



**RSA-G2**  
**Solid Analyzer:**  
**Linear Tension Geometry (pulling)**  
**guide**

Version 1.1.1

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November 17, 2023

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# 1 Introduction

RSA-G2 is a platform for mechanical analysis of solids. It is capable of performing accurate DMA measurements as well as many additional experiments including creep and recovery, stress relaxation, stress ramps, strain rate ramps, iso-strain, iso-force, fatigue, multi-wave, arbitrary waveform, and dielectric thermal analysis. Important specifications of the instrument are listed in table 1 (For full list of specs, visit SMIF/RSA2 website)

Minimum Force	0.0005 N
Maximum Force	35 N
Dynamic Displacement Range	$\pm 0.00005$ to $\pm 1.5$ mm
Displacement Resolution	1 nm
Temperature Range	-150 to 600 °C

Table 1: RSA-G2: force and temperature specifications



Figure 1: RSA-G2 has a touch screen displaying parameters such as **Force** (in [g]), **Gap** and **Temperature**. The keypad at the front of the instrument allows to move the head up and down at low and fast speeds.

## 2 Basic steps quick check

All of your RSA-G2 experiments will have the following general outline. In some cases, not all of these steps will be performed. The majority of these steps are performed using the instrument control software. Read chapter below and refer to resources at MSIF/RSA2 website (or RSA-G2 help) to obtain more details.

1. Select and prepare the sample.
2. Select and install the appropriate geometry for the desired test and sample.
3. Set up your experiment through the TRIOS software.
4. Zero the gap between upper and lower test geometries. This is a prerequisite to setting the gap during sample loading. Zeroing the gap requires lowering the stage until the upper and lower geometries touch, then setting the gap value to read zero millimeters. For some geometries, such as 3-pt bending, shear sandwich, clamped bending (cantilever) and mixed clamped bending, a rigid steel sample is used to perform this operation. Zero-gap is mandatory for all of fixtures. It will measure the offset between the transducer's range and the geometry's compliance for gap correction.
5. Load the sample onto the geometry. The sample loading procedure depends upon the geometry type being used. Consult the individual geometry topics for details. Refer to Available RSA-G2 Geometries.
6. Set the initial temperature through the Environmental Control panel.
7. Apply a proper axial force control if necessary, then close the oven
8. Verify End of Test options.
9. When the temperature reaches the initial value, start the test. To obtain accurate results, follow procedures carefully.

## 3 Getting started: Adding tool

- (2.1) Before you switch the machine **ON**, proceed by adding the **Linear tension geometry**. The kit for linear tension (pulling) is the number T150803.

- (2.2) Place the lower geometry on the motor shaft and tighten the set screws (fig.2).
- (2.3) Place the upper geometry on the transducer shaft, and tighten the set screws.
- (2.4) Geometry baffles prevent heat from entering the transducer and motor areas.

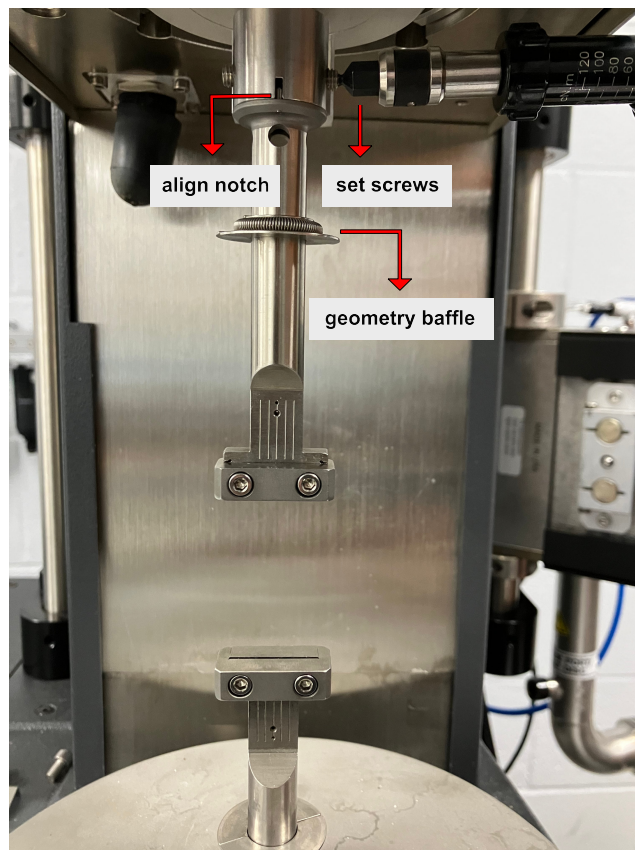


Figure 2: Adding the geometry

- (2.5) While loading the sample onto the geometry, ensure that the sample is centered between the geometry mounting surfaces. Off-center loading may cause misalignment of the transducer/motor shafts, resulting in the appearance of an overload signal. Additionally, misalignment may also affect the accuracy of the data. If misalignment does occur, the sample should be removed from the geometry and carefully reloaded.
- (2.6) Switch the RSA power **ON**. The initialization of the instrument takes around 2 minutes. When is ready, the lights in the front keypad panel

turn green and the top screen shows the values of force, gap size, etc (fig.1).

(2.7) In the computer

- Users account: DMAuser
- Password: bluedevilDMA

(2.8) Launch TRIOS and select **ARESG2-128 @Eng lab**. Click **connect**

(2.9) In **TRIOS** select the appropriate geometry from the **geometry** tab menu. For pulling, select **Tension fixture (rectangle)**

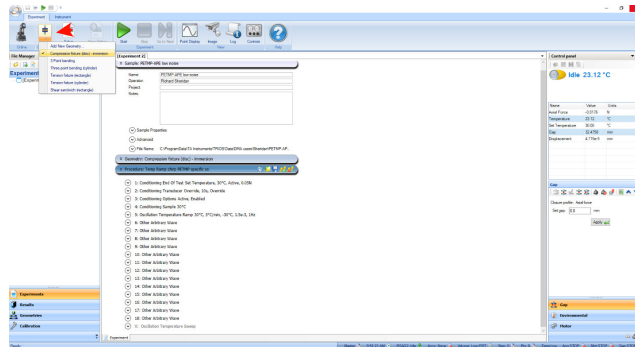


Figure 3: Define the geometry using the **Geometry** tab (red arrow) . For pulling, select **Tension fixture (rectangle)**

## 4 Control Panel

Control Panel provide control over **Gap, Environmental (temperature) conditions, Transducer and Axial force.**

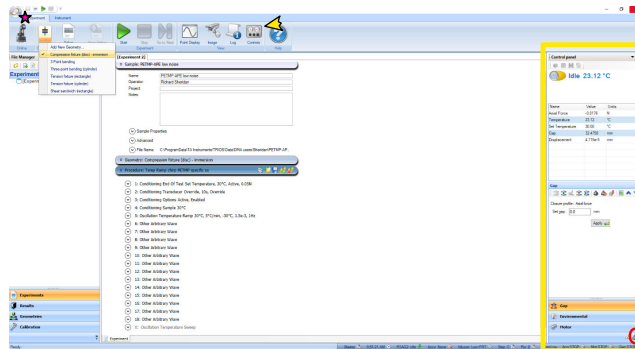


Figure 4: Control panel. Values of relevant parameters, such as **Temperature**, **Axial Force** (in [N]), etc, are found at the upper part of the panel

## 4.1 Environmental Control

Although the experiment temperature is defined in the test procedure, it is often desirable to set the temperature and other **environmental** control options prior to starting the experiments. These parameters can be changed by accessing either the **Environment** tab of the **Control Panel** within TRIOS (fig. 5)

1. The **Environment** tab allows:

- Monitor current status
- Change temperature set point.
- Enable/disable Environmental Control Unit.
- Enable/disable FCO
- Turn on/off the LN2 controller.
- Fill LN2
- Enable rapid cooling for LN2
- Turn on/off FCO oven light
- Enable rapid cooling

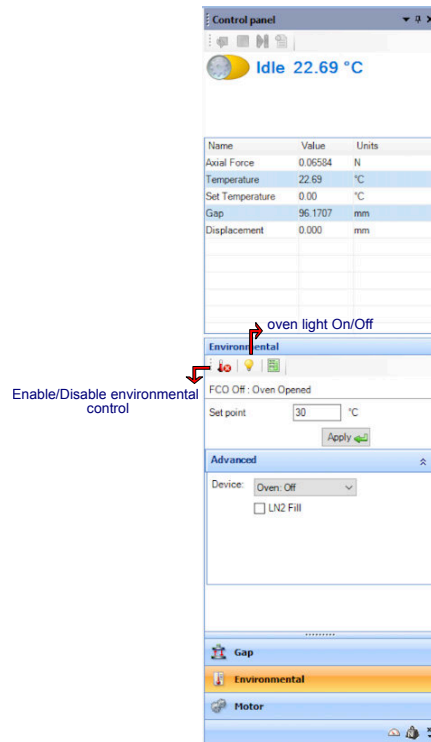


Figure 5: Environmental Controls

2. Temperature set point: in **Set Point**, enter temperature and click **Apply**
3. **Advance** tab:
  - FCO: Select the desired gas source.
  - LN2: Select the desired gas source; enable filling and rapid cooling.

## 4.2 Zeroing the Gap

Zeroing the gap between upper and lower test geometries (except for cone geometries) is a prerequisite to setting the gap during sample loading.

1. Ensure that the upper and lower geometries are clean and properly mounted.
2. Tare the transducer using the **Transducer Control panel** (fig.4 and fig.6).
3. Use the frontal keypad to manually lower the stage using the slew (rapid) mode until the tools are 0.5 [mm] apart, as determined visually.



4. in **Control Panel** go to **Gap** window (fig. 4, functions descriptions in fig 6). Click the **ZeroFixture** button. The procedure takes around 2 minutes to be completed.
5. Raise the stage to a height that allows the sample to be loaded. The sample can now be loaded. When the stage is lowered, the correct distance between geometries is displayed.







RSA-G2 Gap Control Panel Functions	
Item	Function
<b>Stop Head</b> 	Stops any head movement.
<b>Go To Geometry Gap</b> 	Moves the head to the value specified in the geometry gap/truncation gap field for the current geometry.
<b>Go to Loading Gap</b> 	Moves the head to the value specified in the loading gap field for the current geometry.
<b>Zero Fixture</b> 	Runs the zero gap routine.
<b>Tare Gap</b>	Tares the current gap position to zero.
<b>Tare Transducer</b> 	Used to tare both the torque and normal force transducers. Generally used in conjunction with Axial force adjustment or gap setting functions.  On the RSA-G2 touch screen, yellow indicator lights appear next to Tare Torque and Tare Normal on the Instrument tab when an offset is in effect. Note: this control does not bias the fast torque and normal force signal during the data acquisition process.
<b>Remove Transducer Tare</b> 	Removes the transducer tare.
<b>Head up</b>	Moves head up while button remains pushed.
<b>Head down</b>	Moves head down while button remains pushed.
<b>Options</b>	Shortcut to Gap Options.
<b>Set gap</b>	Enter a value and click <b>Apply</b> (the green arrow).

Figure 6: Control Panel functions

If using **Environmental Control**: The effective gap does not only depend on the measured position of the transducer stage, but also on the expansion of the test geometry when temperature changes. When a new test fixture is installed, zero gap is referenced to the position of the stage at the actual temperature. When the temperature and the test geometry length change, the reported gap is corrected for the expansion of the test geometry based on the value of the expansion coefficient. The expansion coefficient for the stainless steel plate geometry in the FCO is typically 2 to 3  $\mu\text{m}/^\circ\text{C}$ . Refer to **Basic Steps Manual in SMIF/RSA2 website**

## 5 Loading the sample

1. Place the sample between the jaws and tighten the geometry's screw. Using the hex wrench included in the kit, tighten the sample loading bolts to secure the specimen in place. Ensure that the sample is aligned in the geometry by using the scribed lines on the flat plate of the sample geometry jaws. This is of particular importance for fiber specimens.
2. Examine the sample to ensure that it exhibits neither wrinkles nor kinks. If these are present the sample should be remounted.
3. Using the stepper motor control buttons on the test station, adjust the stage to provide a very slight tension (less than 1 gram), as indicated by the NORMAL FORCE meter indication on the front panel display, or the Gap Control panel.
4. If desired, properly position the geometry baffles.

## 6 Setting Axial Force (optional)

Axial force control should be used when materials expand (and/or contract) or slip during testing. If changes in volume occur, the material will either be subject to a normal stress field or shrink away from the testing geometry; either situation will cause errors in the results. Generally, volume changes within a material occur by changes in temperature, solvent/moisture loss, or when the material gels or cures. In order to convey the use of axial force completely, the remainder of this section will associate the volume change of a material with a change in temperature, described by the coefficient of expansion. The most widely used test mode to control axial force is in the oscillation mode with a temperature ramp. Axial force control is also used to maintain a static force on the sample to avoid unloading of the sample during oscillation testing.

Axial force control prior to the start of a test procedure is set in the Axial force section of the Control panel. Activate axial force control after loading the sample, but before enabling temperature control.

- In **Control Panel**(fig. 4, red circle)
- Define the type of test:**Compression** or **Tension**
  - Select between: **Tension and Compression**: Define the direction of axial force control by selecting the appropriate radio button. For

example, select Tension for tensile fixtures, and Compression for compression parallel plates or bending fixtures.

- Set **axial force** value in [N]
  - **Axial force** control should be used when materials expand (and/or contract) or slip during testing. If changes in volume occur, the material will either be subject to a normal stress field or shrink away from the testing **geometry**; either situation will cause errors in the results. Generally, volume changes within a material occur by changes in temperature, solvent/moisture loss, or when the material gels or cures. In order to convey the use of axial force completely, the remainder of this section will associate the volume change of a material with a change in temperature, described by the coefficient of expansion. The most widely used test mode to control axial force is in the oscillation mode with a temperature ramp. Axial force control is also used to maintain a static force on the sample to avoid unloading of the sample during oscillation testing.

## 7 Setting experiments in TRIOS

1. In **TRIOS**, Go to tab **Experiment**
2. Name your experiment and add the path to the folder for saving data.
3. in tab **Geometry** add the dimensions of your sample.
4. In **Procedure**, open a previous procedure or create a new one (fig.7).

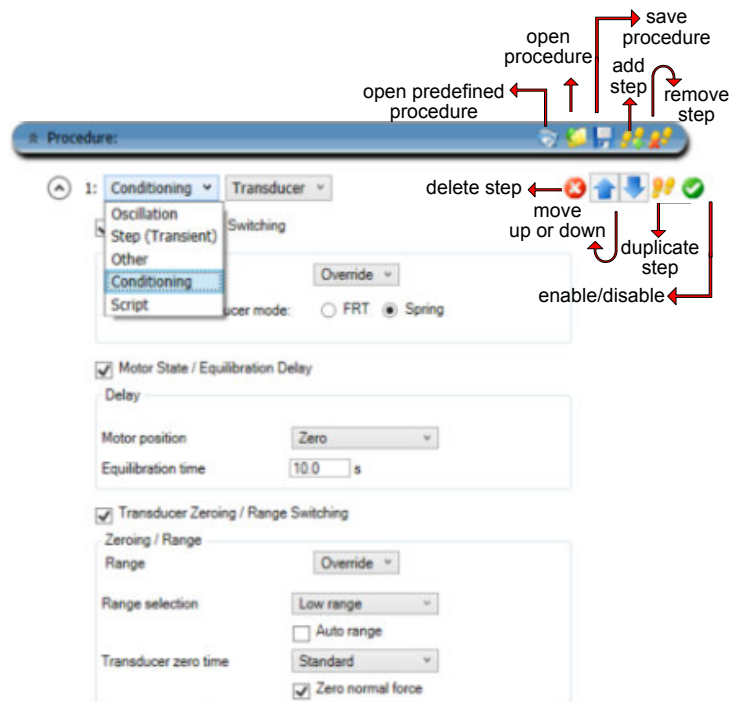


Figure 7: Procedure tab functions.

5. Add a "step test". Options are: **Conditioning, Oscillation, Other, Step(Transient) and Script**. Each step test has a sub-menu of **test modes**. Note that the procedure runs in sequence from **top to bottom**.
  - For detailed information about the options for each step and step mode read the specific guidelines found in **TRIOS Help**. The most relevant ones can be found at the **SMIF/RSA2 website** (<https://smif.pratt.duke.edu/capabilities/56185>). We encourage users to carefully read relevant material before coming to the lab
  - **Conditioning tests** are passive test types in the sense that no test is performed or no test data is generated. Conditioning tests are usually added as the first step in a procedure and can also be inserted among tests to change settings. There is no need to insert a Conditioning test unless the current default conditions should be overwritten. The Condition step controls instrument (motor position, transducer zero acquisition) and environmental (temperature) conditions, as well as test performance conditions such as axial force, strain adjustment (auto strain), stress control tests (creep and recovery), and delays (equilibrium time).

- Select **Other**, test mode **Axial tests** to deform the sample, while controlling the vertical motion of the slide. The dynamics of the axial tests depend on the performance of the motor for the slide motion. Either the axial (normal) force or the vertical displacement is controlled.
- Select **Oscillation tests** to continuously loaded/unloaded the sample with a cyclic deformation for a selected number of cycles.

## 8 Saving Your Data

1. Save your procedure (fig.7) and data. Data can be exported to TXT or Excell, click in the **TA** button at the top left of the screen (fig.4, pink star).

## 9 Shut Down

1. close TRIOS
2. Open the gap manually using the front Keypad and remove your sample
3. Turn off the RSA
4. remove Geometries
5. clean the geometry, if needed, using isopropanol.