

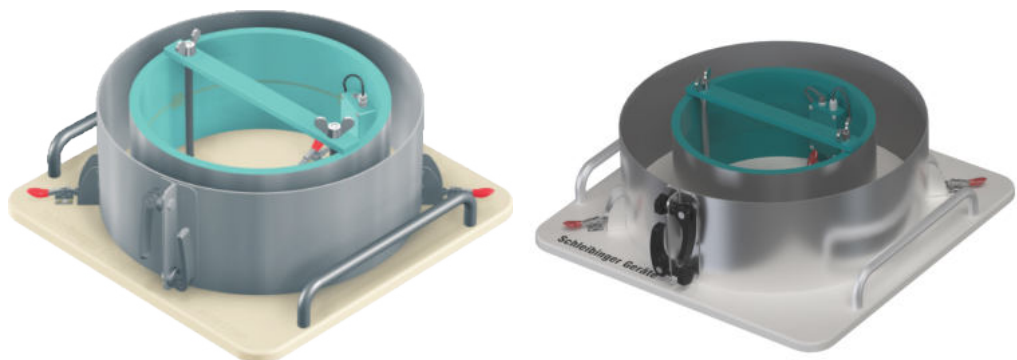
Schleibinger Geräte

Building Materials Testing Systems

User manual - Schleibinger Shrinkage Ring according to ASTM C1581 and AASHTO T 334

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1 Introduction

This user manual contains information on the safe, trouble-free and economical use of the appliance.

This information is intended for people who carry out tasks with or in connection with the appliance.

Keep this user manual or relevant parts of it ready to hand in the immediate vicinity of the appliance.

When handing over the appliance to another person, the operator passes this user manual on to this person.

2 Safety

2.1 Symbols Used

This manual contains Warning and Caution statements. This information is important for safe and efficient installation and operation. The following signal words and symbols are used in this user manual:



Caution indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.



Indicates a dangerous situation which, if not obviated, may result in damage to property.

2.2 Warnings

Make sure that the input voltage and frequency correspond to the device specification. This information is printed on the type label and can be found on the device in the area of the connection cable.



Connect the power supply according to the safety regulation for electrical equipment. Do not damage the power cable. Risk of injury. Damage to or destruction of the sensor.



Disconnect the power supply before servicing.



Avoid shocks and impacts to the sensor.

Avoid contact exposure of sensor to splashes of water.

Avoid exposure of sensor to aggressive media (detergents, cooling emulsions etc).

3 Intended Use

The appliance is designed for use in industrial and laboratory applications. It is used for measuring displacement, distance, position and thickness. It is used for in-process quality control and dimensional testing.

The appliance must only be operated within the limits specified in the technical data.

The appliance must be used in such a way that no persons are endangered or machines and other material goods are damaged in the event of malfunction or total failure of the controller.

Take additional precautions for safety and damage prevention in case of safety-related applications.

The appliance is intended for use in closed rooms.

4 Description of the Appliance

Cementitious building materials change their volume during the hydration. This is a known phenomenon resulting from structural and environmental processes. The process can take up to months and years reflected in shrinkage or expansion of building materials. For the most practical applications of building materials the dimension change is very harmful and has to be minimized.

For the shrinkage of cementitious materials two distinct stages can be defined which are early and later ages. The age of 24 hours and longer refer to the later age shrinkage. This is also the kind of shrinkage which is recorded by standardized test measurements where a certain strength of the material is necessary.

The early stage is commonly defined as the first day while the cementitious materials are setting and starting to harden. The change of the consistency of the cementitious material implements high requirements for a measuring system. At the plastic state, usual physical test methods can not be applied showing difficulties in measuring of the fluid materials.

In addition to the free shrinkage the measurement of the blocked or restrained shrinkage provides further information about the building materials. Under restrained shrinkage, the age of cracking and induced tensile stress characteristics of mortar or concrete and thus their cracking potential can be determined.

The Schleibinger **Shrinkage Ring** - for the determination of age of cracking and induced tensile stress under restrained shrinkage.

4.1 Structural Design of the Appliance

The appliance consists of several components: inner and outer ring which are placed on the base plate and fixed with the clamps (fig. 1).

4.1.1 Fixation Aid

The testing equipment is fixed on the base plate by a pressure piece and two bolts (fig. 1, 1). Unscrew the bolts for dismantling.

4.1.2 Cover Plate

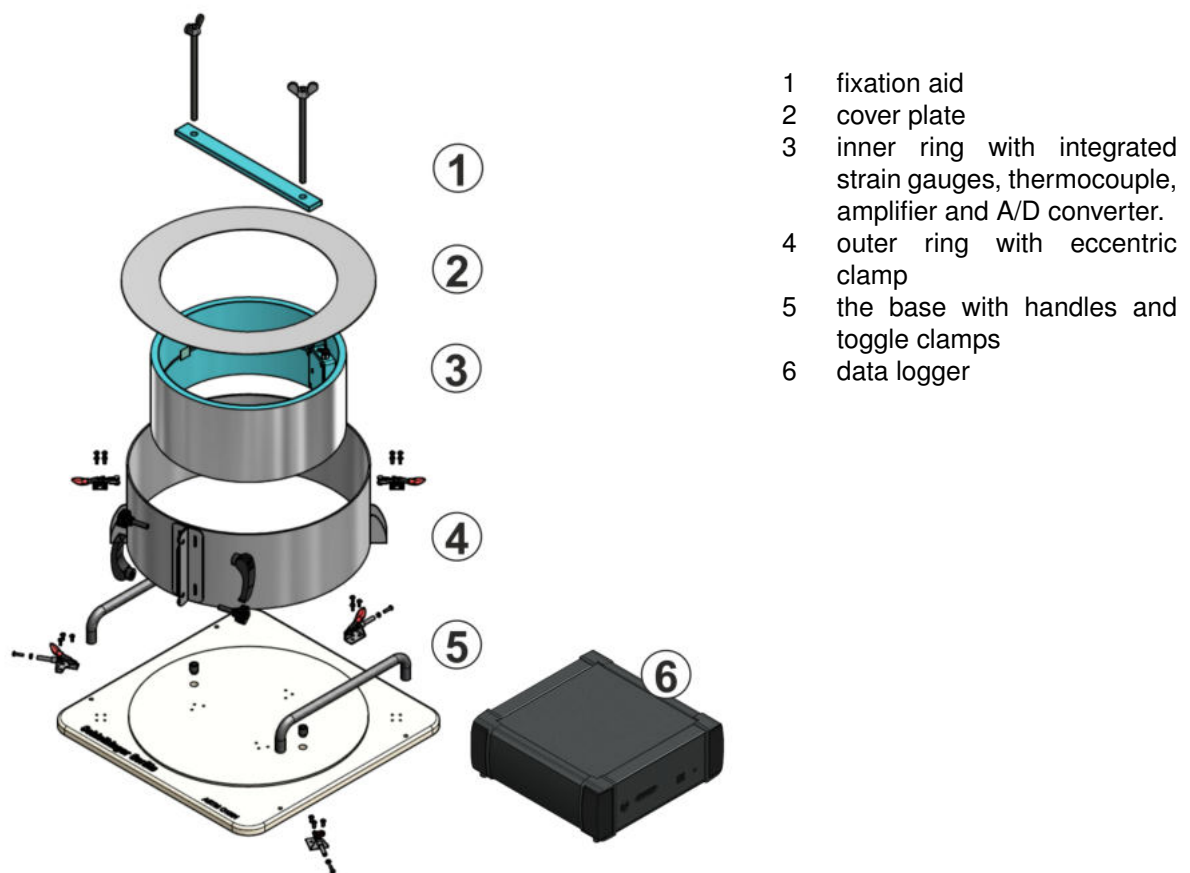
Cover plate (fig. 1, 2) is used to minimize water loss in the first few hours of hydration of the sample.

4.1.3 Inner Ring

The inner ring (fig. 1, 3) is a steel ring. The inner ring is equipped with four full bridge strain gauges an amplifier as well as connectors for the thermocouple and data logger. The inner surface of the ring is powder coated

4.1.4 Outer Ring

The outer ring is used as a shaper for the sample ((fig. 1, 4). The outer ring is closed by two eccentric clamps and fixed on the base plate by a toggle clamps.



- 1 fixation aid
- 2 cover plate
- 3 inner ring with integrated strain gauges, thermocouple, amplifier and A/D converter.
- 4 outer ring with eccentric clamp
- 5 the base with handles and toggle clamps
- 6 data logger

Figure 1: Components of the Shrinkage Ring device.

4.1.5 The Base

The equipment is placed on the non-absorptive base (fig. 1, 5). The base is equipped with the spacers for the inner ring, the toggle clamps for the outer ring and two handles for better transportation of the equipment.

4.1.6 Data Logger

The data logger records the measurement values for several months depending on recording interval (sampling rate) and the amount of channels connected. The data sets are stored non-volatile in the data logger.

The logger is equipped with a network interface and can be connected to a computer directly or be integrated into a lab network. As user interface PC with an Internet browser e.g. Firefox, Chrome or Opera can be used. No special operating system of the computer is needed. Android or iOS based tablets can be used as well.

The computer must be equipped with an Ethernet network interface running the TCP/IP protocol. No special software is needed. During the measurement no running computer is needed. The configuration is described in section 6.1.

As soon the data logger get power, data acquisition starts. This is shown by blinking of the green LED "OK" at the front-side. The computer is only required for setup, online monitoring and data export.

4.1.7 Thermocouples

A thermocouple can be used to measure the temperature development of the sample during the measurement. The use of thermocouple requires the option „Data Logger Channel for the Thermocouple“. This is a built-in option and has to be ordered together with the data logger.

A thermocouple is a temperature measuring device consisting of two dissimilar conductors that contact each other at one or more spots, where a temperature differential is experienced by the different conductors (or semiconductors). It generates a voltage when the temperature of one of the spots differs from the reference temperature at other parts of the circuit.

Thermocouples are a widely used type of temperature sensor for measurement and control. Commercial thermocouples are inexpensive, interchangeable, supplied with standard connectors, and can measure a wide range of temperatures. The main limitation of the thermocouples is their accuracy: system errors of less than one degree Celsius ($^{\circ}\text{C}$) can be difficult to achieve.

There are different types of thermocouples on the market available. Type K (chromel / alumel) is the most common thermocouple type with a sensitivity of approximately $41\mu\text{V}/^{\circ}\text{C}$ (chromel positive relative to alumel when the junction temperature is higher than the reference temperature) (Fig. 2].

The type K of thermocouple is cost-effective and available in a wide variety of probes with the temperature range from $-200\text{ }^{\circ}\text{C}$ to $+1350\text{ }^{\circ}\text{C}$.¹

NOTICE

Use Type K thermocouples provided with the device only. Otherwise the results will be incorrect!



Figure 2: Thermocouple type K.

After the measurement, the thermocouple can be simply pulled out of the sample. If it is not possible, cut it off. Thermocouple can be reused by removing the insulation from the cable head and twisting the cables.

NOTICE

If no thermocouple is connected or it is broken, the temperature will still displayed. This temperature is the temperature of the cold spot at the temperature plug of the device.

¹ Text partly from: Wikipedia contributors. "Thermocouple." Wikipedia, The Free Encyclopedia. Wikipedia, The Free Encyclopedia, 31 May. 2015. Web. 5 Jun. 2015.

4.2 Technical Information

Table 1: General information.

inner ring accord. to ASTM C1581 (d x h)	330 mm x 150 mm
inner ring accord. to AASHTO T334 (d x h)	305 mm x 150 mm
inner ring thickness	13 mm
inner ring	steel 1.0570, tolerances according to ASME B 46.1
inner ring Young modulus	210 GPa
strain gauge	4 bridges in the middle, temperature compensated
resolution	0.01 μ Strain
outer ring	1.4301 stainless steel
outer ring diameter accord. to ASTM C1581	405 mm
outer ring diameter accord. to AASHTO T334	457 mm
base plate	polypropylene (PP)
power supply	100 .. 240 V, 50 .. 60 Hz
dimension of the appliance accord. to ASTM C1581	480 x 480 x 180 mm ³
dimension of the appliance accord. to AASHTO T334	540 x 540 x 210 mm ³
weight of the ring accord. to ASTM C1581	approx. 25 kg
weight of the ring accord. to AASHTO T334	approx. 26 kg

Table 2: Environmental conditions for the operation of the appliance

operating temperature	0 °C to max. +50 °C
storage temperature	+5 °C ...60 °C
rel. air humidity	max. 65 %, non-condensed

5 Delivery and Installation

5.1 Delivery

After delivery, remove the appliance from the packaging.

When the packaging is no longer needed, dispose of it according to local regulations.

5.2 Installation of the Appliance

The installation should be done on the vibration free underground.

Avoid direct sunlight or other direct lights.

Place the equipment in an air-conditioned room. Keep the temperature of the environment as constant as possible during the measurement.

For the installation of the appliance proceed as following:

- Set the inner steel ring onto the base plate and center it using the toggle clamps from the middle of the base plate (figure 3).
- Coat the outer surface of the steel inner ring with a release agent if required.
- Coat the inner surface of the outer ring with a release agent if required.
- Place the outer ring on the base plate, close the eccentric clamps on the outside of the outer ring and center it with the two outer toggle clamps from the base (figures 4), 5).
- The test specimen mould consists of a base, an inner steel ring and an outer ring. The sample is filled between the inner and the outer ring.
- Connect the thermocouple with the amplifier module from the inner ring (fig. 6.) and place the twisted end of the thermocouple into the fresh sample, if required.
- Place the cover plate on the top.
- Fix the inner ring to the base plate with a fixation aid (figure 7, here without cover plate).
- Connect the ring with the data logger by using the orange cable.

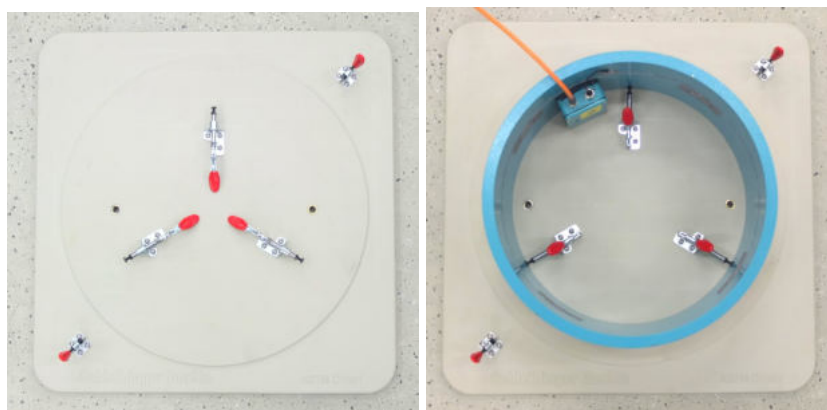


Figure 3: Base plate of the Shrinkage Ring with the toggle clamps (left) and placed inner ring (right).

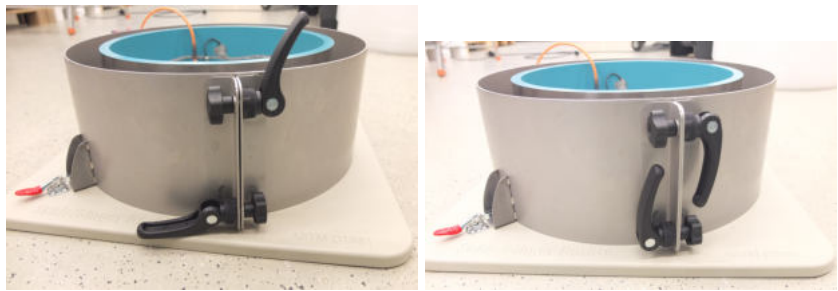


Figure 4: Opening and closing the outer ring with the eccentric clamps.

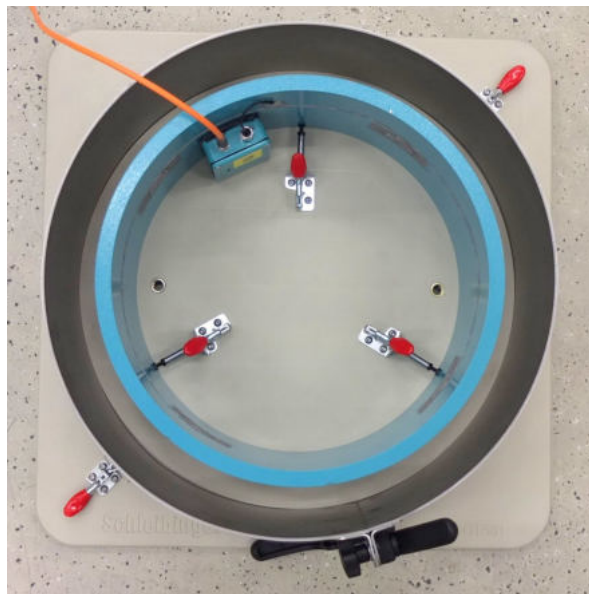


Figure 5: Base plate with the inner and outer ring.

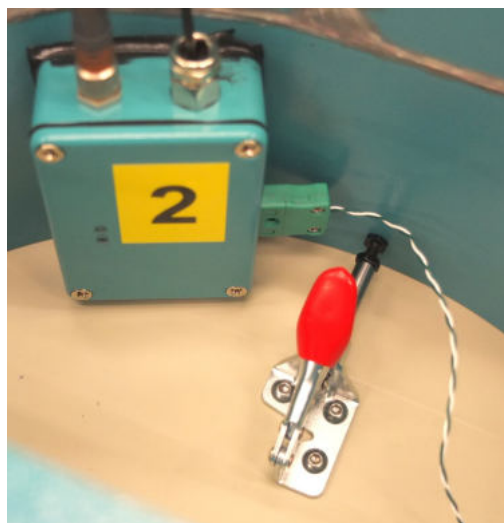


Figure 6: Connection of the thermocouple with the amplifier modul of the inner ring.

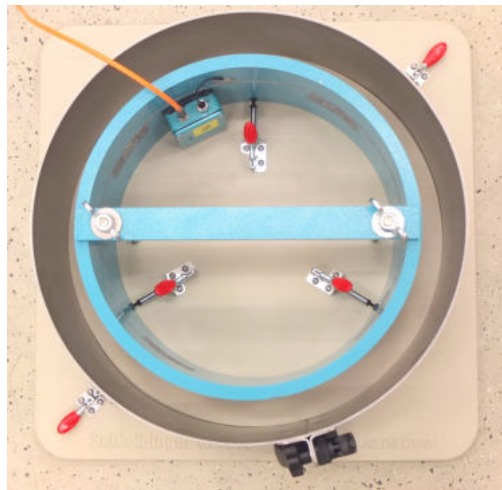


Figure 7: Fixing of the inner ring on the base plate.

- The data logger is delivered with a 100V-240V ~, 50..60Hz power supply. Connect the power supply to the data logger. After some seconds the data logger is running and the LED indicator should blink.
- The network cable is connected to the RJ45 plug on the front side of the data logger. For the configuration of the network interface see chapter 6.1.

5.3 Preparation for Measurement

NOTICE

- Prepare the equipment for placing the sample as described in chapter 5.2.
- Fill the liquid sample between the inner ring and the outer ring to the top. If necessary, compress the sample with a rod. Do not use a vibration table! Compression by vibration table can damage the electronics.
- Pass the thermocouple through the cover ring and place the twisted end into the liquid sample.
- Cover the sample with the cover ring.
- The test specimen shall be cured in the mould for 24 h or as required by the standard or recommendation used. The test specimen should have a certain strength. Remove the fixation aid of the inner ring to the base plate and loosen the inner toggle clips for the centring the ring.
- Loosen the outer toggle clamps and the eccentric clamps of the outer ring. Carefully lift the ring over the sample and let it stand sideways.
- Let the surface of the test specimen covered by the cover ring or with a foil if required.
- Connect the amplifier module from the inner ring with the data logger using the orange cable supplied with the device.
- Connect the data logger to the power supply.

- Connect the data logger with the notebook or personal computer (see chapter 6.1).
- Measurement can be started
 - if only one Shrinkage Ring is connected, the measurement start for both measuring channels (strain gauge and temperature) can be carried out simultaneously using Quickstart (see chapter 6.3.2). If necessary, save the previously measured data (see chapter 6.3.5 and 6.4.5). All data will be deleted using the Quickstart.
 - if several Shrinkage Rings are connected and have to be started at different times, the corresponding channels must be operated separately. For this the procedure needs to be done for the ring channels as following: **offset - data reset - start** and for the temperature channels **reset - start** (see chapter 6.4).

NOTICE

The measurement start can be done after de-moulding or right after filling the test specimen if required. Please note, If changes are made to the equipment during the measurement, this can lead to noises and deflections in the measurement curve!

The amplifier module has two LED lights: green and red (figure 8).

- The red LED flashes when the data logger is connected and the data query is running.
- The green LED lights up permanently when the thermocouple is connected. This light flashes when the thermocouple is not connected or is defective.
- If both LED lights are off, the data logger is not connected.
- If the green LED is on or flashing, but the red LED is not flashing, the program on the data logger is not running or the connection to the ring is not available e.g. cable is damaged.

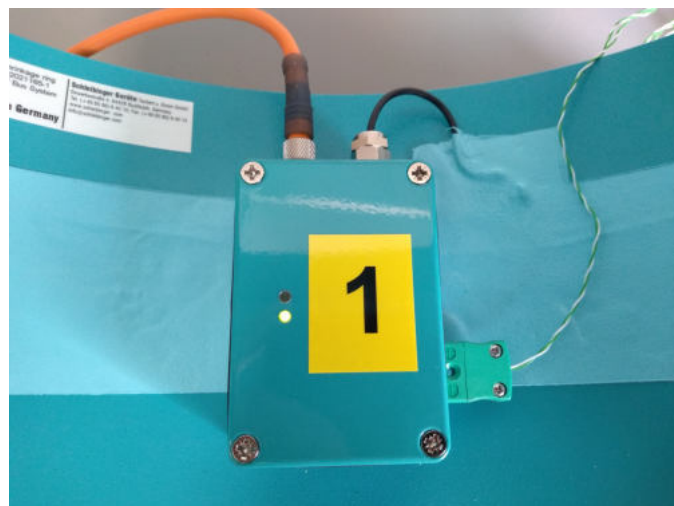


Figure 8: Amplifier module with LED lights.

5.4 Removing the Specimen after the Measurement

After completing the measurement remove the thermocouple and disconnect the orange cable from the amplifier module of the inner ring at first.

Carefully detach the sample from the inner ring. If necessary, use a hammer and chisel.

NOTICE**Do not damage the inner ring and the base!**

User water and brake cleaner for cleaning the inner ring surface. The inner ring is made of steel and can rust. Cover the surface with oil or grease after cleaning.

6 Software Handling from WEB Browser

The appliance is equipped with a network interface. An internet browser allows access to the measurement data.

The appliance can be integrated into a network or connected directly to a computer.

6.1 Configuration of the Network Access

The network configuration can be done with the program Chiptool which can be found on USB stick delivered with the equipment.

The parameters for the network settings can be found on the sticker on the device.

There are two ways to access the device:

- via local network with integrated DHCP and DNS server and automatic obtaining of an IP address.
- by specifying a static IP address.

6.1.1 Obtaining IP address automatically

To connect the system to a local network with an integrated DHCP and DNS server, proceed as follows:

- Connect the appliance to your local network with the supplied network cable and switch on the device.
- Enter the host name of the appliance in the address window of your browser (see factory settings): "**http://...**".

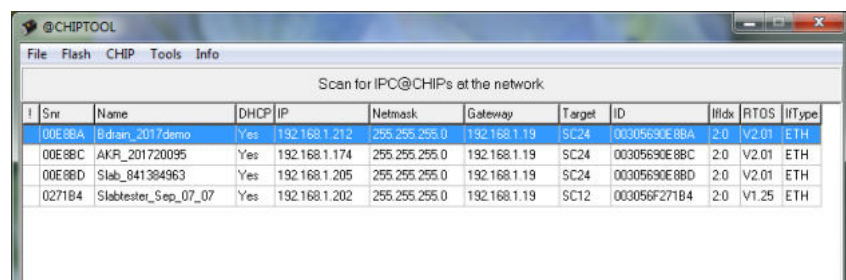
The device is assigned a free IP address via the DHCP server so that it can be reached via the host name using DNS. From time to time, the DHCP server scans the network for IP addresses and the corresponding mappings of the computers on the network. This procedure may take some time.

For questions about your network and DHCP and DNS settings, please contact your IT administrator.

6.1.2 Specification of IP address

Alternatively, the device can be connected via an IP address assigned to it. Assign an IP address to the device using the program „Chiptool“ or similar. To connect the device, enter the IP address in your browser's input window instead of the host name (fig. 10).

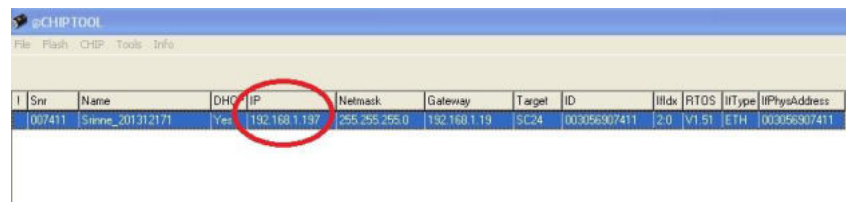
For questions about your network, please contact your IT administrator.



The screenshot shows the Chiptool application window with a menu bar (File, Flash, CHIP, Tools, Info) and a title bar (@CHIPTOOL). The main area displays a table titled "Scan for IPC@CHIPs at the network". The table has columns for Sni, Name, DHCP, IP, Netmask, Gateway, Target, ID, IfIdx, RTOS, and IfType. The first row is highlighted in blue.

Sni	Name	DHCP	IP	Netmask	Gateway	Target	ID	IfIdx	RTOS	IfType
00E8BA	Bdram_2017/demo	Yes	192.168.1.212	255.255.255.0	192.168.1.19	SC24	00305690E8BA	2.0	V2.01	ETH
00E8BC	AKR_201720095	Yes	192.168.1.174	255.255.255.0	192.168.1.19	SC24	00305690E8BC	2.0	V2.01	ETH
00E8BD	Slab_841384963	Yes	192.168.1.205	255.255.255.0	192.168.1.19	SC24	00305690E8BD	2.0	V2.01	ETH
0271B4	Slabkster_Sep_07_07	Yes	192.168.1.202	255.255.255.0	192.168.1.19	SC12	003056F271B4	2.0	V1.25	ETH

Figure 9: Reading out the IP address of the device with the Chiptool program.



I	Snr	Name	DHC	IP	Netmask	Gateway	Target	ID	llIdx	RTOS	llType	llPhysAddress
	007411	Sinne_201312171	Yes	192.168.1.137	255.255.255.0	192.168.1.19	SC24	000056907411	2.0	V1.51	ETH	003056907411

Figure 10: Access to the device with an IP address.

6.1.3 Direct connection to computer

If there is no network or it is not possible to integrate the device into a local network, the device can be connected directly to a computer as following.

1. set static IP address to the computer:

- Open Control Panel → Network and Internet → LAN-Connection → Properties (fig. 11).
- Set a static IP address from the private area e.g.: 192.168.1.1
- Set a network mask for a local network e.g.: 255.255.255.0.

For Windows 10 and 11 instead of subnet-mask the subnet prefix length is required. The subnet prefix length of 24 corresponds to 255.255.255.0. The subnet prefix length of 12 corresponds to 255.255.0.0.

- Gateway does not have to be set.

2. set static IP address to the device:

- Use the network cable to connect the appliance to the computer on which you have just set an IP address and start the program „Chiptool“ or similar there.
- If the computer is configurated correctly, the device will appear in the program window (fig. 9).
- Highlight the entry and right-click on it. In the window select „IP Configuration“. An input window appears (fig. 12).
- deactivate there: Use DHCP.
- Enter a IP address from the same private range. This IP must be different from the previously assigned computer IP address e.g.. 192.168.1.184
- Enter the same subnet mask as before for computer.
- For configuration click on Config.

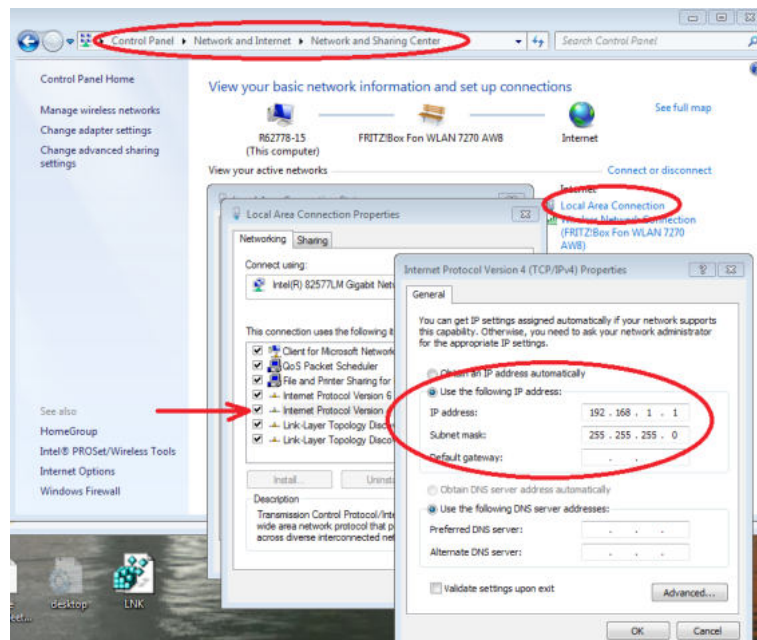


Figure 11: Computer configuration for a direct connection to the device.

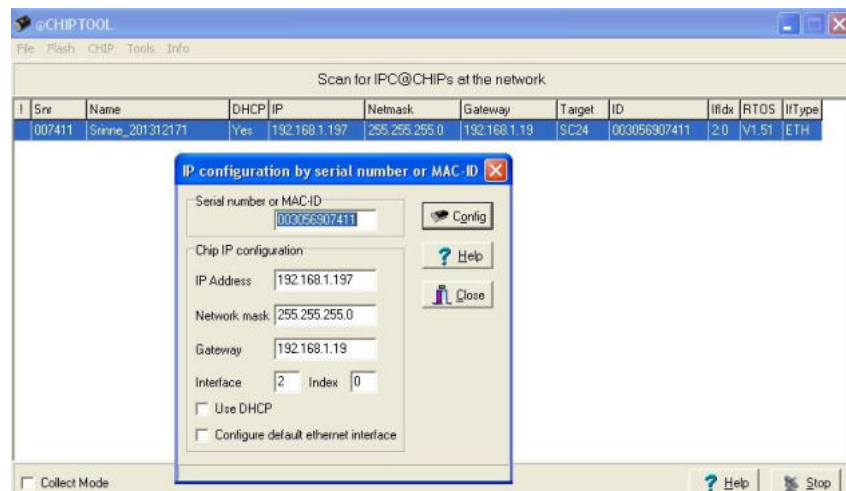


Figure 12: Device configuration for a direct connection to the computer on the program „Chiptool“.

In addition to the http protocol the file transfer protocol (ftp) can be used for readout of the data. The user name for the ftp protocol and the password are „ftp“.

For debugging purposes it is possible to login with the telnet protocol. The user name and the password are „tel“.

6.2 Main menu

Start a web browser and enter the host name or IP address in the address field of the web browser. After successful connection, the start screen is displayed (fig. 13).

In the upper part of the window the menu bar is located showing different tabs. Click on the tab to open the subdirectories.

By selecting „Schleibinger“ you will be forwarded to the Schleibinger Geräte GmbH web page:

www.schleibinger.com

In the header of the page on the left, the drop down menu **All** is shown. All channels are controlled in the same way from this menu. For example starting the measurement, set up of the real time clock, showing data from all channels numerical or graphical.

The single channels available are listed from the menu item „All“ on the right side.

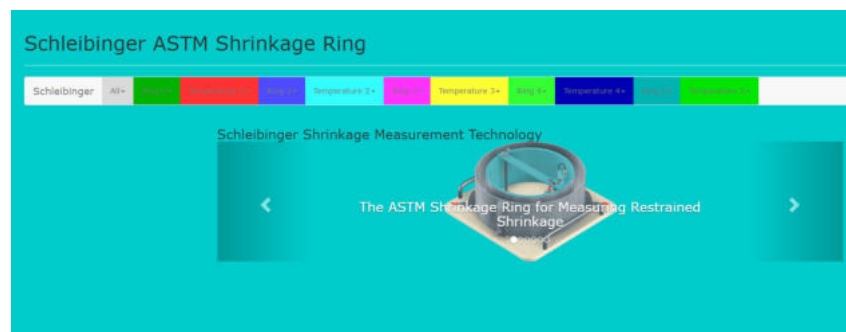


Figure 13: Start screen.

6.3 Operating All Channels Simultaneously

The menu item „All“ allows to control all available channels in the same way at the same time (fig. 14).

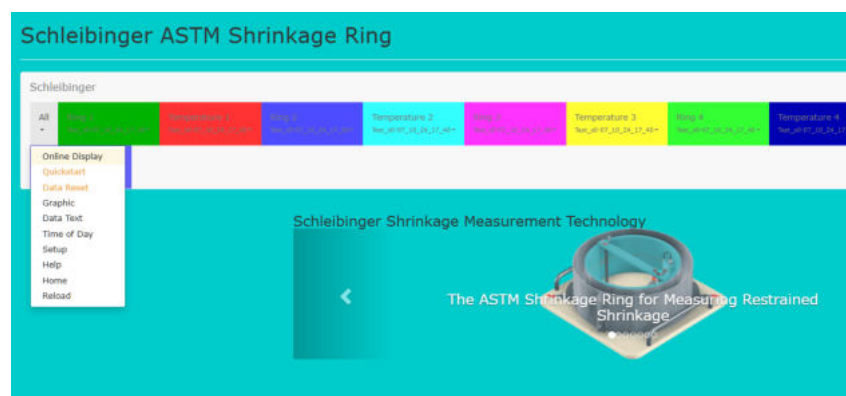


Figure 14: Main menu - All.

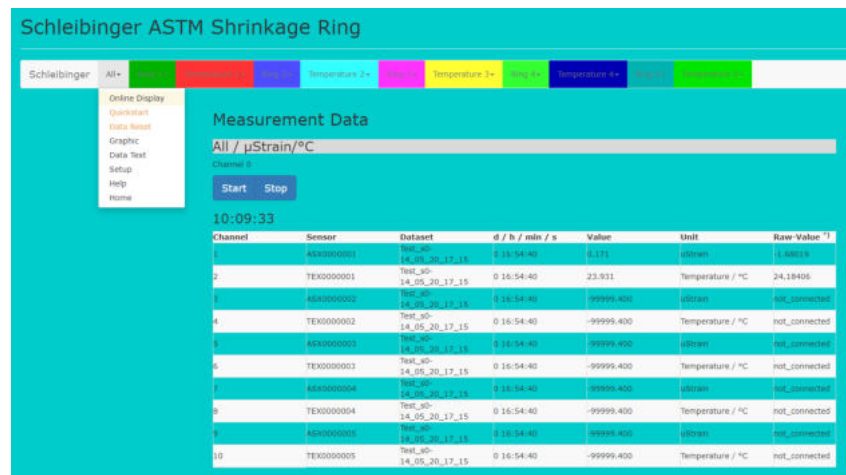
6.3.1 Online Display

Using the subitem „Online Display“ the current values of all channels will be displayed in a form of a table (fig. 15).

Select the subitem „All → Online Display“ and click on „Start“. The data will be displayed and updated every 5 to 10 seconds. Select „Stop“ to stop updating the data.

Each row in the table is assigned to a sensor according to the order. The raw values are shown in the last column of the table.

If the Shrinkage Ring or the thermocouple are not connected or are not found, the message **not connected** appears in the last column of the table.



Channel	Sensor	Dataset	d / h / min / s	Value	Unit	Raw Value ?
1	40X0000003	Test_00_14_05_20_17_15	0 16:54:40	2.171	μStrain	1.188115
2	TEX0000001	Test_00_14_05_20_17_15	0 16:54:40	23.931	Temperature / °C	24.18406
3	40X0000002	Test_00_14_05_20_17_15	0 16:54:40	99999.400	μStrain	not_connected
4	TEX0000002	Test_00_14_05_20_17_15	0 16:54:40	-99999.400	Temperature / °C	not_connected
5	40X0000003	Test_00_14_05_20_17_15	0 16:54:40	99999.400	μStrain	not_connected
6	TEX0000003	Test_00_14_05_20_17_15	0 16:54:40	-99999.400	Temperature / °C	not_connected
7	40X0000004	Test_00_14_05_20_17_15	0 16:54:40	99999.400	μStrain	not_connected
8	TEX0000004	Test_00_14_05_20_17_15	0 16:54:40	-99999.400	Temperature / °C	not_connected
9	40X0000005	Test_00_14_05_20_17_15	0 16:54:40	99999.400	μStrain	not_connected
10	TEX0000005	Test_00_14_05_20_17_15	0 16:54:40	-99999.400	Temperature / °C	not_connected

Figure 15: Online display of the raw values for the shrinkage ring.

6.3.2 Quickstart

For starting the measurement and data acquisition, the existing data files must be deleted, an offset performed, the measurement time set to zero and the measurement itself started. All these steps for all available channels can be carried out simultaneously by using the subitem „Quickstart“ (fig. 16).



Figure 16: Measurement start with Quickstart.

NOTICE

Save the measurement data first. Use of „Quickstart“ erases all data from all channels.

Select the subitem „All → Quickstart“ and click on „Start“.

Optionally, a filename can be entered. This name will appear for all channels in the main menu bar and in the table of the submenu „Online Display“ in the column „Dataset“.

6.3.3 Data Reset

With the subitem „Data Reset“ all the data of all channels will be reset at the same time.

Select the subitem „All → Data Reset“ and click on „Erase“.

6.3.4 Graphic

All the measured values will be displayed from the subitem „Graphic“.

Select the item „All → Graphic“.

The graphical display can be customized. Please note, the display of the data in the web browser may vary depending on the browser.

Selection of the channel: The buttons above the graphic allow the selection of the channels to be displayed. The color of the measurement curves corresponds to the color of the respective channel. After the selection, update the graph with the icon „double-arrow“.

Selection of measuring range in the Y direction: The graph is scaled automatically. By entering in the fields **Y-min** and **Y-max** the graph can be adjusted individually in the Y-axis (temperature axis).

Selection of the measuring range in the X direction: A section on the X-axis (time axis) can be determined with the mouse. Press the left mouse button and mark the area of the graph to be displayed.

For zoom out use the icon „magnifying glass“.

Inserting text: By selecting the icon „paper clip“ a text box opens in the graphic area. Comments or notes can be entered there. For closing the box select the cross on the box.

Printing the graph: Use the print function of the browser.

Firefox: Select „current frame“ from the print dialogue to print the graphic without menu items.

Internet Explorer 9 and others: For the most browsers it is possible to open the print dialogue by pressing the right mouse button and thus print the graphic without menu items or to save the graph as a pdf file.

6.3.5 Data Text

The measurement values will be stored locally on the data logger. The data remains stored even if there is no power.

Select the subitem „All → Data Text“ and click on „Load“. The measured values are displayed (fig. 17). The data file generated contains all data from all channels in tabular form.

By selecting menu item „Clear Screen“ the data is hidden and not displayed.

The data can be copied directly into an Excel sheet, Word or similar. Save the data as txt file using „Strg-S“.

Alternatively, the data can be read in Excel. Select the tab **Save Link** as . . . A new window with the measured data opens. Copy the website address:

for example: <http://192.168.1.186/DATEN/DATA0.TXT>

and import the link in Excel via **Data** → **from the web**.

The data can also be transferred directly from the browser to desired program via copy and paste.

The measurement data are presented in tabular form and are separated by tab characters. The column assignment is listed in table 3.

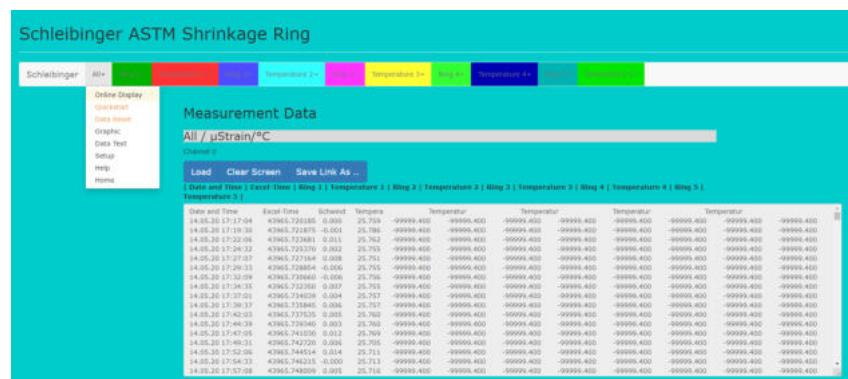


Figure 17: Measures values from all channels.

Table 3: Measurement data column assignment

column assignment	
1	date and time
2	fracture of a day since January 1 st , 1900, to be formate in Data:Time
3	strain data ring 1
4	temperature of the thermocouple ring 1
5	strain data ring 2
6	temperature of the thermocouple ring 2
7	strain data ring 3
8	temperature of the thermocouple ring 3
9	and so forth

In addition to the http protocol the file transfer protocol (ftp) can be used for readout of the data. The user name for the ftp protocol and the password are „ftp“. The datasets can be found in folder:

/httpd/htdocs/daten

Filezilla (free software), wise-ftp or similar programs are recommended.

6.3.6 Time of Day

From the „All → Time of Day“ date and time can be adjusted (fig. 18). The data logger uses the 24-hour clock setting. The European time format is used.

day.month.year:hour:min for example 26.03.03:12:11.

Use „Set Date and Time“ button for confirmation.

NOTICE

Do not change the time during the measurement.

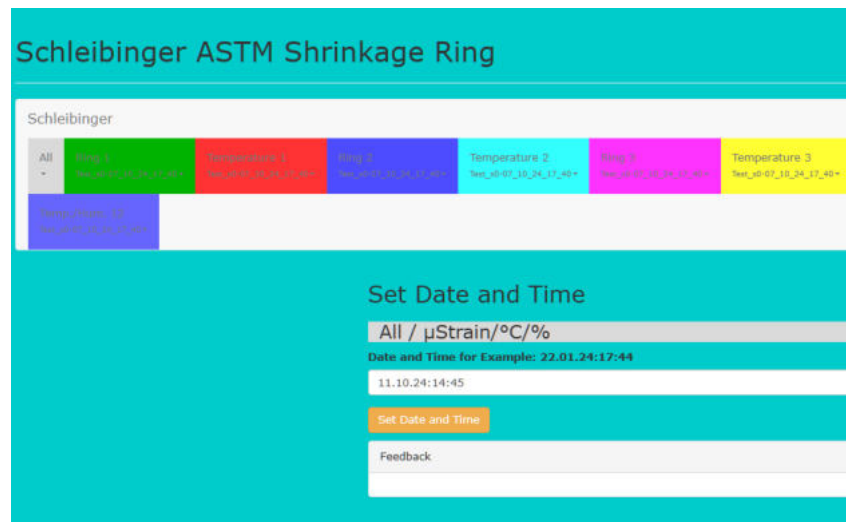


Figure 18: Setup of date and time

6.3.7 Setup

From the submenu „Setup“ the sampling rate of the comprehensive data file can be specified (fig. 19). This shows the recording rate for all channels combined in „All \rightarrow Data Text “.

The values of 30 s, 1 min, 5 min, 15 min, 30 min, 1 h or 4 h can be selected (fig. 20).



Figure 19: Subitem „All“ \rightarrow „Setup“

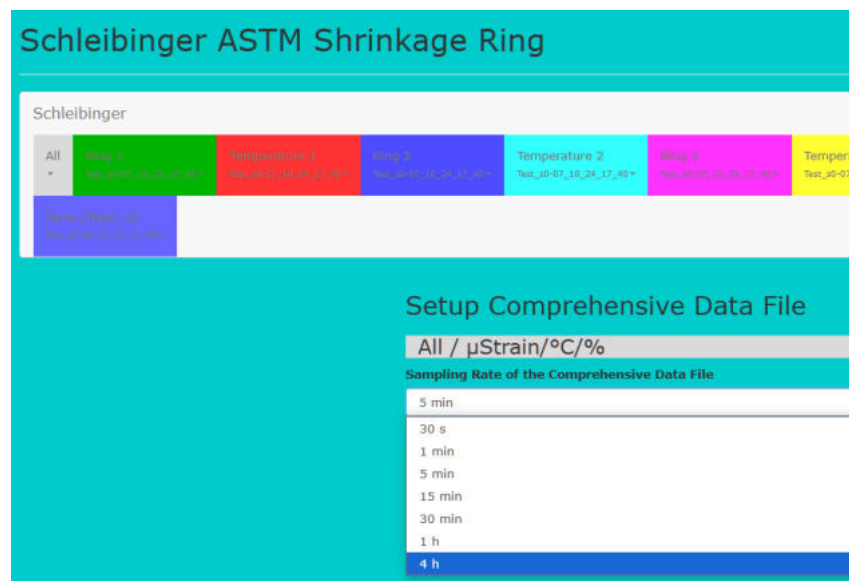


Figure 20: Setup Comprehensive Data File.

6.3.8 Help, Home and Reload

Use the subitem „Help“ to get the user manual in pdf format.

Use the subitem „Home“ to go back to the main menu.

Use the subitem („Reload“) to reload the website view.

6.4 Operating Single Channel separately

The operation of a single channel (sensor) can be done separately. This is particularly interesting when there are several identical sensors (channels) that should be started independently of each other.

6.4.1 Offset

To record relative changes in the measured values, an offset should be carried out before starting the measurement. To do this, proceed as follows:

- Select the channel in the main menu bar.
- Select the submenu item „Offset“.
- Click on „Value=0“ (fig. 21). The current measured value will be set to offset value and will be automatically subtracted from all measured values.

NOTICE

This function is not available for the thermocouple and the combined humidity and temperature sensor.



Figure 21: Offset.

6.4.2 Start

The start setting can be carried out for each individual channel separately or for all channels together (see chapter 6.3.2).

Starting the measurement of the individual channel requires the usage of the submenu item „Start“ from the designed channel (sensor).

- Select the channel from the main menu bar.
- Select submenu item „Start“ (fig. 22).
- If needed, insert the name of the measurement.
- Click on „Start“



Figure 22: Measurement start of the single channel.

6.4.3 Data Reset

The measured values are continuously recorded by all connected sensors once connected to power. For each individual measurement, the previously recorded values for individual channel (sensor) can be deleted separately.

Use the submenu item „Data Reset“ from the designed channel (sensor) to emptying the data file.

- Select the channel from the main menu bar.
- Select submenu item „Data Reset“.
- Click on „Erase“

6.4.4 Graphic

The measured values from the individual channel is displayed from the subitem „Graphic“.

The graphical display can be customized (see also chapter 6.3.4). Please note, the display of the data in the web browser may vary depending on the web browser.

6.4.5 Data Text Single Channel

For each channel text data file is available. For the first channel **data1.txt**, for the second channel **data2.txt** and for the following channel n **data n .txt** accordingly will be generated.

- Select the desired channel from the main menu bar.
- Select „Data Text“ and use „Load“ for displaying the data of the selected channel (fig. 23).
- In the first column seconds since start of the measurement are shown. In the second column the measured values are displayed. The unit of the measured values corresponds to the channel was used and is shown under the header line.
- All columns are separated by tabs.

By selecting menu item „Clear Screen“ the data is hidden and not displayed.

The data can be copied directly into an Excel sheet, Word or similar. Save the data as txt file using „Strg-S“.

Alternatively, the data can be read in Excel. Select the tab `Save Link as . . .`. A new window with the measured data opens. Copy the website address:

for example: `http://192.168.1.186/DATEN/DATA1.TXT`

and import the link in Excel via `Data → from the web`.

The data can also be transferred directly from the browser to desired program via copy and paste.

The measurement data are presented in tabular form and are separated by tab characters. The column assignment is listed as following:

- first column: seconds since reset according to sampling rate.
- second column: measured value



- The sampling rate can be adjusted from the „Sampling Rate“ in the range of 10 seconds to 4 hours (fig. 25, left). The corresponding measurement values are recorded according to the set interval.
- The limit value for each channel from the „Limit“ can be specified (fig. 25, right). If the limit is set to ∞ the data will be collected according to the set recording interval of the sampling rate. If the limit is set to for example to $n=5$ the data logger will record the additional data where the difference of the measured value between two measurement points bigger than 5. This gives the possibility to record the changes in the measured value independent from the set recording interval. The unit of the limit value is due to the channel selected.
- From the „Time Format“ the format of the recording interval can be set. Two possibilities are available: „Time/s“ and „n · sampling rate/s“.

With „Time/s“ the sampling interval may vary for ± 1 second due to small deviations in the response time of the several software processes running on data logger.

With „n · sampling rate/s“ the actual measuring time is rounded down to the interval of the sampling rate.

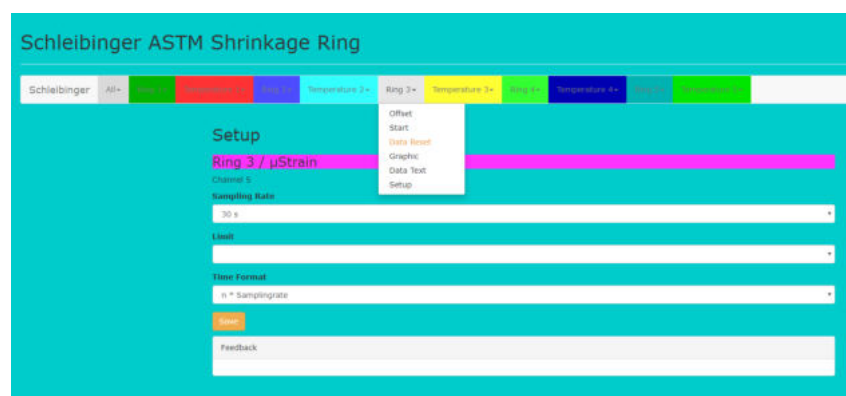


Figure 24: Channel setup

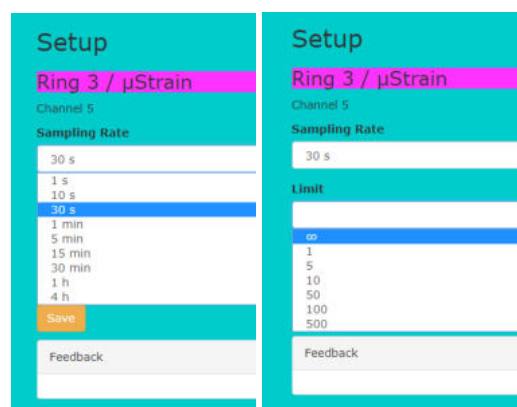


Figure 25: Channel setup with sampling rate (left) and limit adjustment (right).

7 Service Hints and Maintenance

7.1 Cleaning the Appliance

CAUTION

Before cleaning always switch off the appliance.

Keep the appliance and individual components clean. The cleaning of the appliance and individual components must be carried out by the user after each use.

Use a commercially available mild cleaning agent.

Use a lint-free cloth or non-scratching sponge to clean.

NOTICE

Do not use abrasive sponges or scourers. Do not use concentrated cleaning agent and never use cleaning agents containing sand, chloride or strong acids as these would damage the surfaces and could cause corrosion.

Disconnect the thermocouple and the orange cable from the amplifier module first.

NOTICE

Remove the test specimen. Be careful when using hammer and chisel. Do not damage the surface of the inner ring and the base as well!

Clean the surface of the rings with a lint-free cloth or paper towel. **Never scratch the surface of the ring.**

User water and brake cleaner for cleaning the outer surface of the inner ring. The inner ring is made of steel and can rust. Cover the outer surface of the inner ring with oil or grease when not in use.

8 Decommissioning and Disposal

For the decommissioning clean up all parts of the appliance. To protect against rust, the appliance can be rubbed with a lint-free cloth soaked in oil.

The appliance can be stored at temperatures from +5 °C to +60 °C, non-condensing.

The appliance contains valuable materials and must be collected separately from unsorted municipal waste. The disposal of disused appliance must be carried out professionally and properly in accordance with the locally applicable regulations and laws.

Information about proper disposal can be obtained from the city or local authority or a waste disposal company.

The company Schleibinger Geräte GmbH will take the appliance back free of charge. The user bears the costs for an environmentally friendly delivery.

9 Additional Informations

9.1 Theory of Operation

The standard ASTM C 1581 “Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage” [2] is describing a more simple setup. The Shrinkage Ring from Schleibinger Geräte was developed and constructed based on the ASTM C1581 standard.

A sample of freshly mixed mortar or concrete is placed in between the steel rings. The compressive strain developed in the steel ring caused by shrinkage of the mortar or concrete is measured (figure 26).

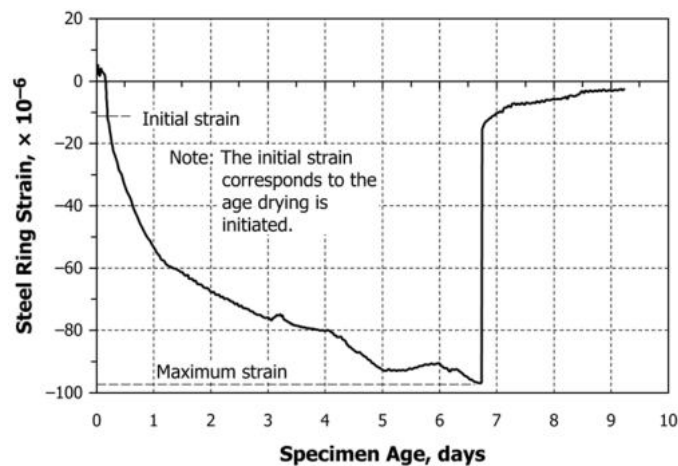


Figure 26: Typical curve shape due to restrained shrinkage (see also Fig.2 from ASTM C1581).

This test method covers the laboratory determination of the age at cracking and induced tensile stress characteristics of mortar or concrete specimens under restrained shrinkage. The procedure can be used to determine the effects of variations in the proportions and material properties of mortar or concrete on cracking due to both drying shrinkage and deformations caused by autogenous shrinkage and heat of hydration. This test method is not intended for expansive materials.

The test method can be used to determine the relative effects of material variations on induced tensile stresses and cracking potential. For materials that have not cracked during the test, the rate of tensile stress development at the time the test is terminated provides a basis for comparison of the materials.

9.2 Interpretation of the Results for Further Analysis

The time and the strain development of the test specimen are recorded. For the comparison of the results ambient temperature and relative humidity of the testing environment have to be constant and recorded.

It is recommended to monitor and record the strain in the steel ring for at least 28 days after initiation of drying, unless cracking occurs prior to 28 days.

The strain is plotted against specimen age (fig. 26). A sudden decrease in compressive strain indicates cracking. The sudden decrease in compressive strain at cracking is usually greater than 30 microstrains.

Since the force acts inwards, the measured values are negative. Multiply these values by -1 to work with.

For further calculations one microstrains corresponds to a length change of $1 \mu\text{m}/\text{m}$. According to ASTM C1581 a factor for the tensile stress of $G=72.2 \text{ GPa}$ is given. Thus 1 microstrain corresponds to 72 kPa and the tensile strength can be calculated accordingly.

The potential of cracking can be defined as high, moderate-high, moderate-low or low. For further details and calculations use the corresponding standard.

2

² Parts of the text in chapter 9 are cited from the standard ASTM C1581.

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