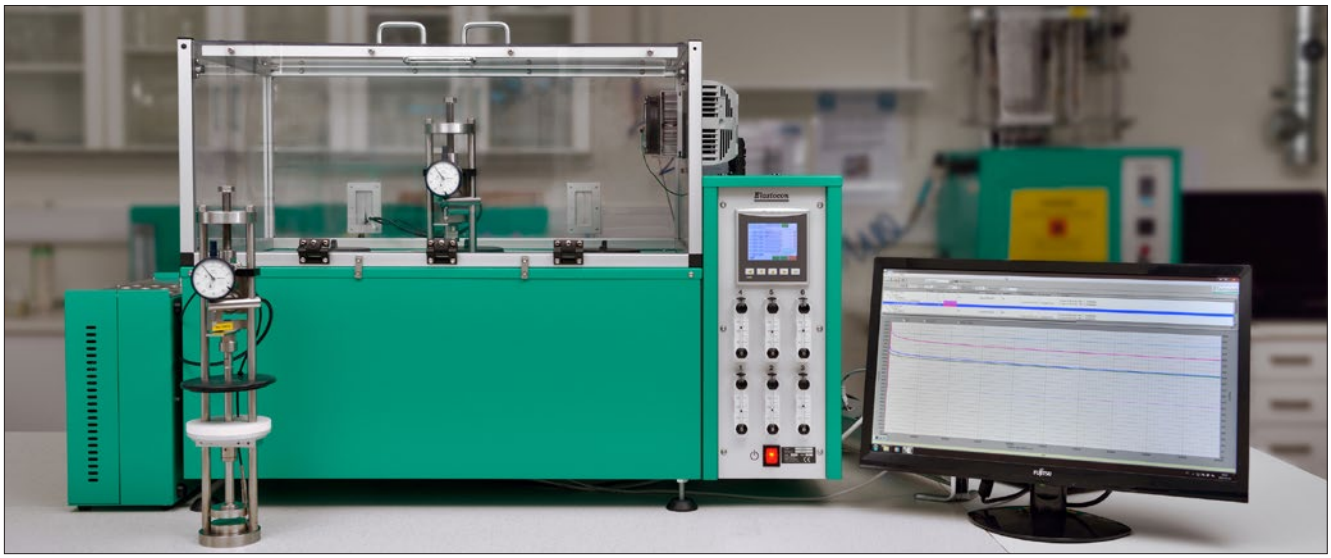
Elastocon®

Stress Relaxation and Creep Systems



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 whilest 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.

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Complete Stress Relaxation test systems

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

Continuous stress relaxation testing	Discontinuous stress relaxation testing
Less manual work, measurement will continue throughout the test after it is started.	More manual work, needed to manually perform the measurements at certain points during the test period.
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.	No extra data is saved, only the manual taken measurements. Not possible to add extra evaluation points after the test is finalized.
No physical movement of the rigs after the test is started.	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.
Most of Elastocon's customers around the world ask for this type of testing, several big companies have it in their company standard.	Less customers ask for this type of test, it is included in the internal standards of some large companies.
Possible to run tests automatically according to ISO 3384-1, ISO 3384-2 as well as ISO 6914 and other technically equivalent standards.	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.
Possible to run tests automatically with either stable or cyclic temperatures.	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).
Test either in compression or tension, in air/gases or liquid.	Test in compression, air or liquid (liquid might be rather messy during the measurements).
Automatic testing according to ISO 3384-1 method B with a programmable oven.	
Cycling testing according to ISO 3384-2 in temperature interval -40 to +250 °C	

Instruments for continuous testing of stress relaxation

Stress Relaxation Rig, EB 02

This is a rig for continuous stress relaxation measurements in both compression and tension.

The rig works together with the cell ovens EB 21, EB 22, EB 23, the programmable temperature cell ovens EB 17 and EB 23LTP.

EB 02 relaxation rigs arranged for different test methods


Rig 1

Rig 1 *is arranged for testing in compression according to ISO 3384.*


Rig 2

Rig 2 *is arranged for testing in tension according to ISO 6914 method A.*


Rig 3

Rig 3 *is arranged for testing in liquid according to ISO 3384.*


Rig 4

Rig 4 *is arranged for testing according to ALE-test.*

We can supply an optional test piece holder (EB 02.26) for the relaxation rig, to attach test pieces for tensile test for ageing during the relaxation test.

Note! *Make sure to choose a correct load cell for the testing. Recommendation is to use the load cell between 10 % to 100 % of specified max load. Below 10 % the accuracy may be lower than the specified ±1 % in ISO 3384 and ISO 6914.*

Rigs

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

Accessories to the rigs

EB 02.01	Container and pressure plate for measurements in liquid for temperatures up to 200 °C (only for EB 02 rig).
EB 02.01P	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.
EB 02.12	Container for testing in liquids in tension up to 200 °C (only for use with EB 02TE rig).
EB 02.05.1	Extension cord for load cells, 2.5 m (for other placement of amplifier box than directly behind the cell oven).
EB 02.05.2	Extension cord for temperature sensor, 2.5 m (for other placement of amplifier box than directly behind the cell oven).
EB 02.26	Test piece holder for the relaxation rig for ageing other samples simultaneously as the relaxation test.
EB 02.23	Stand for relaxation rigs for secure placement on the laboratory bench.

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.

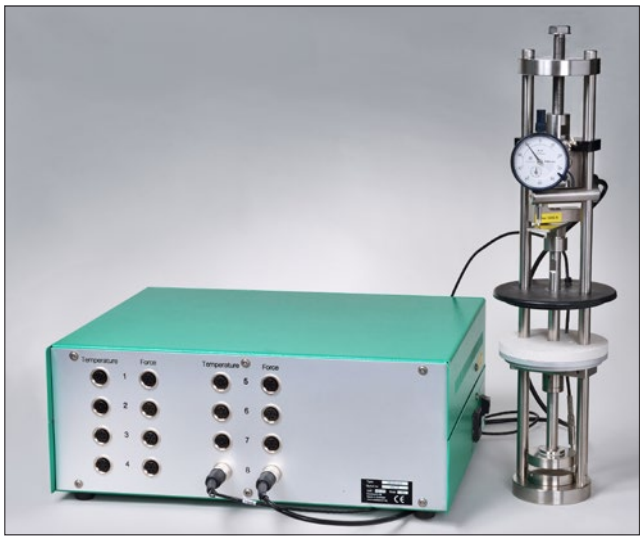
EB 02.01 Container
for testing of stress relaxation in compression in liquids.

EB 02.01P
Air tight container (max 150 °C).

Compression plates »

« Tension Grips

Amplifier box for relaxation rigs



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.

High force compression rig/oven

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.

ALE-test

Aeration and Liquid Exchange test

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.

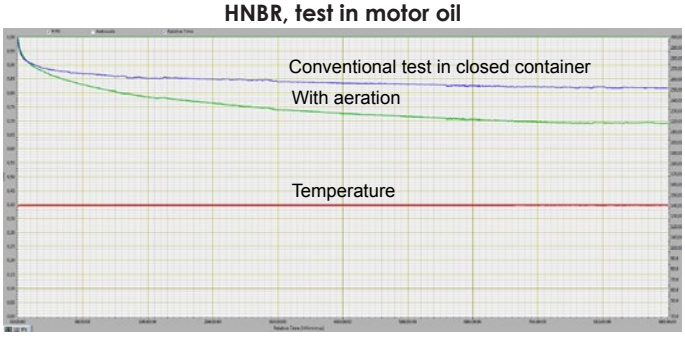
The ALE-test instrument was developed in a joint project with Scania, AB Volvo, Volvo Cars, SP Technical Research Institute of Sweden, Lanxess and Elastocon about ageing of elastomers in biofuels. The project was financed by the Swedish Energy Agency and participating companies.

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.

HNBR, test in motor oil



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.

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.

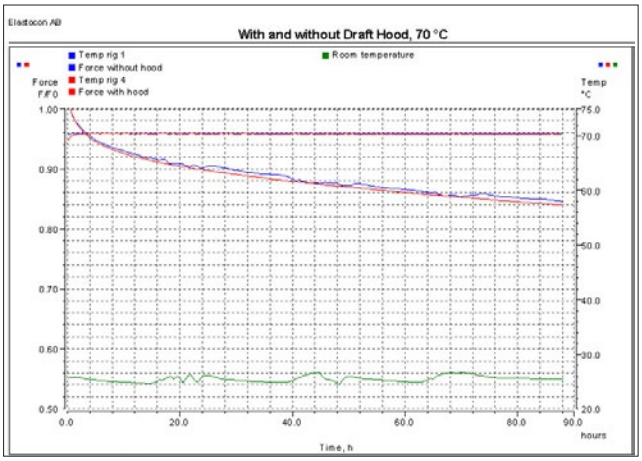
EB 23 4 cells with the same temperature control.

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.



The graph shows a test run with and without the temperature hood. The blue curves are the rigs without a hood and for the red curves a hood is used. The green curve is the room temperature.

Cell oven, EB 21. *For relaxation tests with 4 cells with individual temperatures.*

Cell oven, EB 22. *For relaxation tests with 6 cells with individual temperatures.*

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.

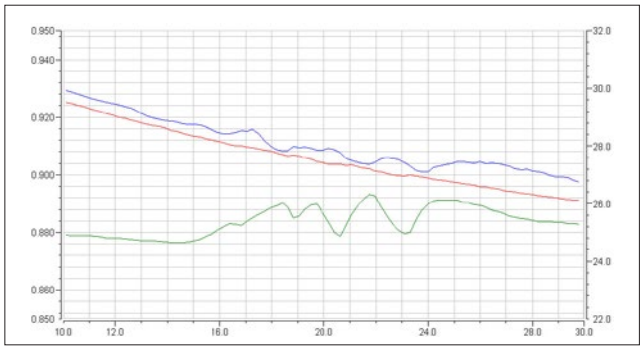
Our second type of cell oven for cycling temperature is **EB 23LTP**, it has 4 cells with the same temperature for all cells, with temperature range between approximately +20 to +200 °C. This oven is cooled with tap water, which should not exceed +18 °C to have a satisfying cooling function throughout 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.

Liquid circulator, **EB 17.01**

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.



This graph shows a test run with and without the Room temperature box when testing at 23 °C. The blue curves are the rigs without the box and for the red curves the box is used. The green curve is the room temperature.

The room temperature box, EB 02.08 and the low temperature box, EB 02.25 look similar, but the latter has cooling by tap water.

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.

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

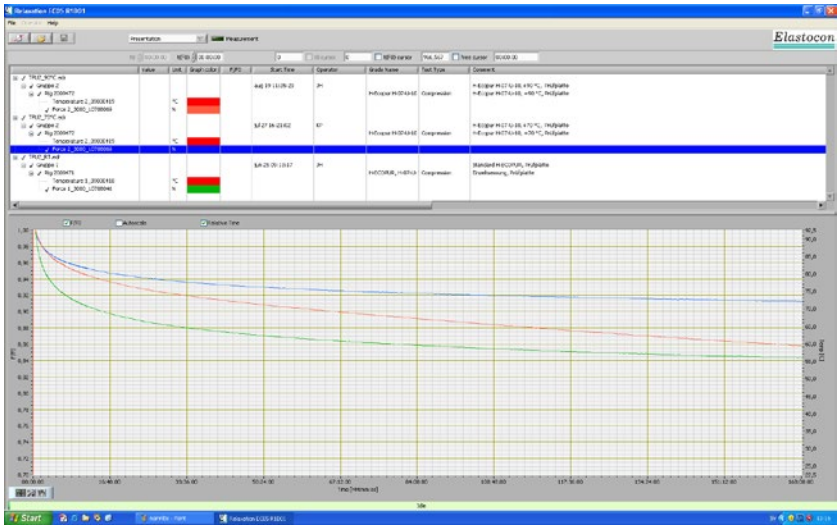
This software evaluates results from relaxation tests according to ISO 3384 and ISO 6914.

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



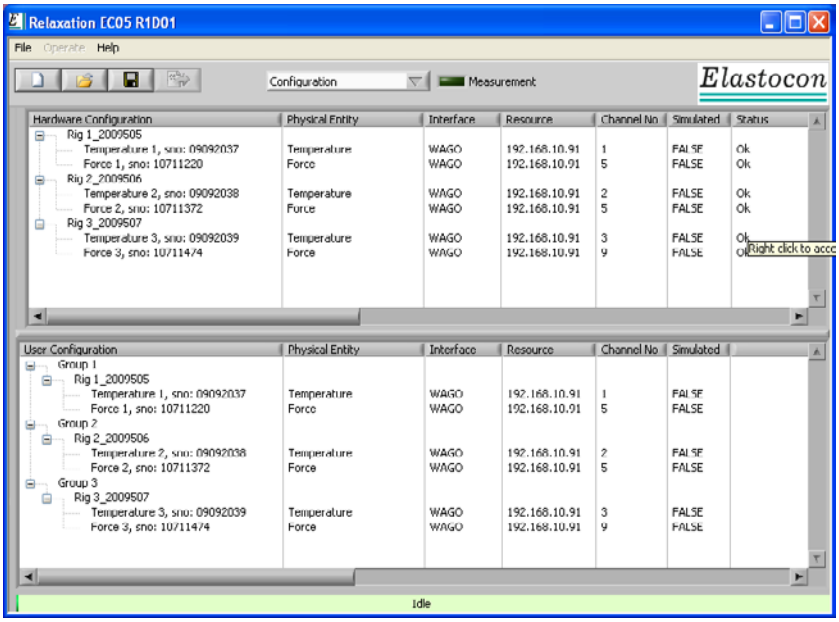
*In the **presentation view** test data can be presented and compared and printed as a test report.*

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.

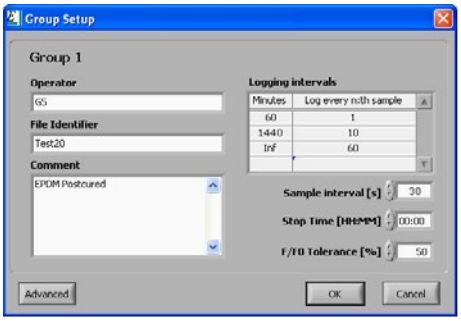
Configuration view



*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



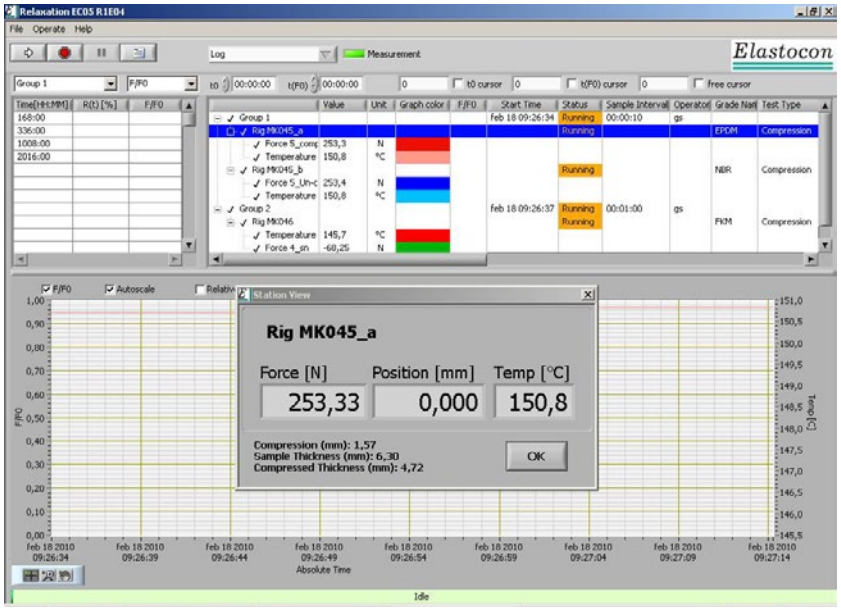
*In the **Group Setup** the file name is given together with comments.*

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.

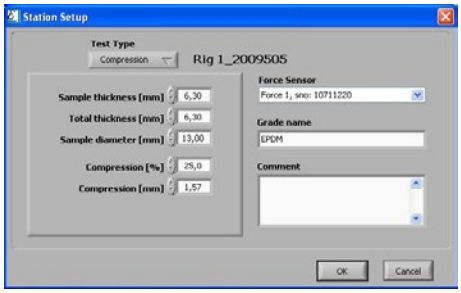
Software for Relaxation Testing, EC 05

Logging view



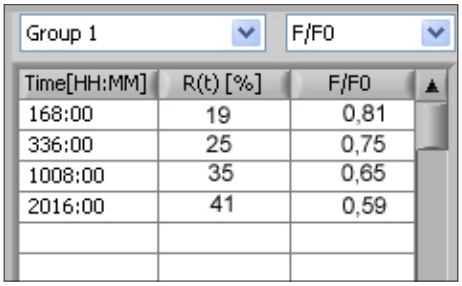
*In the **Logging view** the user sets the logging details, the evaluation points – time for t_0 and F_0, the colour of curves and starts the test.*

Station Setup



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

Evaluation points



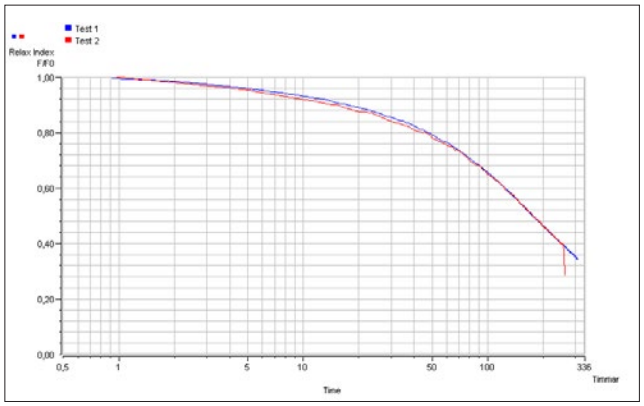
Group 1 | F/F0

Time[HH:MM]	R(t) [%]	F/F0
168:00	19	0,81
336:00	25	0,75
1008:00	35	0,65
2016:00	41	0,59

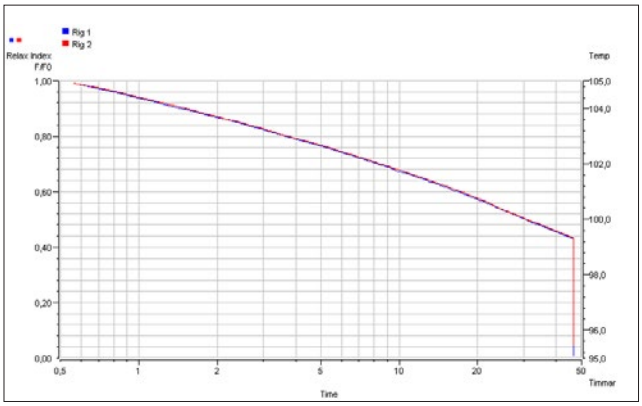
For each Group (= File) times can be given when the software will calculate the percent relaxation and F/F_0.

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.

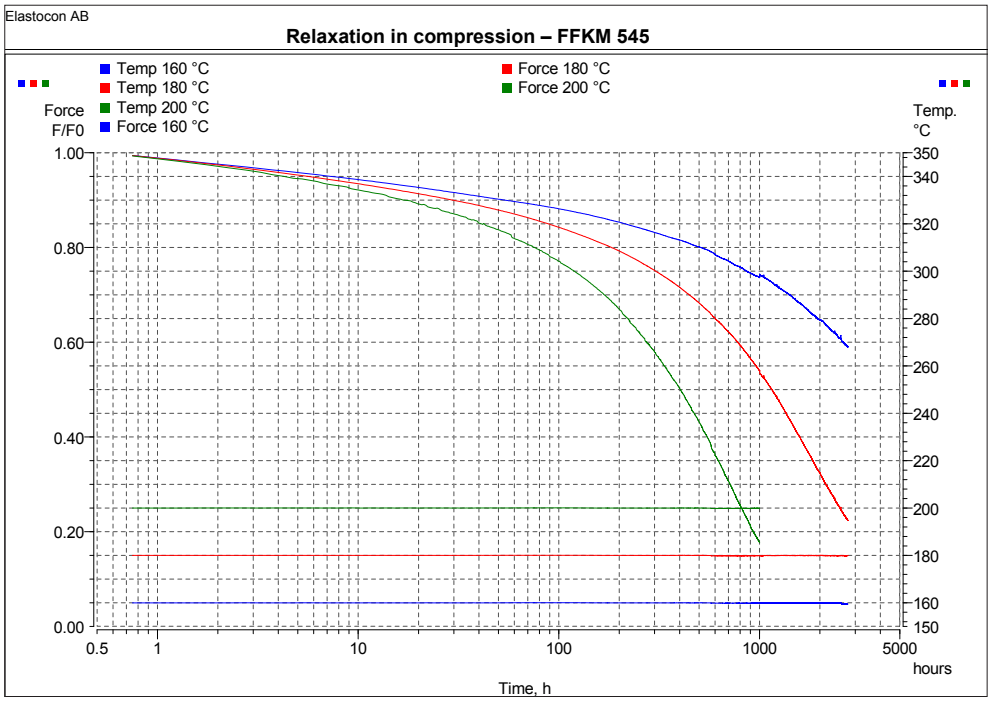
The time to reach this level is determined for each temperature.

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.

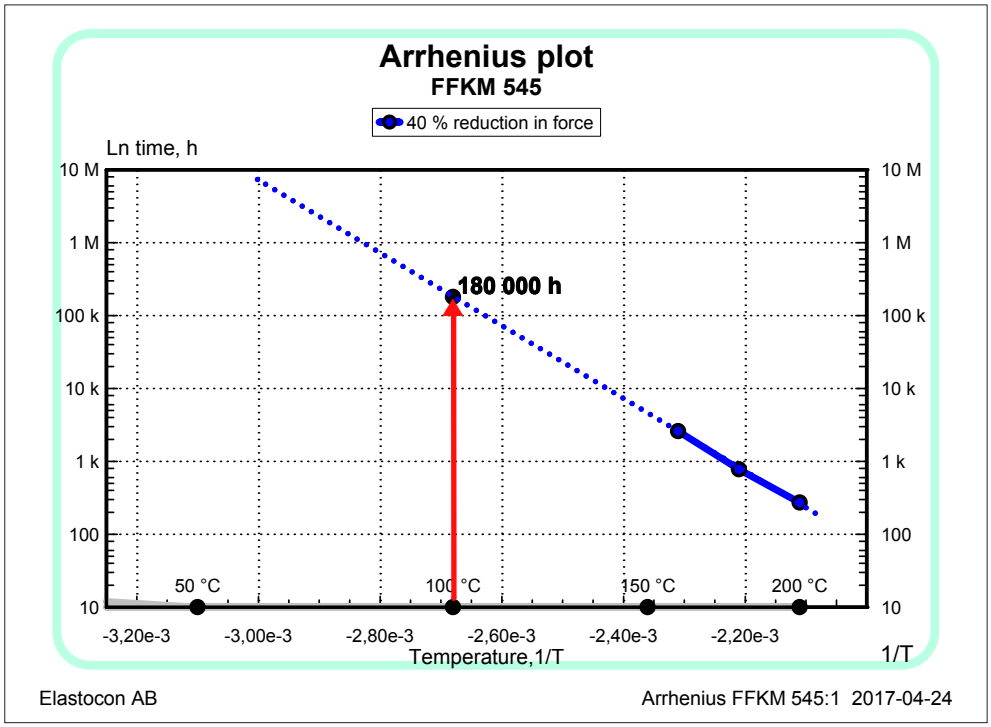
The times to reach the "end of life" time for each temperature are plotted in an Arrhenius plot, which is a graph with logarithmic time on the Y-axis and 1/T on the X-axis, where T is the temperature in Kelvin, see figure.

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.*



Stress Relaxation test at three temperatures of a per-fluoro rubber.



Automatic Relaxation and Creep Tester, EB 18-II-3

For stress relaxation tests and creep tests

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.

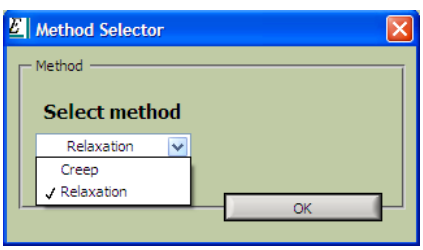
Other accessories such as for testing in liquids, tension or temperature range up to +300 °C can be ordered separately.

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

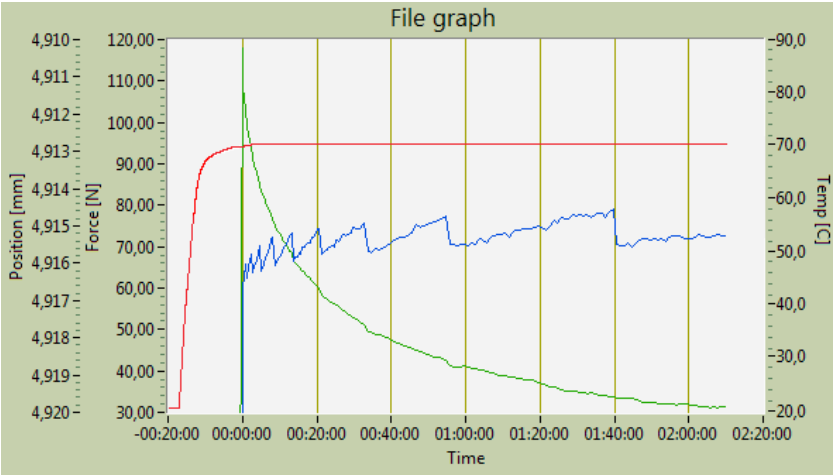
Both testing methods, stress relaxation and creep uses the same accessories. The shifting between the two test methods is done when the software is started. Changing between compression and tension consist of a simple rebuilding of the rigs, thoroughly described in the manual.



Test station for testing in compression and for testing in tension.

For Stress Relaxation Tests

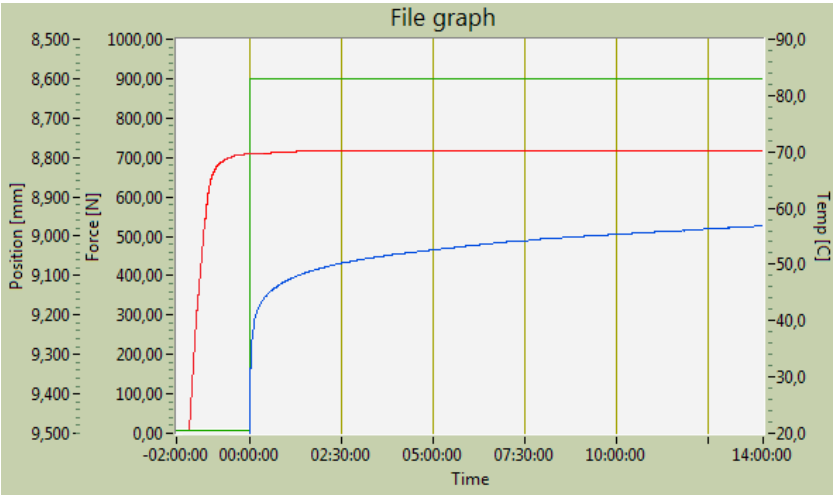
- Relaxation tests can be done in both compression and tension.
- Utilising load cells and servo motors to apply and hold the compression in the EB 18-II-3, automatically compensates for the spring effect in the load cells.
- The compression or tension in mm or % is set in the software and the computer 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/Fo 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.*

For Creep tests

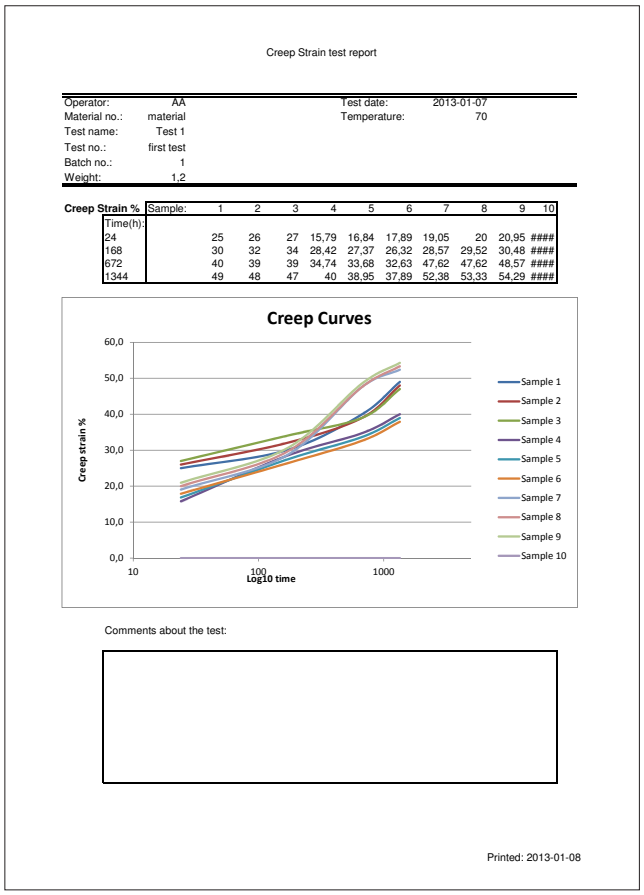
- Creep test can be done in both compression and tension.
- Utilising load cells and servo motors to apply and hold the load, the EB 18-II-3 tester eliminates the handling problems associated with dead load weights.
- The load in MPa or N is set in the software and the computer instructs the closed loop 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.*

Film Creep Tester EB 24

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.



Creep Strain test report

Operator:	AA	Test date:	2013-01-07
Material no.:	material	Temperature:	70
Test name:	Test 1		
Test no.:	first test		
Batch no.:	1		
Weight:	1,2		

Creep Strain %	Sample:	1	2	3	4	5	6	7	8	9	10
Time(h):											
24		25	26	27	15,79	16,84	17,89	19,05	20	20,95	####
168		30	32	34	28,42	27,37	26,32	28,57	29,52	30,48	####
672		40	39	39	34,74	33,68	32,63	47,62	47,62	48,57	####
1344		49	48	47	40	38,95	37,89	52,38	53,33	54,29	####

Comments about the test:

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Spreadsheet template report.

The Film Creep Tester has a fixed set air exchange rate, 7 or 14 changes per hour. It includes hooks to hang 10 test pieces 25 × 100 mm and 10 sets of grips to attach to the test pieces, together with weights, 1,3 kg and 2,3 kg.

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.

Instruments for discontinuous stress relaxation tests

Elastometer, EF 02-II

- **For compression tests on profiles**
- **For discontinuous stress relaxation tests**

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 economical 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/Fo, 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.

Relaxation test jig

A new Elastometer model is under development. This image shows the previous model, EF 02.

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).

Temperature chamber, EF 02.03

- **For testing at elevated and low temperature**

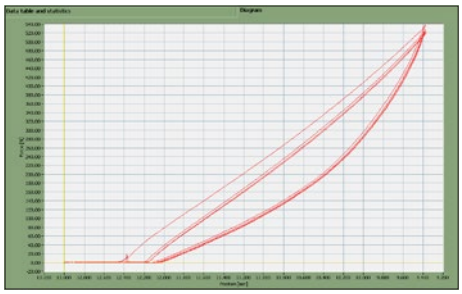
The EF 02.03 oven for discontinuous stress relaxation tests at elevated or low temperatures in Elastometer EF 02-II. The temperature range depends on the range of the optional liquid circulator used (EF 02.06, EF 02.07, EF 02.08 or EF 02.09).

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.



Modulus according to ISO 7743.

Technical specifications

Stress Relaxation Rig	EB 02	EB 02HT	EB 02TE	EB 02TEHT
Maximum temperature, °C:	+200	+300	+200	+300
Default range in compression/tension, N:	1000	1000	100	100
Resolution, compression/tension, N:	0,1	0,1	0,01	0,01
Optional range in compression, N *(must be specified in order):*	500/2000	500/2000	–	–
Resolution, compression/tension, N:	0,05/0,2	0,05/0,2	–	–
Accuracy, %:	± 0,1 of full range	± 0,1 of full range	± 0,1 of full range	± 0,1 of full range
Dimensions, dia × h, mm:	120 × 450	120 × 450	120 × 450	120 × 450
Weight, kg:	4,5	4,5	4,5	4,5
Material:	Stainless steel	Stainless steel	Stainless steel	Stainless steel
Temperature sensor:	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN
Standards:	ISO 3384	ISO 3384	ISO 6914	ISO 6914
Suitable accessories				
Liquid container:	EB 02.01	–	EB 02.12	–
Air tight container:	EB 02.01P	–	–	–
Pressure gauge for air tight container:	EB 02.01P6	–	–	–
Test piece holder:	EB 02.26	EB 02.26	EB 02.26	EB 02.26
Extension cords for load cell:	EB 02.05.1	EB 02.05.1	EB 02.05.1	EB 02.05.1
Extension cords for temperature:	EB 02.05.2	EB 02.05.2	EB 02.05.2	EB 02.05.2

Stress Relaxation Rig	EB 02AP	EB 02SA	EB 02ALE	EB 02HF
Maximum temperature, °C:	+150	+200	+200	+200
Default range in compression/tension, N:	1000	1000	1000	45000
Resolution, compression/tension, N:	0,1	0,1	0,1	–
Optional range in compression, N *(must be specified in order):*	500/2000	500/2000	500/2000	–
Resolution, compression/tension, N:	0,05/0,2	0,05/0,2	0,05/0,2	–
Accuracy, %:	± 0,1 of full range	± 0,1 of full range	± 0,1 of full range	± 0,1 of full range
Dimensions, dia × h, mm:	120 × 450	120 × 450	120 × 450	120 × 450
Weight, kg:	4,5	4,5	4,5	4,5
Material:	SS2343 (acid proof)	SS2378 (super acid proof)	Stainless steel	Stainless steel
Temperature sensor:	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN
Standards:	ISO 3384	ISO 3384	–	ISO 3384
Suitable accessories				
Liquid container:	–	included	included	–
Air tight container:	included	–	–	–
Pressure gauge for air tight container:	EB 02.01P6	–	–	–
Test piece holder:	–	–	included	–
Extension cords for load cell:	EB 02.05.1	EB 02.05.1	EB 02.05.1	EB 02.05.1
Extension cords for temperature:	EB 02.05.2	EB 02.05.2	EB 02.05.2	EB 02.05.2
			NOTE! *Must be connected to special control box, EB 02.24-x*	

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 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.*

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

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

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

Technical specifications

Film Creep Tester, EB 24

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

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

Cell Ageing Ovens

	EB 21	EB 22	EB 23
Temperature range, °C:	+40 to +200	+40 to +200	+40 to +200
HT-version, °C:	+40 to +300	+40 to +300	–
Temp. control,+40 to +100 °C, °C:	± 0,5	± 0,5	± 0,5
+101 to +200 °C, °C:	± 1,0	± 1,0	± 1,0
+201 to +300 °C, °C:	± 1,5	± 1,5	–
Temp.variation in time,°C:	± 0,25	± 0,25	± 0,25
Temperature sensors:	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN
No. of temperatures:	4	6	1
No. of cells:	4	6	4
Air speed, m/s:	<0,001	<0,001	<0,001
Air changes, changes/hour:	3 to 20	3 to 20	3 to 20
Useful volume, l:	4 × 1,3	6 × 1,3	4 × 1,3
Dimensions, inner, dia × h, mm:	100 × 160	100 × 160	100 × 160
Dimensions, external, w × h × d, mm:	760 × 715 × 520	960 × 715 × 520	760 × 715 × 520
Weight, kg:	50	57	50
Voltage, V/phase/freq:	220–240/1/50 (110–120/1/60)	220–240/1/50 (110–120/1/60)	220–240/1/50 (110–120/1/60)
Power, W:	900	1300	900
Standards:	ISO 188 method A, ISO 3384-1 method A	ISO 188 method A, ISO 3384-1 method A	ISO 188 method A, ISO 3384-1 method A

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.

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

Technical specifications

Cell Ageing Ovens	EB 17	EB 17HT	EB 23LTP
Temperature range, °C:	-40 to +200	-40 to +245	+20 to +200
Temp. control, -40 to +20 °C, °C:	± 2,0	± 2,0	–
+21 to +100 °C, °C:	± 1,0	± 1,0	–
+40 to +100 °C, °C:	–	–	± 0,5
+101 to +200 °C, °C:	± 2,0	–	± 1,0
+101 to +245 °C, °C:	–	± 2,0	–
Temp.variation in time,°C:	± 0,25	± 0,25	± 0,25
Temperature sensors:	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN	Pt 100, 1/3 DIN
No. of temperatures:	1	1	1
No. of cells:	6	6	4
Air speed, m/s:	<0,001	<0,001	<0,001
Air changes, changes/hour:	3 to 20	3 to 20	3 to 20
Useful volume, l:	6 × 1,3	6 × 1,3	4 × 1,3
Dimensions, inner, dia × h, mm:	100 × 160	100 × 160	100 × 160
Dimensions, external, w × h × d, mm:	960 × 715 × 520	960 × 715 × 520	
Weight, kg:	approx. 74	approx. 74	approx. 62
Voltage, V/phase/freq:	220–240/1/50 or 60	220–240/1/50 or 60	220–240/1/50 (110–120/1/60)
Power, W:	300	300	900
Water flow l/min:	–	–	0,1-1
Standards:	ISO 188 method A, ISO 3384-1 method A + B, ISO 3384-2 and ISO 6914	ISO 188 method A, ISO 3384-1 method A + B, ISO 3384-2 and ISO 6914	ISO 188 method A, ISO 3384-1 method A + B, ISO 3384-2 and ISO 6914
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

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

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:

Cell no 3	Cell no 4	Cell no 3	Cell no 4	Cell no 3	Cell no 4
40	70	60	200	50	70
Cell no 1	**Cell no 2**	**Cell no 1**	**Cell no 2**	**Cell no 1**	**Cell no 2**
100	200	200	200	200	200

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
Standards:	ISO 188 method A, ISO 3384-1 method A, ISO 6914, ISO 899 with modification

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:	240/1/50 110/1/60
Standards:	ISO 3384, ISO 7743

Materials:

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

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**	EF02.07 **Low temperature**
Working temperature range, °C:	+20 to +200	-20 to +200
Temperature control:	PID, cascade	PID, cascade
Temperature stability, °C:	± 0.01	± 0.01
Display resolution, °C:	0,1	0,1
Heater capacity, W:	2000	2000
Cooling capacity at, °C: W:	– –	20 0 -20 260 200 60
Cooling system:	Water cooling	Refrigerant R134a
Pump capacity, pressure, bar:	0,23 to 0,45	0,23 to 0,45
flow rate, l/min:	11-16	11-16
Bath opening / bath depth (W × L/D), mm:	130 × 150/150	120 × 140/140
Filling volume, l:	4,5	4,5
Dimensions (W × L × H), mm:	210 × 420 × 380	230 × 420 × 610
Weight, kg:	9,6	31
Ambient temperature, °C:	5 to 40	5 to 40
	Built in cooling coils	Rapid cool down time

Other temperature ranges with other circulator models are available on request.

Included accessories

- **Manual** in English

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

Elastocon®

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