Stress relaxation tests on rubber materials have become highly popular for determining the properties of rubber. From the beginning stress relaxation tests were predominantly used in scientific projects at universities, but a growing use in industrial applications has been shown in recent years, mainly due to the introduction of stress relaxation tests in different product standards, such as sealing rings for pipes and in specifications in the automotive industry.

Stress relaxation is a reduction in the counterforce for maintaining the applied strain, the force is not constant but decreases with time when the material ages. This is expressed as a percentage of the initial force.

The process that is mainly responsible for stress relaxation may be chemical or physical in nature, and under normal conditions both types of process will occur simultaneously.

However at low or normal temperatures, and/or over a short time, stress relaxation is dominated by physical processes whilst over long time periods or high temperatures chemical processes are dominant.

A key factor in achieving good reproducibility and repeatability while conducting the stress relaxation test is to keep the temperature and compression constant during all measurements.

There are mainly two different ways of testing stress relaxation, continuous and discontinuous. One advantage with continuous testing is that it requires much less labour time of the operator.

Simplified you can describe the continuous test as a test that you start and then don’t have to think about until the test time is ended. The same simplified description of the discontinuous test would be that you make a manual measuring of the force, put the test rig away for ageing, at specified time intervals the rig is removed from the ageing environment, a new manual measurement is taken and the rig returned to the ageing process, this continues until the test is terminated.

Standardised test methods
The present standard ISO 3384-1 includes two methods, A and B, which can be used in both air or liquids.

In method A, the compression is applied and all counterforce measurements are made at the test temperature.

In method B, the compression is applied and all counterforce measurements are made at standard laboratory temperature. The test pieces are stored at the test temperature.

ISO 3384-2 is a newer second part describing tests with temperature cycling.

ISO 6914 method A describes the testing of stress relaxation in tension.

Our equipment will naturally work with other technically equivalent standards as well.
Continuous test system

- Stress relaxation rigs – the ISO standards recommend 3 samples/material/temperature, but 2 are ok
- Amplifier box
- Cell ageing oven – specially designed for stress relaxation tests, for testing in elevated temperatures, cycling temperatures or temperatures below laboratory temperature
- Computer
- Software
- UPS

Optional accessories

- Extension cords
- Liquid containers
- Room temperature box, for testing in room temperatures or for conditioning of the samples
- Low temperature box, for testing in temperatures between +4 and +40 °C

Discontinuous test system

- Jigs
- Ageing oven
- Compression tester
- Computer
- Software

Optional accessories

- Liquid containers
- Oven – for measurements at subnormal and elevated temperatures
- Liquid circulator – to control the temperature of the oven

Comparison of continuous and discontinuous stress relaxation testing

<table>
<thead>
<tr>
<th>Continuous stress relaxation testing</th>
<th>Discontinuous stress relaxation testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less manual work, measurement will continue throughout the test after it is started.</td>
<td>More manual work, needed to manually perform the measurements at certain points during the test period.</td>
</tr>
<tr>
<td>Logging automatically and continuously which means that if wanted, it is possible to obtain measured values from any given point from the test after the test is terminated.</td>
<td>No extra data is saved, only the manual taken measurements. Not possible to add extra evaluation points after the test is finalized.</td>
</tr>
<tr>
<td>No physical movement of the rigs after the test is started.</td>
<td>It has been shown that each time a rig is moved the result may be affected due to the vibration that occurs in this operation.</td>
</tr>
<tr>
<td>Most of Elastocon’s customers around the world ask for this type of testing, several big companies have it in their company standard.</td>
<td>Less customers ask for this type of test, it is included in the internal standards of some large companies.</td>
</tr>
<tr>
<td>Possible to run tests automatically according to ISO 3384-1, ISO 3384-2 as well as ISO 6914 and other technically equivalent standards.</td>
<td>No automatic testing is possible, requires a lot of manual work. But testing according to ISO 3384-1 and 3384-2 is possible of course.</td>
</tr>
<tr>
<td>Possible to run tests automatically with either stable or cyclic temperatures.</td>
<td>The temperature will not be stable throughout the whole test, the measurements will, as default, take place in ambient room temperature (can also be done within a special temperature chamber).</td>
</tr>
<tr>
<td>Test either in compression or tension, in air/gases or liquid.</td>
<td>Test in compression, air or liquid (liquid might be rather messy during the measurements).</td>
</tr>
<tr>
<td>Automatic testing according to ISO 3384-1 method B with a programmable oven.</td>
<td></td>
</tr>
<tr>
<td>Cycling testing according to ISO 3384-2 in temperature interval -40 to +250 °C</td>
<td></td>
</tr>
</tbody>
</table>
Stress Relaxation Rig, EB 02
This is a rig for continuous stress relaxation measurements in both compression and tension.

EB 02 relaxation rigs arranged for different test methods

<table>
<thead>
<tr>
<th>Rig</th>
<th>Type of testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>EB 02</td>
<td>Compression, temperatures up to 200 °C (ISO 3384).</td>
</tr>
<tr>
<td>EB 02HT</td>
<td>Compression, temperatures up to 300 °C (ISO 3384).</td>
</tr>
<tr>
<td>EB 02HF</td>
<td>High force compression, up to 45 kN, temperatures up to 300 °C (ISO 3384).</td>
</tr>
<tr>
<td>EB 02TE</td>
<td>Tension, temperatures up to 200 °C (ISO 6914).</td>
</tr>
<tr>
<td>EB 02TEHT</td>
<td>Tension, temperatures up to 300 °C (ISO 6914).</td>
</tr>
<tr>
<td>EB 02AP</td>
<td>Acid proof material for testing in liquids and compression, temperatures up to 150 °C, including air tight liquid container and compression plate (ISO 3384).</td>
</tr>
<tr>
<td>EB 02SA</td>
<td>Super acid proof material for testing in liquids and compression, temperatures up to 200 °C, including liquid container and compression plate (ISO 3384).</td>
</tr>
<tr>
<td>EB 02ALE</td>
<td>Compression with possibility to exchange liquid and air, temperatures up to 200 °C.</td>
</tr>
</tbody>
</table>

Liquid containers
Available in standard version which are not air tight or as an air tight container that can be used up to a pressure of 3 Bar.

Accessories to the rigs

<table>
<thead>
<tr>
<th>Rig</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EB 02.01</td>
<td>Container and pressure plate for measurements in liquid for temperatures up to 200 °C (only for EB 02 rig).</td>
</tr>
<tr>
<td>EB 02.01P</td>
<td>Air tight container and pressure plate for measurements in liquid for pressure up to 3 Bar and temperatures up to 150 °C (only for EB 02 and EB 02AP rig). A pressure gauge (EB 02.01P6) for this container is also available as an option.</td>
</tr>
<tr>
<td>EB 02.05.1</td>
<td>Extension cord for load cells, 2.5 m (for other placement of amplifier box than directly behind the cell oven).</td>
</tr>
<tr>
<td>EB 02.05.2</td>
<td>Extension cord for temperature sensor, 2.5 m (for other placement of amplifier box than directly behind the cell oven).</td>
</tr>
<tr>
<td>EB 02.26</td>
<td>Test piece holder for the relaxation rig for ageing other samples simultaneously as the relaxation test.</td>
</tr>
<tr>
<td>EB 02.23</td>
<td>Stand for relaxation rigs for secure placement on the laboratory bench.</td>
</tr>
</tbody>
</table>

Instruments for continuous testing of stress relaxation
When testing stress relaxation in fuels and oils the liquid may be ageing faster than the rubber, so the liquid has to be replaced at intervals.

The testing is traditionally done in a closed container without oxygen present and this does not correlate with the actual situation in a fuel tank or a motor.

To make it possible to perform more realistic ageing tests we have developed a system where we replace the liquid by pumping and we add air and have an agitation of the liquid to get the air and newly inserted liquid evenly distributed. The rate of liquid exchange and air can be programmed.

The ALE-test instrument was developed in a joint project with Scania, AB Volvo, Volvo Cars, SP Technical Research Institute of Sweden, Lanxess and Elastocon about ageing of elastomers in biofuels. The project was financed by the Swedish Energy Agency and participating companies.

EB 02ALE rig with EB 02.24-x ALE control box
The electronic control box handles both the liquid circulation, air pump and the stirrer function of the ALE-rig. All of these parameters are controlled from the PLC colour touch screen on the control box.

X = number of rigs that can be connected to the control box, available in sizes; 2, 4 or 6 rigs per box.

EB 02HF is a rig for very high forces, which enables stress relaxation test in compression with forces up to 45 kN (45 000 N). The compression is made in an external compression tester (not included).

The EB 02HF.01 oven for the high force rig is specially designed to keep the temperature on the high force rig and the sample during the compression in the external tension-compression tester.

The graph shows a test run in motor oil with and without the ALE-test. The blue curve is the rigs in conventional relaxation and the green curve is with aeration.

EB 02.14-x. The amplifier box communicates via a network connection. This means that the amplifier can be directly connected to the network connector on a PC, or anywhere in a local ethernet network.

The box can also have up to 24 channels or connect 12 relaxation rigs.

X = number of rigs that can be connected to the amplifier box, available in sizes; 2, 4, 6, 8 or 12 rigs/box.

EB 02HF rig with EB 02.24-x ALE control box
The electronic control box handles both the liquid circulation, air pump and the stirrer function of the ALE-rig. All of these parameters are controlled from the PLC colour touch screen on the control box.

X = number of rigs that can be connected to the amplifier box, available in sizes; 2, 4, 6, 8 or 12 rigs/box.
Cell Ovens for Stress Relaxation

Elastocon offers cell ovens designated for stress relaxation tests. This means that the inner height of the cells are adapted to fit our relaxation rigs so that they will achieve as good thermal contact as possible with the bottom of the cell.

The ovens have an integrated draught hood that eliminates the changes in the force during the test, due to temperature changes in the environment around the top part of the rigs. The hood is made of polycarbonate, and has a temperature control system (Peltier cooling system) capable of keeping the temperature within ± 0.25 °C.

The ovens are available in the following versions:

**EB 21** 4 cells with individual temperature control.
**EB 22** 6 cells with individual temperature control.
**EB 23** 4 cells with the same temperature control.
**EB 17** 6 cells with the same temperature and cycling between subzero to elevated temperature.
**EB 23 LTP** 4 cells with the same temperature and cycling between RT to elevated temperature.

Common specifications for EB 17, EB 21, EB 22 and EB 23 cell ovens

- The ovens perform well inside the apparatus requirements in ISO 188, IEC 811 and other equivalent standards.
- The oven is controlled from a PLC (with a colour touch screen).
- Integrated draught hood.
- Special design with controlled air exchange rate and low air speed.
- The casing consists of steel, painted with powder paint in bluegreen colour.
- The inner cells are made of aluminium.
- Temperature controller with 0.1°C setpoint (PLC) or liquid circulator EB 17.
- Fixed over temperature fuse.
- Flowmeters with needle valves, for setting the air exchange rate.
- The air speed is low and is dependent on the air exchange rate only, as specified in ISO 188 method A.
- Alarm for low air pressure (PLC).
- Built in air pump.
- Cooling channels in the casing for low surface temperature.
- Temperature controlled cooling fan for the electronics cabinet.
- Indication of power failure (PLC).
- Run-time meter (PLC).
- Countdown timer (PLC).
- Individual cell identifier “Test name”.
- Microfilter for the air which removes 99.99 % of all particles over 0.1 μm.
Room temperature box

The room temperature box, EB 02.08, is used when testing at room temperature to avoid variation in the load curve caused by temperature variation in the laboratory.

The capacity of the box is 8 rigs. It can also be used for conditioning test pieces at 23 °C.

Low temperature box

The low temperature box, EB 02.25 is almost the same as EB 02.08, but this box is equipped with water cooling by tap water. This cooling enables temperature range between +4 to +40 °C. Tap water temperature cannot exceed +18 °C.

EB 02.08/EB 02.25
• The casing consists of steel, painted with powder paint in bluegreen colour.
• Temperature is set from a computer.

Temperature cycling relaxation tests

Temperature cycling is important within the automotive industry, where the shrinkage of the seals is an important factor, since this can lead to leakage. We have two different solutions for temperature cycling ovens.

EB 17 with 6 cells with the same temperature for all cells, is combined with liquid circulator EB 17.01 for temperatures between -40 to +200 °C. A high temperature option is also available, EB 17HT + EB 17.01, for temperatures between -40 to +245 °C. Both options can run tests according to ISO 3384-1 method A and B, ISO 3384-2 as well as ISO 6914 method A.

Our second type of cell oven for cycling temperature is EB 23LTP, it has 4 cells with the same temperature for all cells, with temperature range between approximately +20 to +200 °C. This oven is cooled with tap water, which should not exceed +18 °C to have a satisfying cooling function throughout the whole temperature interval. The lowest temperature is dependent of the tap water temperature. This oven can run tests according to ISO 3384-1 method A and B as well as ISO 6914 method A.

All-in-one computer, ED 04, to run the Relaxation Testing software

The ED 04 computer has Windows, minimum i5 processor, 8 GB RAM, 20-inch monitor, keyboard, mouse.

Uninterruptible Power Supply (UPS), ED 06

To eliminate disturbances from shorter power failures. The computer and amplifier box is recommended to be connected to a power back up. Only available for 230V, 50-60Hz, 1000 VA double conversion.
Software for Relaxation Testing, EC 05

This software evaluates results from relaxation tests according to ISO 3384 and ISO 6914.

The software is user friendly and many functions can be done by a mouse click.

**Functions**

- Evaluation points showing relaxation at different times.
- End condition can be set as $F/F_0$ or time.
- Possibility to calculate the median value when testing double or triple test pieces.
- Calculated compensation for the load cell deformation can be switched on or off.
- Automatic increase of logging time interval.
- Switching between graphic presentation in absolute force in N or $F/F_0$.
- Switching between absolute time or relative time.
- Easy to "zero" the force.
- Easy to set $F_0$.
- All information in the same window.
- Presentation as linear or logarithmic time.

**Presentation view**

In the **presentation view** test data can be presented and compared and printed as a test report.

**Viewer**

We can also supply a separate "Viewer" software which can be installed on other computers in the network. The operator can then check and evaluate the tests from the office computer.

**Configuration view**

In the **Configuration view** the user can combine one, two or three rigs to a group. Data for the group is saved in one file. The software calculates the median results from the rigs in the group.

**Group Setup**

In the **Group Setup** the file name is given together with comments. The logging intervals are set in a table and will change automatically. The end conditions are set as time, $F/F_0$, or a combination of both.
Software for Relaxation Testing, EC 05

Logging view

In the Logging view the user sets the logging details, the evaluation points – time for $t_0$ and $F_0$, the colour of curves and starts the test.

Station Setup

In the Station Setup the user sets the type of test, compression or tension and the test piece dimensions.

Evaluation points

For each Group (= File) times can be given when the software will calculate the percent relaxation and $F/F_0$.

Examples of test results

The graph shows a comparison of three materials.

The graph shows the repeatability of the relaxation rigs. This graph is from two tests of the same compound run at different times.

This is a graph from two samples of the same compound run at the same time in different rigs.
Support Agreement

We can offer you a support agreement, which will be valid for 12 months before renewal. Included in the support agreement are:

- Free e-mail and telephone support for both technical and testing issues
- Free remote control support for problem solving and/or updates
- Free software update during the validity time of the support agreement.

The support agreement should be renewed annually for continuous validity.

Estimation of lifetime from relaxation tests

Stress relaxation tests are ideal for making lifetime estimations using an Arrhenius plot.

How to do an estimation of lifetime of rubber materials using an Arrhenius plot is described in the ISO standard ISO 11346.

When doing an Arrhenius plot, tests are made of a critical property at different times and at least at three test temperatures.

The tests are normally run until the properties are reduced to 50% of the original value, see figure.

The time to reach this level is determined for each temperature.

The test temperatures are chosen so the test time for the highest temperature is at least one week and the time for the lowest temperature is about 3–9 months.

The times to reach the "end of life" time for each temperature are plotted in an Arrhenius plot, which is a graph with logarithmic time on the Y-axis and 1/T on the X-axis, where T is the temperature in Kelvin, see figure.

A straight line is drawn through the points and extrapolated to the temperature of use, to obtain an estimation of the life-time of the tested material.

Please note that this function is not included in the EC 05 software, this page is strictly informative.
With the Automatic Relaxation and Creep Tester EB 18-II-3 tests can be carried out automatically.

The instrument has individual control of each test station as well as the temperature of each cell.

The test rigs are based on our relaxation rig EB 02, but here the lowering and raising of the rigs as well as the compression or stretching of the samples are motor driven by a servo motor.

The instrument is, by default, delivered with compression plates and 1000 N load cells with a temperature range between +40 up to +200 °C.

If testing at room temperature is wanted, the test can be performed with the rigs in their raised position in the hood instead of down in the cells of the oven.

Other accessories such as for testing in liquids, tension or temperature range up to +300 °C can be ordered separately.

The test rigs are built into a cabinet made of polycarbonate with aluminium profiles, which provides the same temperature stability around the upper part of the rigs as our other continuous relaxation test systems.

The oven is one of our high precision ageing ovens, and meets the international standard ISO 188 method A as well as other technically equivalent standards.

Easy to change between test methods

Both testing methods, stress relaxation and creep uses the same accessories. The shifting between the two test methods is done when the software is started. Changing between compression and tension consist of a simple rebuilding of the rigs, thoroughly described in the manual.
For Stress Relaxation Tests

- Relaxation tests can be done in both compression and tension.
- Utilising load cells and servo motors to apply and hold the compression in the EB 18-II-3, automatically compensates for the spring effect in the load cells.
- The compression or tension in mm or % is set in the software and the computer instructs the closed loop circuit of the servo motor and load cell amplifier to keep the set value.
- High accuracy in the displacement measurement.
- Results are presented in graphical or table formats as absolute relaxation in N or as F/F₀ in absolute or relative time as well as linear or log time.
- Possibility of running new features such as load and temperature ramps controlled by the computer.
- Test can be made in liquids using a liquid container (option).

![Relaxation test. The red curve is the temperature, the green curve is the force and the blue curve shows the position and each step is an adjustment of 0.001 mm.](image)

For Creep tests

- Creep test can be done in both compression and tension.
- Utilising load cells and servo motors to apply and hold the load, the EB 18-II-3 tester eliminates the handling problems associated with dead load weights.
- The load in MPa or N is set in the software and the computer instructs the closed loop circuit of the servo motor and load cell amplifier to keep the set load. This means that the load is kept even if the computer fails.
- High accuracy in the displacement measurement.
- Results are presented in graphical or table formats as absolute creep or creep index. In order to study the actual sample failure the data logging rate is increased just before break occurs.
- Possibility of running new features such as load and temperature ramps controlled by the computer.
- Test can be made in liquids using a liquid container (option).

![Creep test. The red curve is the temperature, the green curve is the load and the blue curve is the creep.](image)
The Film Creep Tester EB 24 is based on our Ageing Oven EB 10-II, with a digital ruler system including a line laser pointer for manually measuring the creep. The ruler is connected to the included computer and the values are fed into an spreadsheet template, which calculates the result and presents the graphs.

**Common specifications**

- The oven performs well inside the apparatus requirements in ISO 188, IEC 811 and other equivalent standards.
- Special design with controlled air exchange rate and low air speed.
- The casing consists of steel, painted with epoxy powder paint in bluegreen colour.
- The inner chamber is made of stainless steel.
- Temperature controller with 0,1°C setpoint.
- Solid state relay for safe control.
- Temperature indicator with sensor in the inner chamber.
- Fixed over temperature fuse.
- Fixed set air exchange rate 7 or 14 changes per hour, preset by manufacturer.
- The air speed is low and is dependent on the air exchange rate only.

- Cooling channels in the casing for low surface temperature.
- Controlled cooling fan for the electronics cabinet.
- Run-time meter.
- Countdown timer.
- Door sensor to turn off laser and illumination when the door is opened.

**Options**

- **EB-P** Ramp function for temperature settings in the PLC.
- **EC 11** Monitor software.
- **ED 06** UPS 1000 VA double converter.
- Network cable.
The test jigs for stress relaxation are simple in design but made with very high accuracy regarding surface finish and parallelism of the platens.

The discontinuous stress relaxation system has an economic advantage when many materials are to be tested during very long times.

The instrument is a specialised compression tester controlled by the included computer.

The software permits several types of tests to be performed, such as:

- discontinuous stress relaxation tests according to ISO 3384 method A or method B.
- standard compression tests to measure modulus, such as in ISO 7743.
- customer specified tests on products like O-rings and profiles.

The results can be expressed in different ways:

- for stress relaxation as absolute force, relative force, F/F₀, against time.
- for compression tests as MPa, N, and N/m length.
- for O-rings the result is expressed as N/mm average circumference.

The very accurate compression results are obtained due to the high accuracy in the displacement measurement, which includes a compensation for deformation in the load cell and in the instrument.

If equipped with the optional oven, test can be performed from -40 °C to +200 °C. This means that relaxation tests according to ISO 3384 method A can be performed when using the oven. The precision of tests made according to Method B is also improved at 23 °C, if the oven is used. A container for testing in liquids is also available (optional).

A new Elastometer model is under development. This image shows the previous model, EF02.

With this oven it is possible to make tests according to both method A and B of ISO 3384.

When performing tests according to method A (measurements at test temperature), the test jig is transferred from the ageing oven to the Elastometer oven and when the test temperature has stabilised the measurement is done.

When doing tests according to method B (measurements at standard laboratory temperature) the jigs are removed from the ageing oven and left to cool in the laboratory temperature. When the jig has reached about the correct temperature the jig is placed in the Elastometer oven (+23 °C) and when the test temperature has stabilised the measurement is done.

If a circulator with compressor cooling is used it is possible to study the counterforce at subzero temperatures.
# Technical specifications

## Stress Relaxation Rig

<table>
<thead>
<tr>
<th></th>
<th>EB 02</th>
<th>EB 02HT</th>
<th>EB 02TE</th>
<th>EB 02TEHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum temperature, °C:</td>
<td>+200</td>
<td>+300</td>
<td>+200</td>
<td>+300</td>
</tr>
<tr>
<td>Default range in compression/tension, N:</td>
<td>1000</td>
<td>1000</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Resolution, compression/tension, N:</td>
<td>0,1</td>
<td>0,1</td>
<td>0,01</td>
<td>0,01</td>
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<tr>
<td>Optional range in compression, N (must be specified in order):</td>
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<td>–</td>
<td>–</td>
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<td>Resolution, compression/tension, N:</td>
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<td>0,05/0,2</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Accuracy, %:</td>
<td>± 0,1 of full range</td>
<td>± 0,1 of full range</td>
<td>± 0,1 of full range</td>
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<tr>
<td>Dimensions, dia × h, mm:</td>
<td>120 × 450</td>
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</tr>
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<td>Weight, kg:</td>
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<tr>
<td>Material:</td>
<td>Stainless steel</td>
<td>Stainless steel</td>
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<td>Temperature sensor:</td>
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<td>Pt 100, 1/3 DIN</td>
<td>Pt 100, 1/3 DIN</td>
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<td>Standards:</td>
<td>ISO 3384</td>
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<td>ISO 6914</td>
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</table>

**Suitable accessories**

<table>
<thead>
<tr>
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<th>EB 02</th>
<th>EB 02HT</th>
<th>EB 02TE</th>
<th>EB 02TEHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid container:</td>
<td>EB 02.01</td>
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<td>EB 02.12</td>
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</tr>
<tr>
<td>Air tight container:</td>
<td>EB 02.01P</td>
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<td>–</td>
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</tr>
<tr>
<td>Pressure gauge for air tight container:</td>
<td>EB 02.01P6</td>
<td>–</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Test piece holder:</td>
<td>EB 02.26</td>
<td>EB 02.26</td>
<td>EB 02.26</td>
<td>EB 02.26</td>
</tr>
<tr>
<td>Extension cords for load cell:</td>
<td>EB 02.05.1</td>
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<tr>
<td>Extension cords for temperature:</td>
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<td>EB 02.05.2</td>
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</tr>
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</table>

## Stress Relaxation Rig

<table>
<thead>
<tr>
<th></th>
<th>EB 02AP</th>
<th>EB 02SA</th>
<th>EB 02ALE</th>
<th>EB 02HF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum temperature, °C:</td>
<td>+150</td>
<td>+200</td>
<td>+200</td>
<td>+200</td>
</tr>
<tr>
<td>Default range in compression/tension, N:</td>
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<td>0,05/0,2</td>
<td>0,05/0,2</td>
<td>–</td>
</tr>
<tr>
<td>Accuracy, %:</td>
<td>± 0,1 of full range</td>
<td>± 0,1 of full range</td>
<td>± 0,1 of full range</td>
<td>± 0,1 of full range</td>
</tr>
<tr>
<td>Dimensions, dia × h, mm:</td>
<td>120 × 450</td>
<td>120 × 450</td>
<td>120 × 450</td>
<td>120 × 450</td>
</tr>
<tr>
<td>Weight, kg:</td>
<td>4,5</td>
<td>4,5</td>
<td>4,5</td>
<td>4,5</td>
</tr>
<tr>
<td>Material:</td>
<td>SS2343 (acid proof)</td>
<td>SS2378 (super acid proof)</td>
<td>Stainless steel</td>
<td>Stainless steel</td>
</tr>
<tr>
<td>Temperature sensor:</td>
<td>Pt 100, 1/3 DIN</td>
<td>Pt 100, 1/3 DIN</td>
<td>Pt 100, 1/3 DIN</td>
<td>Pt 100, 1/3 DIN</td>
</tr>
<tr>
<td>Standards:</td>
<td>ISO 3384</td>
<td>ISO 3384</td>
<td>ISO 3384</td>
<td>ISO 3384</td>
</tr>
</tbody>
</table>

**Suitable accessories**

<table>
<thead>
<tr>
<th></th>
<th>EB 02AP</th>
<th>EB 02SA</th>
<th>EB 02ALE</th>
<th>EB 02HF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid container:</td>
<td>–</td>
<td>included</td>
<td>included</td>
<td>–</td>
</tr>
<tr>
<td>Air tight container:</td>
<td>included</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Pressure gauge for air tight container:</td>
<td>EB 02.01P6</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Test piece holder:</td>
<td>–</td>
<td>included</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Extension cords for load cell:</td>
<td>EB 02.05.1</td>
<td>EB 02.05.1</td>
<td>EB 02.05.1</td>
<td>EB 02.05.1</td>
</tr>
<tr>
<td>Extension cords for temperature:</td>
<td>EB 02.05.2</td>
<td>EB 02.05.2</td>
<td>EB 02.05.2</td>
<td>EB 02.05.2</td>
</tr>
</tbody>
</table>

### Included in the purchase of relaxation rigs
- Manual in English
- Necessary tools
- Accredited calibration with certificate

## Types of Stress Relaxation rigs

- **EB 02**: Compression
- **EB 02HT**: Compression, high temperatures
- **EB 02TE**: Tension
- **EB 02TEHT**: Tension, high temperatures
- **EB 02AP**: Acid proof material for testing in liquids and compression
- **EB 02SA**: Super acid proof material for testing in liquids and compression
- **EB 02ALE**: Compression with liquid exchange and aeration
- **EB 02HF**: High force compression

Elastocon reserve the right to modify these specifications in part or in whole.
Technical specifications

Container and compression plate for testing of stress relaxation in liquids, EB 02.01

- Maximum temperature, °C: +200
- Diameter, mm: 90
- Height, mm: 95
- Weight, kg: 1
- Material: Stainless steel

Container for testing of stress relaxation in liquids (tension), EB 02.12

- Maximum temperature, °C: +200
- Diameter, mm: 90
- Height, mm: 150
- Weight, kg: 1.4
- Material: Stainless steel

Airtight container for testing of stress relaxation in liquids (compression), EB 02.01P

- Temperature range, °C: +5 to 150
- Diameter, mm: 90
- Height, mm: 95 + 25
- Weight, kg: 1.1
- Material: Stainless steel
- Seals: FPM default or EPDM

Consumables

- EB 02.01P1: set of 6 O-rings, FPM for EB 02.01P
- EB 02.01P2: set of 6 O-rings, EPDM Peroxide cured for EB 02.01P

Test piece holder for relaxation rig, EB 02.26

On the holder there are room for either 5 small O-rings or standard specimens e.g. ISO 37-3 alternatively 3 bigger O-rings (e.g. 40 mm in diameter).

Amplifier Box EB 02.14

Pt 100 input

- Connection type: 3 wire
- Temperature range; °C: -200 to +850
- Resolution, °C: 0.1
- Conversion time, ms: 320
- Measuring error (25 °C), %: ±0.2 of full range
- Bit width, bits: 2 × 16

Load Cell input

- Signal voltage, Ud, mV: -16 to +16
- Signal voltage Uref, V: -10 to +10
- Resolution, bits: 16
- Conversion time, ms: 250
- Measuring error, %: 0.1 of full range
- Bit width, bits: 16

Communication

- Transmission medium: Twisted pair S-UTP 100 × cat5
- Buscoupler connection: RJ45
- Max length of fieldbus segment: 100 m between hubstation segment: EB 02.14
- Baud rate: 10 mbits/s
- Protocols: ModBus/TCP, HTTP, bootp, ModBus, UDP

Common specifications

- Dimensions, external, w × h × d, mm: 400 × 150 × 310
- Weight, kg: 6
- Power, w: 100
- Voltage, V/phase/freq: 90–240 VAC/1/50–60

NOTE: If the amplifier box will not be placed directly behind the oven, please include the extension cords to the relaxation rigs (EB 02.05.1 and EB 02.05.2, one of each per rig) to facilitate the manual work in the laboratory.

Elastocon reserve the right to modify these specifications in part or in whole.
Technical specifications

**ALE control box, EB 02.24-x**

- Air flow, ml/min: 0 to 100
- Liquid flow, ml/min: 0,001 to 2,5
- No. of channels: 2, 4 or 6
- Stirrer speed, rpm: 0 to 2 500
- Maximum temperature of liquid in the pump, °C: 50
- Dimensions, external, w × h × d, mm: 410 × 500 × 580
- Weight, kg: 30
- Power, w: 500
- Voltage, V/phase/freq: 200–240/1/50–60 or 100–120/1/50–60

**Included accessories**

- Manual in English
- Necessary tools (e.g. stylus pen for PLC touch screen)
- Calibration including certificate

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**Room Temperature Box, EB 02.08**

- Temperature range, °C: + 10 to +40*
- Nominal temperature, °C: + 23
- Temp. variation in time, °C: ± 0,25
- Temperature reduction, below ambient, °C: min 12
- Temperature sensor: NTC
- Dimensions, external, w × d × h, mm: 620 × 610 × 630
- No. of relaxation rigs: 8
- Weight, kg: 33
- Voltage, V/phase/freq: 200–240/1/50–60 or 100–120/1/50–60
- Cooling power, W: 62
- Total power, W: 200

*Lowest temperature depending of ambient temperature

**Included accessories**

- Manual in English
- Accredited calibration including certificate

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**ELASTOCON reserve the right to modify these specifications in part or in whole.**
Technical specifications

**Film Creep Tester, EB 24**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range, °C:</td>
<td>+40 to +200</td>
</tr>
<tr>
<td>Temp. control, 40 to 100 °C, °C:</td>
<td>± 0,5</td>
</tr>
<tr>
<td>101 - 200 °C, °C:</td>
<td>± 1,0</td>
</tr>
<tr>
<td>Temp. variation in time, °C:</td>
<td>± 0,25</td>
</tr>
<tr>
<td>Temp. variation in space, %:</td>
<td>± 0,5</td>
</tr>
<tr>
<td>Temperature sensors:</td>
<td>Pt 100, 1/3 DIN</td>
</tr>
<tr>
<td>Air speed, m/s:</td>
<td>&lt;0,001</td>
</tr>
<tr>
<td>Air changes, changes/hour:</td>
<td>14</td>
</tr>
<tr>
<td>Useful volume, l:</td>
<td>120</td>
</tr>
<tr>
<td>Dimensions, inner, w × h × d, mm:</td>
<td>550 × 550 × 400</td>
</tr>
<tr>
<td>Dimensions, external, w × h × d, mm:</td>
<td>920 × 820 × 780</td>
</tr>
<tr>
<td>Dimension, window, 4 glass, mm:</td>
<td>370 × 300</td>
</tr>
<tr>
<td>Illumination of the inner chamber:</td>
<td>2 × 10 W, 24 V halogen</td>
</tr>
<tr>
<td>Weight, kg:</td>
<td>103</td>
</tr>
<tr>
<td>Voltage, V/phase/freq:</td>
<td>220–240/1/50</td>
</tr>
<tr>
<td>Power, W:</td>
<td>2100</td>
</tr>
<tr>
<td>Standards:</td>
<td>ISO 188, IEC 811 and other equivalent standards</td>
</tr>
</tbody>
</table>

**Included accessories**
- Manual in English
- Necessary tools (e.g. stylus pen for PLC touch screen)
- Accredited calibration including certificate

**Options**
- EC 11 Monitor software
- Network cable
- Ramp function for temperature settings in the PLC

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**Cell Ageing Ovens**

<table>
<thead>
<tr>
<th>Specification</th>
<th>EB 21</th>
<th>EB 22</th>
<th>EB 23</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range, °C:</td>
<td>+40 to +200</td>
<td>+40 to +200</td>
<td>+40 to +200</td>
</tr>
<tr>
<td>HT-version, °C:</td>
<td>+40 to +300</td>
<td>+40 to +300</td>
<td>–</td>
</tr>
<tr>
<td>Temp. control, +40 to +100 °C, °C:</td>
<td>± 0,5</td>
<td>± 0,5</td>
<td>± 0,5</td>
</tr>
<tr>
<td>+101 to +200 °C, °C:</td>
<td>± 1,0</td>
<td>± 1,0</td>
<td>± 1,0</td>
</tr>
<tr>
<td>+201 to +300 °C, °C:</td>
<td>± 1,5</td>
<td>± 0,25</td>
<td>–</td>
</tr>
<tr>
<td>Temp. variation in time, °C:</td>
<td>± 0,25</td>
<td>± 0,25</td>
<td>± 0,25</td>
</tr>
<tr>
<td>Temperature sensors:</td>
<td>Pt 100, 1/3 DIN</td>
<td>Pt 100, 1/3 DIN</td>
<td>Pt 100, 1/3 DIN</td>
</tr>
<tr>
<td>No. of temperatures:</td>
<td>4</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>No. of cells:</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Air speed, m/s:</td>
<td>&lt;0,001</td>
<td>&lt;0,001</td>
<td>&lt;0,001</td>
</tr>
<tr>
<td>Air changes, changes/hour:</td>
<td>3 to 20</td>
<td>3 to 20</td>
<td>3 to 20</td>
</tr>
<tr>
<td>Useful volume, l:</td>
<td>4 × 1,3</td>
<td>6 × 1,3</td>
<td>4 × 1,3</td>
</tr>
<tr>
<td>Dimensions, inner, dia × h, mm:</td>
<td>100 × 160</td>
<td>100 × 160</td>
<td>100 × 160</td>
</tr>
<tr>
<td>Dimensions, external, w × h × d, mm:</td>
<td>760 × 715 × 520</td>
<td>960 × 715 × 520</td>
<td>760 × 715 × 520</td>
</tr>
<tr>
<td>Weight, kg:</td>
<td>50</td>
<td>57</td>
<td>50</td>
</tr>
<tr>
<td>Power, W:</td>
<td>900</td>
<td>1300</td>
<td>900</td>
</tr>
</tbody>
</table>

**Included accessories**
- Manual in English
- Necessary tools (e.g. stylus pen for PLC touch screen)
- Accredited calibration including certificate

**Options**
- Network cable.
- Ramp function for temperature settings in the PLC.
## Technical specifications

### Cell Ageing Ovens

<table>
<thead>
<tr>
<th>Specification</th>
<th>EB 17</th>
<th>EB 17HT</th>
<th>EB 23LTP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range, °C:</td>
<td>-40 to +200</td>
<td>-40 to +245</td>
<td>+20 to +200</td>
</tr>
<tr>
<td>Temp. control, -40 to +20 °C, °C:</td>
<td>± 2,0</td>
<td>± 2,0</td>
<td>–</td>
</tr>
<tr>
<td>+21 to +100 °C, °C:</td>
<td>± 1,0</td>
<td>± 1,0</td>
<td>± 0,5</td>
</tr>
<tr>
<td>+40 to +100 °C, °C:</td>
<td>–</td>
<td>–</td>
<td>± 1,0</td>
</tr>
<tr>
<td>+101 to +200 °C, °C:</td>
<td>± 2,0</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>+101 to +245 °C, °C:</td>
<td>–</td>
<td>± 2,0</td>
<td>–</td>
</tr>
<tr>
<td>Temp. variation in time, °C:</td>
<td>± 0,25</td>
<td>± 0,25</td>
<td>± 0,25</td>
</tr>
<tr>
<td>Temperature sensors:</td>
<td>Pt 100, 1/3 DIN</td>
<td>Pt 100, 1/3 DIN</td>
<td>Pt 100, 1/3 DIN</td>
</tr>
<tr>
<td>No. of temperatures:</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>No. of cells:</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Air speed, m/s:</td>
<td>&lt;0,001</td>
<td>&lt;0,001</td>
<td>&lt;0,001</td>
</tr>
<tr>
<td>Air changes, changes/hour:</td>
<td>3 to 20</td>
<td>3 to 20</td>
<td>3 to 20</td>
</tr>
<tr>
<td>Useful volume, l:</td>
<td>6 × 1,3</td>
<td>6 × 1,3</td>
<td>4 × 1,3</td>
</tr>
<tr>
<td>Dimensions, inner, dia × h, mm:</td>
<td>100 × 160</td>
<td>100 × 160</td>
<td>100 × 160</td>
</tr>
<tr>
<td>Dimensions, external, w × h × d, mm:</td>
<td>960 × 715 × 520</td>
<td>960 × 715 × 520</td>
<td>approx. 62</td>
</tr>
<tr>
<td>Weight, kg:</td>
<td>approx. 74</td>
<td>approx. 74</td>
<td>approx. 62</td>
</tr>
<tr>
<td>Voltage, V/phase/freq:</td>
<td>220–240/1/50 or 60</td>
<td>220–240/1/50 or 60</td>
<td>(110–120/1/60)</td>
</tr>
<tr>
<td>Power, W:</td>
<td>300</td>
<td>300</td>
<td>900</td>
</tr>
<tr>
<td>Water flow l/min:</td>
<td>–</td>
<td>–</td>
<td>0,1-1</td>
</tr>
</tbody>
</table>

**Programmable temperature from PLC**

**Included accessories**
- Manual in English
- Necessary tools (e.g. stylus pen for PLC touch screen)
- Accredited calibration including certificate

### Liquid circulator, EB 17.01, for Cell Ageing Ovens EB 17 and EB 17HT

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating power, W:</td>
<td>1800</td>
</tr>
<tr>
<td>Cooling power at +20 °C, W:</td>
<td>900</td>
</tr>
<tr>
<td>Cooling power at -40 °C, W:</td>
<td>700</td>
</tr>
<tr>
<td>Temperature stability °C:</td>
<td>± 0,05</td>
</tr>
<tr>
<td>Dimensions, external, w × l × h, mm:</td>
<td>500 × 590 × 640</td>
</tr>
<tr>
<td>Weight, kg:</td>
<td>130</td>
</tr>
<tr>
<td>Volume, l:</td>
<td>5,2</td>
</tr>
<tr>
<td>Pump flow rate, l/min:</td>
<td>16-30</td>
</tr>
<tr>
<td>Cooling of compressor:</td>
<td>air</td>
</tr>
</tbody>
</table>

**Included accessories**
- Hoses and valves for connection and communication with EB 17 or EB 17HT
- Manual in English

### Examples of temperature combinations between cells with individual temperature, °C:

<table>
<thead>
<tr>
<th>Cell no 3</th>
<th>Cell no 4</th>
<th>Cell no 3</th>
<th>Cell no 4</th>
<th>Cell no 3</th>
<th>Cell no 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>70</td>
<td>60</td>
<td>200</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>100</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

**Elastocon reserve the right to modify these specifications in part or in whole.**
Technical specifications

Automatic Relaxation and Creep Tester, EB 18-II (3 test stations)

Temperature range, °C: +40 to +200 (HT=+300)
Temp. control, 40 - 100 °C, °C: ± 0,5
101 - 200 °C, °C: ± 1,0
201 - 300 °C, °C: ± 1,5
Temp. variation in time, °C: ± 0,25
Temperature sensors: Pt 100, 1/3 DIN
No. of temperatures: 3
No. of cells: 3
Air speed, m/s: <0,001
Air changes, changes/hour: 3-20
Force range compression, N: 0 - 1 000 (alternatively 100, 500 or 1 500)
Force range tension, N: 100 (Tension is optional)
Force resolution, N: 0,1 in compression and 0,01 in tension
Force accuracy, N: 0,2 (0,02, 0,1, 0,4)
Displacement resolution, mm: 0,0001
Displacement accuracy, mm: 0,003
Transport speed, mm/min: 0,1-200
Testing speed, mm/min: 0,1-200
Compression plate, mm dia: 50
Power, W: 900
Voltage, V/Hz: 220–240/1/50, or 110–120/1/60

Materials
Compression plates: Stainless steel
Compression rig: Stainless steel and aluminium
Casing: Powder painted steel
Size, w × d × h, mm: 1170 × 500 × 1220
Weight, kg: 151

Included accessories
• Embedded computer (Windows) with mouse, keyboard and monitor
• Software for testing in both relaxation and creep
• Installation by Elastocon engineer (only available for countries where the Swedish authorities say is safe to travel to and within)
• Support agreement first year
• Manual in English
• Necessary tools (e.g. stylus pen for PLC touch screen)
• Accredited calibration including certificate

Optional accessories
For rebuilding the rigs to tension
EB 02.02 Grips for testing relaxation in tension, according to ISO 6914.
EB 02.03 Load Cell 100 N for tests in tension, including adapters.

For testing in liquids
EB 02.01 Container and pressure plate (with a hole in the centre) for measurement in liquids, according to ISO 3384.
EB 02.01P Sealed container for testing of stress relaxation in volatile liquids and coolants up to 3 Bar pressure. (maximum 150 °C).
EB 02.12 Container for testing in liquids in tension.

ELASTOCON reserve the right to modify these specifications in part or in whole.
Technical specifications

**Elastometer EF02-II**

- **Force range, N:** 2 to 1000
- **Force accuracy, N:** 0,1
- **Displacement resolution, mm:** 0,0001
- **Displacement accuracy, mm:** 0,002
- **Transport speed, mm/min:** 0,001 to 1000
- **Testing speed, mm/min:** 0,001 to 1000
- **Compression plate, mm dia:** 110
- **Power, W:** 60
- **Voltage, V:** 240/1/50
- **Weight, kg:** 46

**Materials:**
- **Compression plates:** Nickel plated steel?
- **Compression rig:** Steel, stainless steel and aluminium?
- **Casing:** Powder painted steel
- **Size, w × d × h, mm:** 46
- **Weight, kg:** included
- **Computer:** included

**Standards:**
- ISO 3384, ISO 7743

**Included accessories**
- Manual in English
- Necessary tools (e.g. stylus pen for PLC touch screen)
- Accredited calibration including certificate

**Heating circulator**

- **EF02.06 Room temperature**
  - Working temperature range, °C: +20 to +200
  - Temperature control: PID, cascade
  - Temperature stability, °C: ± 0.01
  - Display resolution, °C: 0,1
  - Heater capacity, W: 2000
  - Cooling capacity at, °C: –
  - Cooling system: Water cooling
  - Pump capacity, pressure, bar: 0,23 to 0,45
  - Flow rate, l/min: 11-16
  - Bath opening / bath depth (W × L/D), mm: 130 × 150/150
  - Filling volume, l: 4,5
  - Dimensions (W × L × H), mm: 210 × 420 × 380
  - Weight, kg: 9,6
  - Ambient temperature, °C: 5 to 40
  - Built in cooling coils

- **EF02.07 Low temperature**
  - Working temperature range, °C: -20 to +200
  - Temperature control: PID, cascade
  - Temperature stability, °C: ± 0.01
  - Display resolution, °C: 0,1
  - Heater capacity, W: 2000
  - Cooling capacity at, °C: 20, 200, 60
  - Cooling system: Water cooling
  - Pump capacity, pressure, bar: 0,23 to 0,45
  - Flow rate, l/min: 11-16
  - Bath opening / bath depth (W × L/D), mm: 120 × 140/140
  - Filling volume, l: 4,5
  - Dimensions (W × L × H), mm: 230 × 420 × 610
  - Weight, kg: 31
  - Ambient temperature, °C: 5 to 40
  - Built in cooling coils

**Standards:**
- Built in cooling coils
- Rapid cool down time

**Included accessories**
- Manual in English

*ELASTOCON reserve the right to modify these specifications in part or in whole.*

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