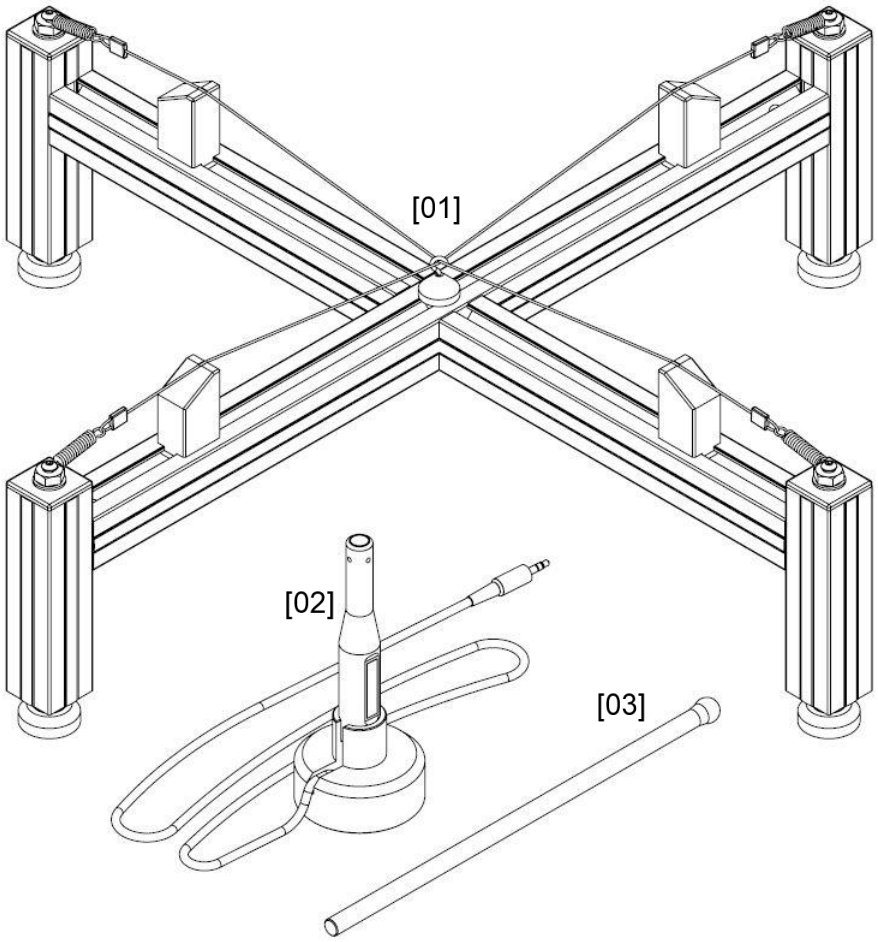
SX-PD Support allows discs and ring-shaped specimens to rest on the nodal lines of the planar vibration mode. This support is a practical and adjustable system according to the specimen under test dimensions.

For greater convenience, SX-PD Support may be combined with IED Automatic Impulse Device.

4. Configurations, parts, accessories and optional items

SX-PD Support is available in both manual and automatic configurations. Optional items are offered to customize the Sonelastic® Systems.

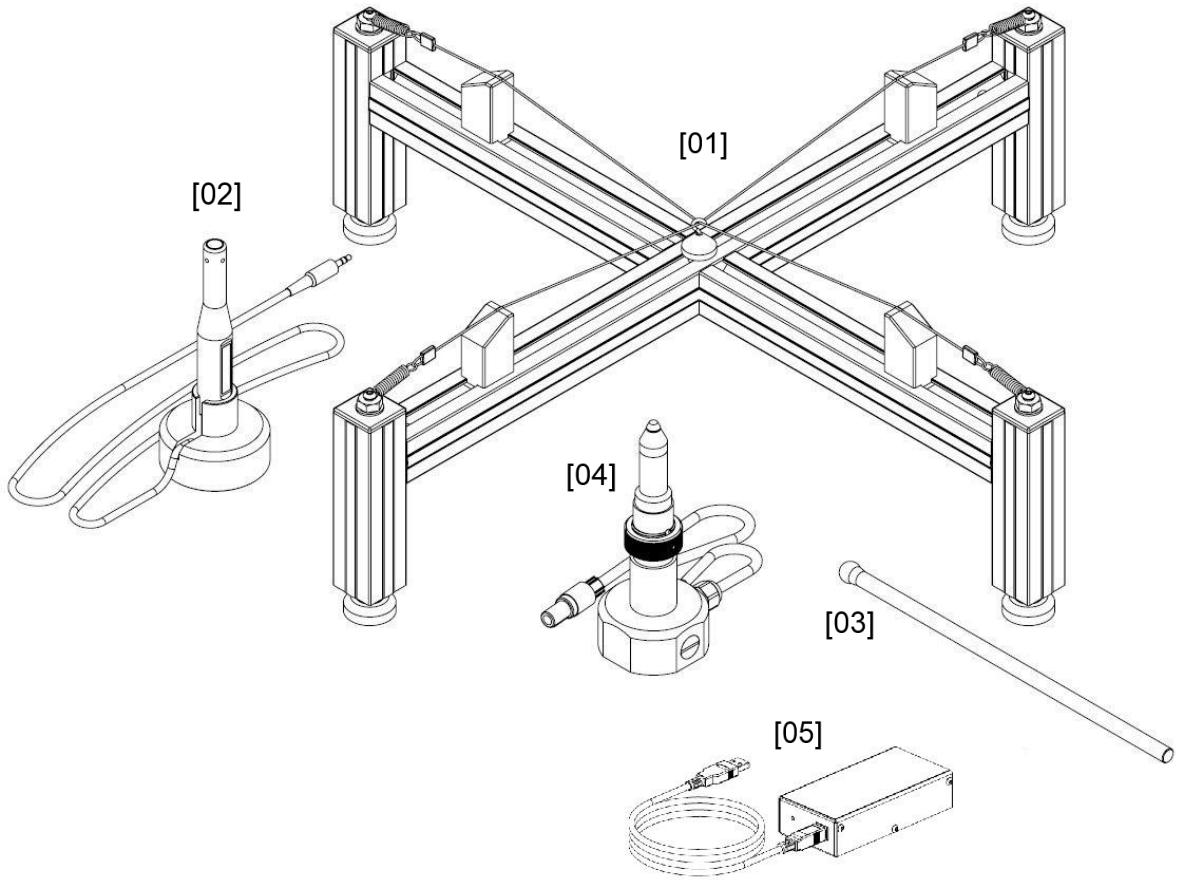
Manual configuration



Parts:
[01] – SX-PD Support;
[02] – CA-PD Acoustic Sensor with vertical mounting base.

Accessories:
[03] – Medium Manual Impulse Device.

Automatic configuration



Parts:

[01] – SX-PD Support;

[02] – CA-PD Acoustic Sensor with vertical base.

Accessories:

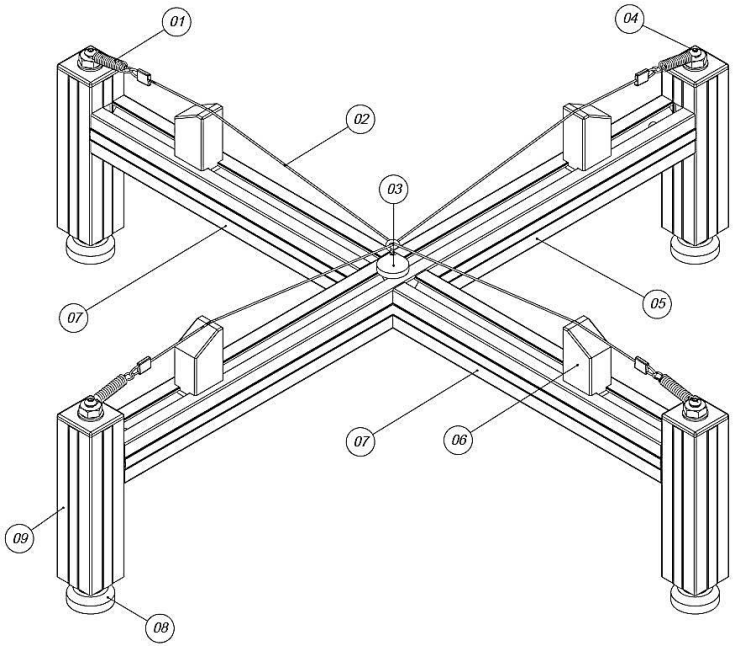
[03] – Medium Manual Impulse Device;

[04] – IED Automatic Impulse Device / Medium RT Impulse Device;

[05] – IED Automatic Impulse Device / Control unit.

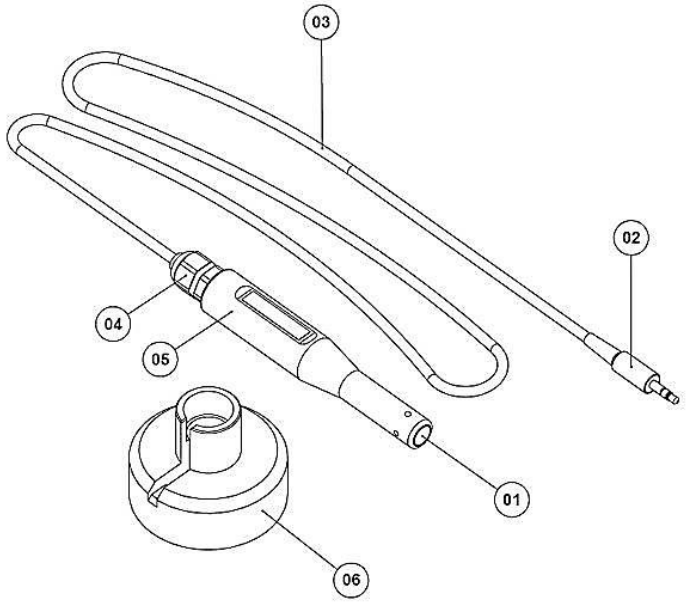
5. Parts identification

SX-PD Support



01- Support-cables tensioning spring;
02- Support-cable;
03- Central anchor;
04- Support-cable fastener;
05- Large bearing bar;
06- Sliding prop;
07- Small bearing bar;
08- Leveling feet;
09- Vertical bearing bar.

CA-PD Acoustic Sensor



01- Sensor;
02- P2 plug (3.5 mm);
03- Flexible cable;
04- Cable gland;
05- Frame;
06- Vertical mounting base.

6. Specifications

Maximum dimensions for circular specimens (D x T) ..... 380 x 60 mm

Minimum dimensions for circular specimens (D x T) ..... 80 x 5 mm

Maximum dimensions for rectangular specimens (L x W x T) ..... 380 x 380 x 60 mm

Minimum dimensions for rectangular specimens (L x W x T) ..... 60 x 60 x 5 mm

Maximum weight capacity..... 30 kg

Distance between the SLIDING PROPS (minimum - maximum) ... 50 - 385 mm

Support dimensions (L x W x T) ..... 562 x 562 x 160 mm

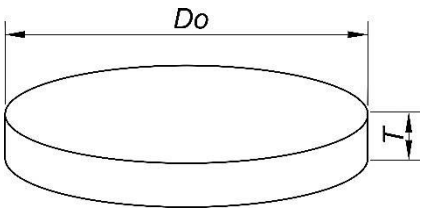
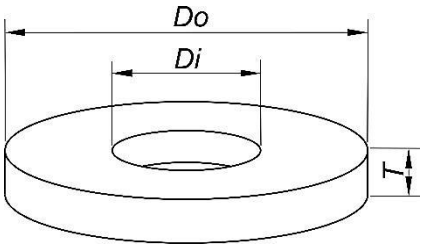
Support weight..... 1.6 kg

Working temperature range ..... 10 - 40°C (50 - 104 °F)

7. Specimens

7.1 Recommended aspect ratios

Minimum aspect ratios must be observed to avoid coupling between specimen's vibration modes. In addition, aspect ratio determines the pattern of frequency spectrum of the acoustic response. We advise users to standardize the aspect ratio in order to facilitate the frequencies identification. The table below presents the recommended aspect ratio and typical dimensions for discs and rings.

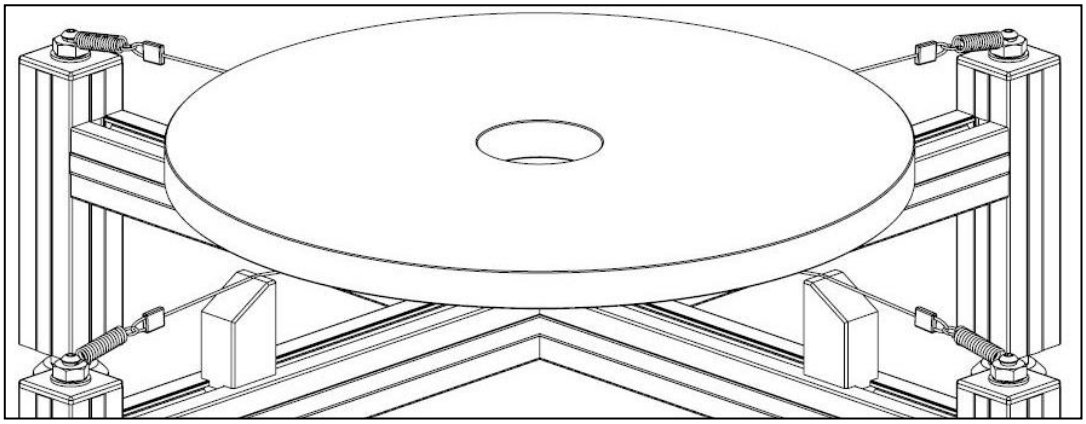
Geometry	Recommended aspect ratio
 Discs	$\frac{D_o}{T} \geq 10$ The ration between diameter (D_o) and thickness (T) must be greater than or equal to 10.
 Rings	$\frac{D_o}{T} \geq 10$ The ratio between outer diameter (D_o) and thickness (T) must be greater than or equal to 10. $\frac{D_o}{D_i} \geq 2$ The ratio between outer diameter (D_o) and inner diameter (D_i) must be greater than or equal to 2.

Important observations for preparing and finishing the specimens:
- The recommended dimension tolerance is 2%;
- Faces should be flat and parallel;
- Corners should not be rounded.

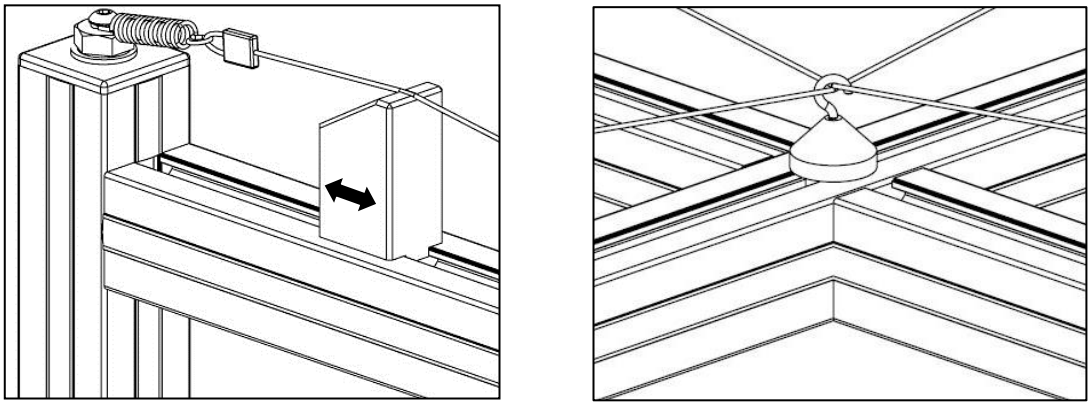
Note: Minimum dimensions may vary as a function of aspect ratio and material Young's modulus; the frequency should be lower than CA-DP Acoustic Sensor maximum frequency (96 kHz). It is possible to estimate the frequency using Sonelastic® Software simulation tool. The higher the Youngs' modulus, the higher the frequency.

7.2 Placing the specimen

The specimen should be symmetrically placed on the support-cables, and only by its edges.



Typical placement for an abrasive grinding wheel.



Cable sliding prop adjustment (left) and center anchor (right).

8. Support installation

8.1 Requirements

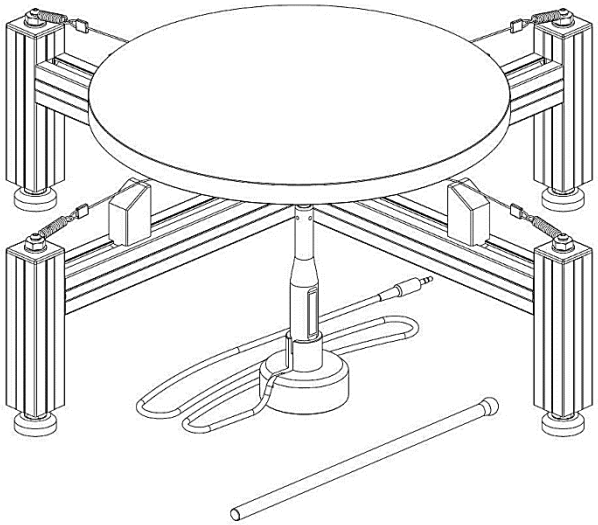
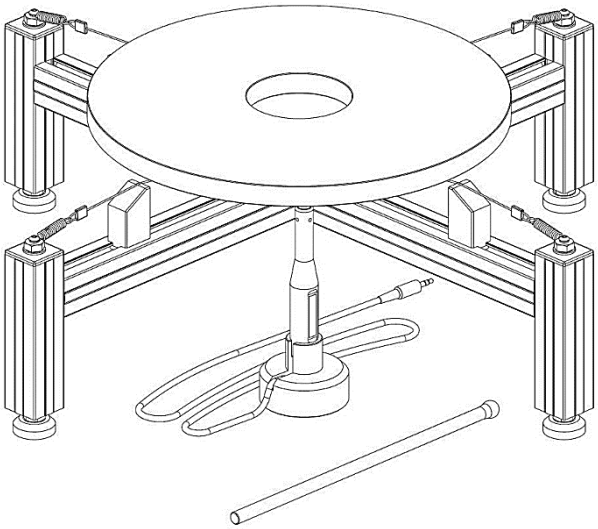
- A flat and leveled workbench with a free space of at least 60 x 120 cm (depth and width). This space is enough to fit SX-PD Support, specimens, computer and optional items.

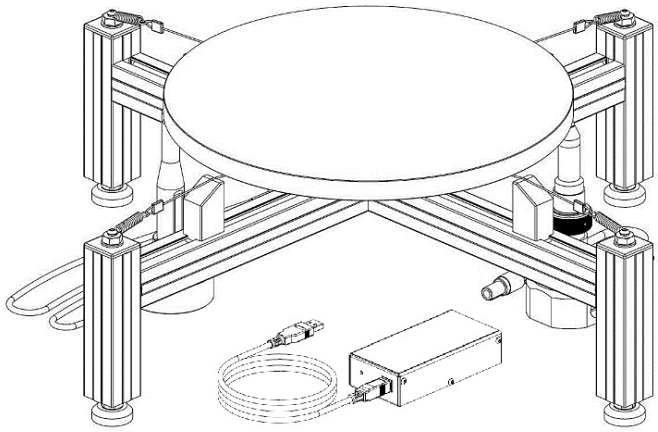
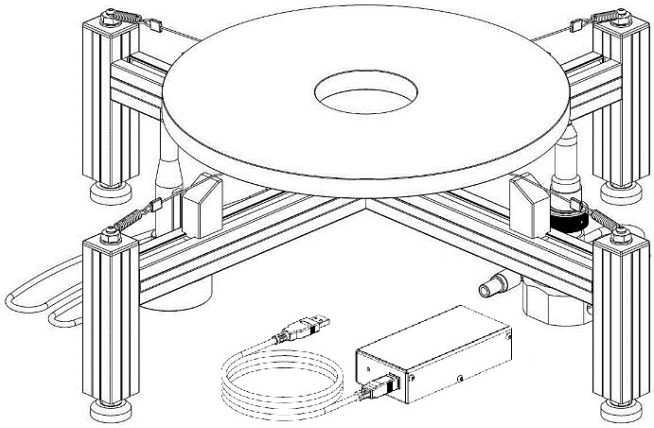
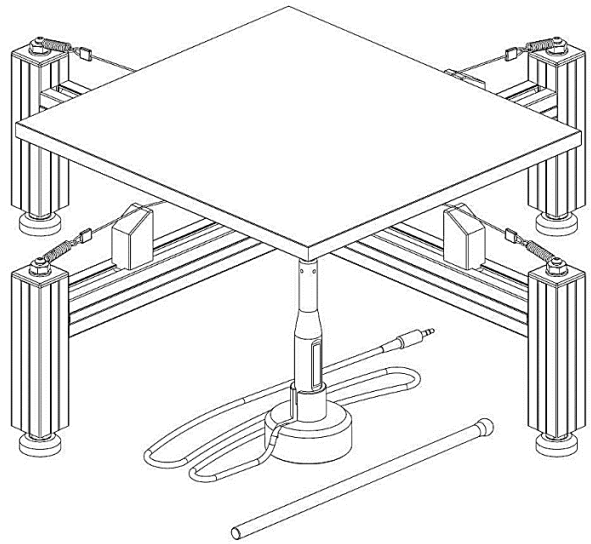
- A 127 or 220 VAC three-pin ground wired electrical mains plug. This plug is needed to power the computer up.

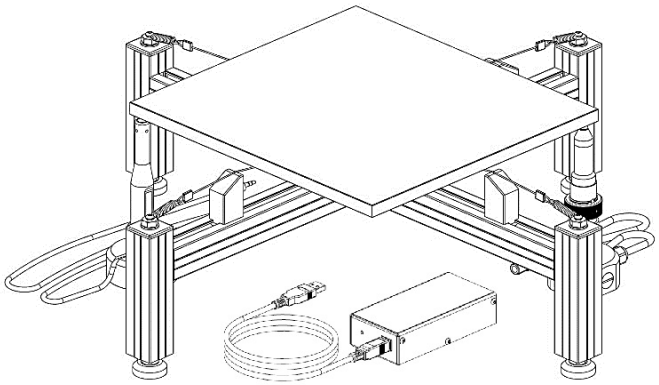
The support installation consists of positioning it over the workbench, coupling the acoustic CA-DP Acoustic Sensor to the vertical base and connecting it to the acquisition card.

8.2 Typical arrangements

Next are presented the typical arrangements for SX-PD Support:

 **[1]**	**Configuration:** Manual. **Specimen:** Disc. **Acoustic sensor:** Using a vertical mounting base. **Impulse device:** Medium Manual Impulse Device.
 **[2]**	**Configuration:** Manual. **Specimen:** Ring. **Acoustic sensor:** Using a vertical mounting base. **Impulse device:** Medium Manual Impulse Device.

 **[3]**	**Configuration:** Automatic. **Specimen:** Disc. **Acoustic sensor:** Using a vertical mounting base. **Impulse device:** IED Automatic Impulse Device with Medium RT Impulse Device for IED.
 **[4]**	**Configuration:** Automatic. **Specimen:** Ring. **Acoustic sensor:** Using a vertical mounting base. **Impulse device:** IED Automatic Impulse Device with Medium RT Impulse Device for IED.
 **[5]**	**Configuration:** Manual. **Specimen:** Rectangular plate. **Acoustic sensor:** Using a vertical mounting base. **Impulse device:** IED Automatic Impulse Device with Medium RT Impulse Device for IED.

 **[6]**	**Configuration:** Automatic. **Specimens:** Rectangular plate. **Acoustic sensor:** Using a vertical mounting base. **Impulse device:** IED Automatic Impulse Device with Medium RT Impulse Device for IED.

Attention! Before using SA-BC Support, verify if its four rubber feet are on the workbench (not wobbly). If any of its feet is not flat on the workbench, readjust it until all feet are securely placed and flat on the surface.

8.3 Replacing the support-cables

SX-PD Support comes fitted with support-cables ready for use. To replace it, follow the steps below:

Step 01 - Slide the four sliding props to the ends of the support bars, then release the support-cables off the central anchor to lower the tension applied on them.

Step 02 – Slide the sliding props to the center of the support to free up space near the tensioning springs.

Step 03 - Using pliers, firmly secure the ends of the support-cable and pull to detach it from the tensioning spring lug.

Step 04 – Release the other support-cable end of its tensioning spring lug, then the cable will free from the support.

Step 05 – Repeat the previous steps if it is need to remove both support-cable.

Step 06 – Attach the new support-cable to one of the tensioning springs lugs.

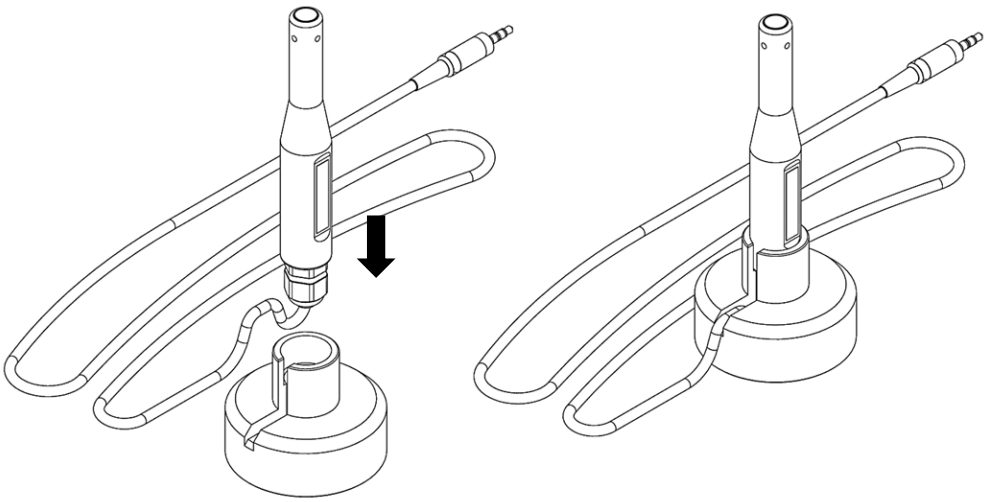
Step 07 – Using the pliers, firmly secure the other end of the cable and pull it until it is fitted in the tensioning spring lug on the other side. Ensure the cable fitted and that is tensioned by the tensioning spring.

Step 08 – Repeat the previous steps to fit the other support-cable, if necessary.

Step 09 – Verify if both support-cables are correctly supported on the top of the sliding props. Then hook the cables through in the central anchor.

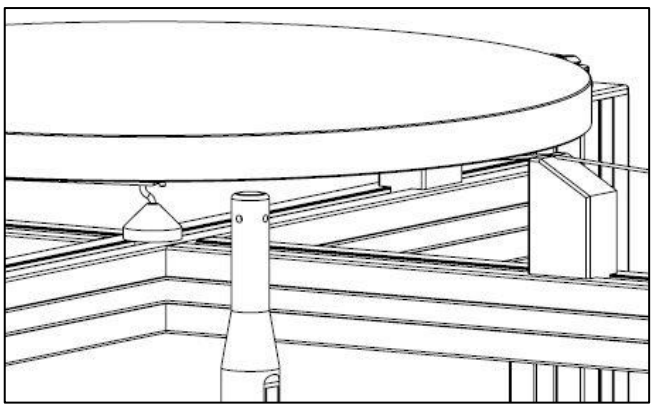
8.4 Mounting the acoustic sensor in the vertical base

Step 01 – Insert the acoustic sensor in the vertical mounting base ensuring the wire goes out through the side opening, as shown below:



Step 02 – Press the base against the acoustic sensor until it feels coupled and secured to the base.

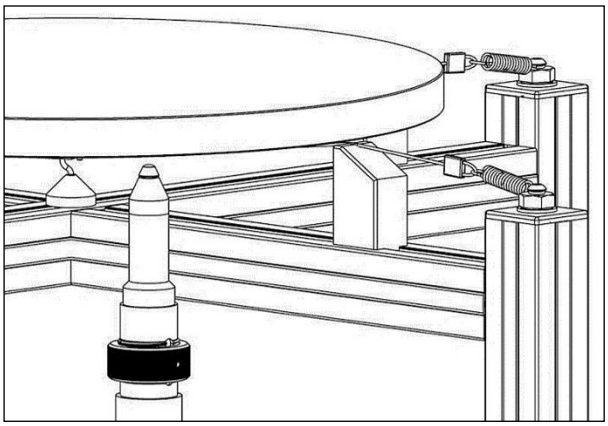
Step 03 – Position the acoustic sensor under the specimen, near its edges, allowing a distance of approximately 1 cm between the specimen face and the acoustic sensor, as shown next:



Step 04 – Connect the acoustic sensor to the acquisition card.

8.5 Installing the IED Automatic Impulse Device

Step 01 – Place the RT Impulse Device below the specimen, near the edge, diametrically opposite to the acoustic sensor. Adjust the distance between the impact tip and the specimen surface to approximately 1 cm as shown next:



Step 02 – Connect the RT Impulse Device cable to the output jack at the IED Automatic Impulse Device control unit

9. Support operation

After following 8 – Support Installation steps, the SX-PD support will be ready for use:

9.1 Positioning the specimen

To carry out a fast and precise characterization of specimens using SX-PD Support:

Step 01 – Prepare the support according to all information provided up to this point;

Step 02 – Adjust the sliding props, allowing a distance between them at least 2 cm bigger than the specimen outer diameter so the specimen will rest only on the support-cables;

Step 03 – Place the specimen on the support-cables and, using a ruler, centralize the sliding props and the specimen with respect the support.

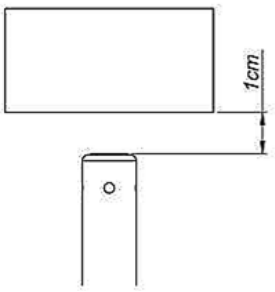
After completing these steps, the specimen will be read for characterization.

Attention! *Respect the maximum and minimum dimensions as describe in 6 – Specifications.*

9.2 Positioning the acoustic sensor

Step 01 – Mount the acoustic sensor on the vertical mounting base, as described in *8.4 – installing the acoustic sensor for acoustic signal acquisition.*

Step 02 – Adjust the acoustic sensor distance so its face is approximately 1 cm away from the face of the specimen. *Note: This distance is not critical for the results.*

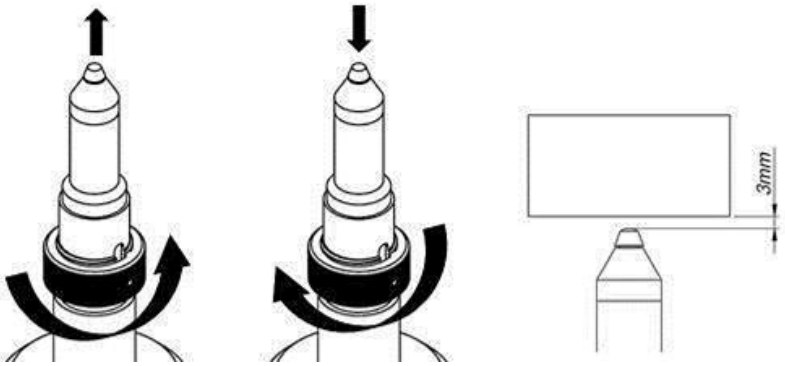


Step 03 – Position the acoustic sensor (height already adjusted) under the the specimen for acoustic response acquisition.

9.3 Positioning the IED Automatic Impulse Device

Step 01 – Install the RT Impulse Device as described in *8.5 – Installing the IED Automatic Impulse Device.*

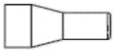
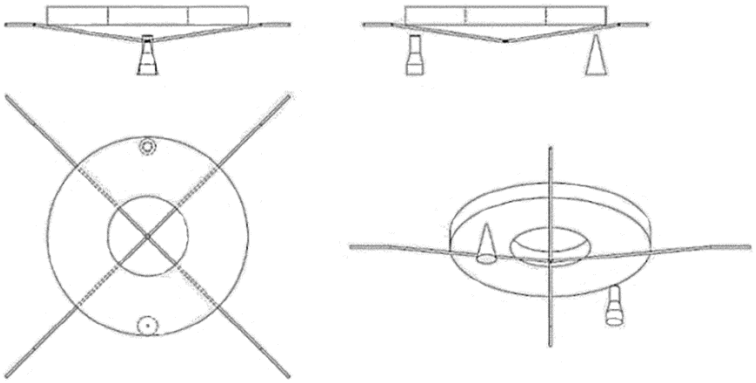
Step 02 – Turn the impulse device adjusting nut anti-clockwise so the tip of the device moves and stays at approximately 3 mm away from the specimen's face.



Step 03 – To configure the Impulse Device intensity, verify the IED Installation and Operation Manual.

10. Acquisition and excitation modes

The table below describes in details the most practical positioning of the acoustic sensor and impulse device for characterizing discs and rings employing the planar vibration mode.

<table>
<tr><td colspan="2">Impulse:  Acoustic sensor:  </td></tr>
<tr><td>Planar mode – ring (anti-flexural)
Excitation and acquisition, on the inferior face diametrically opposed.
Allows Young's Modulus (E) characterization.
Applicable only to disks and rings.</td><td>  </td></tr>
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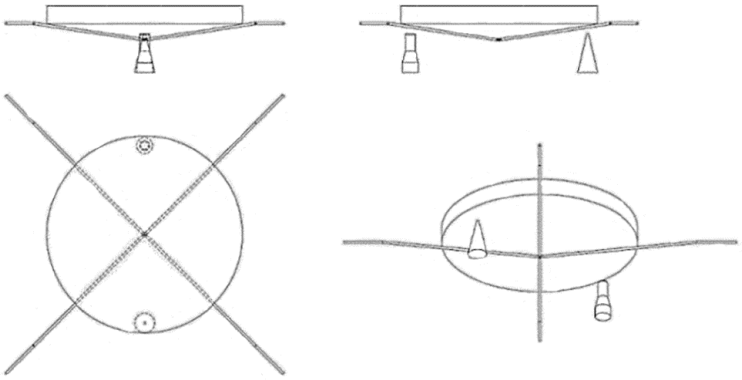
Applicable only to disks and rings.</td><td>  </td></tr>
</table>

SX-PD Support may be used to characterize the resonance frequencies of rectangular plates too, however, the equipment is not able to calculate elastic moduli for this geometry.

11. Warnings and support transportation

⚠ Reading all the information contained in this Installation and Operation Manual is compulsory for the correct use of the support;
⚠ The electricity network where the optional items and accessories will be connected for use must have a functional ground system;
⚠ Do not use this support for other purposes apart from the ones specified by this Manual;
⚠ The non-compliance with the instructions provided by this manual in what regards the use of the support may reduce or invalidate warranty time.

Support Transportation:
- Transport the support with care;
- Avoid impacts and falls when transporting the support;
- Do not transport the support under the rain, even when wrapped in its original packaging.

12. Maintenance and troubleshooting

- Depending on the specimen material, detachment of residues may occur during handling. To avoid hazards and possible damages to the support, clean frequently using a slightly damp cloth.
- To maintain the support in a good condition and extend its life, keep all accessories, optional items and chutes clean.

Troubleshooting:

Problem	Possible cause	Solution
Cable sliding prop is locked.	The sliding chutes are dirty or have been obstructed.	Clean the chutes or remove any objects obstructing the way.
The support wobbles when placed over a workbench.	The workbench surface is not completely flat or presents irregularities.	Adjust the rubber feet until the four of them are completely flat and supported by the surface.
The specimen touches the central anchor hook and disturb the measuring.	The weight of the specimen is above the specified limit.	Verify *8 – Specifications* to verify the weight limits specified by the manufactures.
Specimen does not fit between the sliding props.	The dimensions of the specimen are above the specified limits.	Verify *8 – Specifications* to verify the maximum dimensions specified by the manufactures.

13. Symbology

Attention! Risk of danger.

14. Technical support and warranty

If the support presents any abnormality, verify if the problem is listed in 12 – Maintenance and troubleshooting. If the problem still cannot be fixed, contact ATCP.

ATCP Physical Engineering offers a 12-month warranty with this support, starting from the date of purchase. It covers manufacturing defects or materials defects, but some factors may cause the loss of warranty:

1 - The non-compliance with the recommended care regarding the installation and operation of this support, as describe herein;

2 - Accidents, falls, inadequate installation or any other damage cause by incorrect use or action of natural agents.

3 - Violation, repair or any other modification or alteration done in the support or parts of the support carried out by non-authorized agents (non-authorized by ATCP Physical Engineering).

After the 12 months of warranty, parts, expenses and services shall be charged.

15. Statement of responsibility

ATCP Physical Engineering takes total technical and legal responsibility over the SX-PD Support and guarantees that all information here provided are true.

Notes: