Anton Paar

Measure,
what is measurable,
and make measurable
that which is not.

Galileo Galilei (1564-1642)

Instruction Manual

RheoCompass™ Software

Software Manual

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1   RheoCompass™ – Overview

1.1   Description

The RheoCompass™ software is used for the control of the Anton Paar MCR rheometer series. The measurement parameters and results as well as all settings are recorded in a database. The settings for a measuring device are stored as a measuring set configuration.

To facilitate getting started with the rheological measurements, RheoCompass™ contains various templates suited to different applications and methods. The templates can be selected from the application flow shown at the first start of the software. Each template includes a full test definition from the first start to the evaluation of measurement results. The test definition, the results and all presentation windows are stored in separate projects which can be retrieved at any time.

The figure below shows the main elements. The definitions for the software items, e.g. ribbons or navigation, will be used throughout this manual.
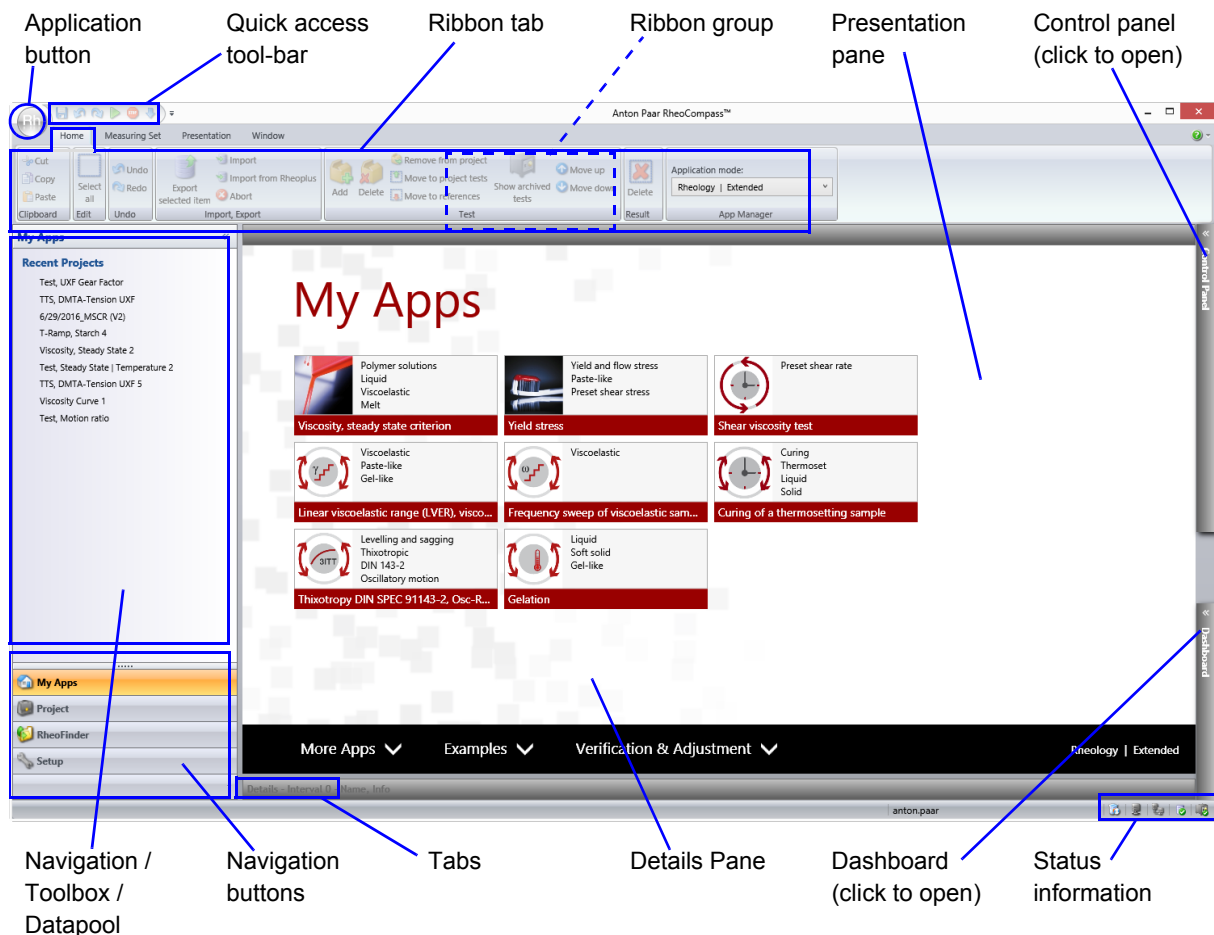
Fig. 1 - 1   Overview of User Interface

- **Application button**
  The Application button contains the main file functions such as "Open", "Save" or "Print". You have further access to the "Options" dialog for general settings in RheoCompass™. The options should be changed with great care only.

- **Quick access tool-bar**
  Use the quick access bar to undo or redo the last action or to save the currently opened project. "Start" and "Stop" are applied to the test Definition contained in the project.

- **Ribbon tab**
  In the ribbon tabs, you find all software functions grouped by their relevant context. The groups of buttons within a ribbon are called ribbon groups.

- **Navigation buttons**
  These are used to select the main area, usually you will be working with "Projects". The "Setup" area contains functions for installing new devices or accessories, for example, and the "RheoFinder" gives access to the database functions.

- **Navigation / Toolbox / Data pool**
  The content of the navigation pane area depends on the currently selected main area of RheoCompass™, e.g. whether you are editing settings in the general setup or whether you are running measurements. The "Navigation" always lists all available items or options, the "Toolbox" contains the actions for a test definition and the "Datapool" shows all measurements and analyses in the currently opened project.

- **Presentation Pane**
  The "Presentation pane" is the main working area of RheoCompass™. Here you will find the test definition, diagram and table windows, report windows and so on. To change settings for the various items inside this pane, you click on the items and make the changes in the details Pane.

- **Details Pane**
  The details pane contains the detailed settings for the current content of the presentation pane. The settings can be edited in this pane. As RheoCompass™ is working with a database, the changes take effect immediately, a confirmation is not necessary.

2 Options

The "Options" dialog contains general settings for the operation of the software and for logging and database handling. As the settings influence the overall behavior of RheoCompass™, changes should be made with great care.

2.1 Popular Options

2.1.1 User-Specific Options

The loss factor reaches infinite value for purely viscous or purely elastic materials, the measurement of the storage respectively loss modulus does not make sense in that case. To have a clearly defined limit value, if this occurs, activate the option "Limit loss factor" and select the level of warning (information, warning or error) that you would like to see in case a limit is reached. The default limit values may be changed, if necessary.

2.1.2 Default Unit and Default Marker Options

RheoCompass™ uses either SI-Units or the most common unit as the default. This default is used for all new diagrams, tables, measurement window and so on. To change the default unit for a physical variable, select the variable group or "All variables" and highlight the variable in the list.

Make the required changes to unit, number format, number of digits (precision), scaling type, marker style and marker size and close the dialog with **"Close"**. The changes will be applied to all newly created windows or projects.

To reset the highlighted variable or all variables to the default click the appropriate button and close the dialog box with **"Close"**.

2.1.3 LAOS Calculation Options

Define whether the strain or the stress signal is sinusoidal. Use auto-detection to let the software decide whether the strain or the stress signal is sinusoidal.

- Select the option sinusoidal strain if TruStrain™ is ON and a set strain is defined in the measurement

- Select the option sinusoidal stress if TruStrain™ is OFF. This option applies for stress (CSS mode) and strain (CSD mode) controlled tests with TruStrain™ deactivated.

Define the maximum harmonic used for the LAOS calculations. The default value is 21, whereas for most presentations 9 harmonics are sufficient as the higher harmonics are too noisy.

2.1.4 Save Documents

The currently opened project is stored at defined time intervals while a test is running to avoid loss of data points in case of a computer or power failure. This option is enabled by default with a time interval of five minutes. To change the time interval, enter the required value. To disable the automatic saving, remove the check mark (not recommended.) Every project is stored after a test has been finished.

To change the path where videos and images are stored, click the button to the right of the text field and select the required location. As these files may become rather large, make sure that sufficient disk space is available in the selected location.

2.1.5 Database Options

The software checks regularly, if the connection to the database is still available. In case a timeout occurs, the software tries to re-establish the connection. The timeout values for checking and re-connection can be set in these options. The default value is three minutes for both.

2.1.6 ASCII Import and Export Options

The software allows to import text data (ASCII) e.g. to be able to compare literature data or data from third-party software to measurement data. For the software to be able to recognize the ASCII data, the settings in this dialog have to match the data that are to be imported.

The export of data can be started manually from any table window or automatically in a test definition using the action **"Export"**.

The settings have the following functions:

- *Comment character*
  Enter the delimiter that separates the data you would like to import from any comments. It is not possible to use a comma (,) as a delimiter.

- *Number of headlines to skip*
  Enter the number of lines at the beginning of the ASCII files for import that do not need to be imported.

- *Use dash line for header separation*
  Check this option if your data are separated from other information by a line of at least 40 hyphens.

- *Show variable name in data column header*
  This option needs to be checked.

- *Show unit in data column header*
  Check if the units of your data are available in a second heading line. These units can be converted by RheoCompass™ into default units (usually SI units). The unit has to be written with angle brackets. If the unit is not available in the imported data the software will assume that SI units have been used.

- *Column Separation Character*
  <Tab>, <Space> and semicolon (;) are recognized as separators, as well as the sign that has been specified as column separator in the Windows™ Control Panel.
  If "Windows defined" has been selected for the separation character, the software uses the separation character defined in the regional settings of the operating system (Windows control panel).

2.2 Security Options

Access to the RheoCompass™ software is protected by a login function, which requires a user name and a password to be entered at the start-up of the software. There are two login types: RheoCompass™ login and Windows login:

- **Windows account for login**: If the Windows account login is activated, the current Windows user is logged in automatically with the Windows user name. If the user is not setup in RheoCompass™, this user is added automatically to the RheoCompass™ users list. A new role is assigned to this user depending on the settings of the Default RheoCompass™ role. If the Default RheoCompass™ role is not RheoCompass™ Administrator, the user has restricted permissions. Any RheoCompass™ administrator is allowed to change the role of a user in <Setup>, <User administration> (see also *Chapter 10.5.2, "User Administration"*).

- **RheoCompass™ account for login**: We recommend to use the RheoCompass™ login in combination with the 21 CFR Part 11 feature of the RheoCompass™ software. Optionally the Windows login can be used.

For more information on the login, refer to *Chapter 10.5.3.5, "Login"* of this manual.

2.2.1 Logging Options

All actions, or events, listed in the logging categories can be recorded during the operation of the software. By default, both errors and warnings are logged. To add more events to the logbook (audit trail), enable the corresponding categories.

The occurrence of an event in any of the activated categories is shown in message list and a sound is played. To disable the sound, disable the **"Play sound..."** option. The message window cannot be deactivated. To display the

window, after it has been closed, click the warning sign in the lower right corner of RheoCompass™ window. To view the complete log, go to the **"RheoFinder"** and select the entry logbook (audit trail).

The logbook (audit trail) can be stored in RheoFinder (default setting) or in a separate file in a defined destination. Enter the path in the text-box or click the button next to it to select a log-file that is already existing.

The logbook (audit trail) can also be exported to pdf using the appropriate ribbon function in the Logbook ribbon.

Details on logging categories

Log Errors: serious events in the software, logging cannot be disabled

Log Warnings: events that can influence the feasibility of settings, e.g. exceeding a temperature limit

Log users log in and out events: should be enabled for 21 CFR Part 11 compliance. Logs failed and successful logins and logout.

Device communication: commands send to and from the instrument, only for service use

Log Signature: should be enabled for 21 CFR Part 11 compliance. Logs the (electronic) signing of measurement results by a user.

Log Setup operations: logs the installation of devices, accessories or measuring systems.

For more information on logging, refer to the chapter 7.5.3.3 of this manual.

2.2.2 Backup Options

To avoid loss of data, a backup of the of the main database including all archives should be carried out at regular intervals. The automatic backup will be carried out at the specified time every day, if the option **"Start backup automatically..."** is activated. A manual backup may be started at any time with the button **"Backup now"**.

- RheoCompass connected with a local database: A manual backup may be started at any time with the button "**Backup now**".

The software can automatically delete previous backups to reduce the amount of data stored in the database location. Enable the option **"Delete backups older than..."** to use this feature and enter the number of backups that should be kept.

The backup files are stored in the local directory C:\ProgramData\Anton Paar\RheoCompass\DbBackups. Use the option 'Copy last backup file of each month to external directory when starting RheoCompass (e.g. to a file server with

network share)' if you wish to make a copy of the locally stored files. They can be copied from this location for file backup. The original SQL files cannot be copied directly without loss of data.

Any images or videos that are recorded in the operation of the software are not part of the database but are stored as files in the path defined as media path. The files are therefore not included in the automatic backup routine for the database but need to be secured separately. To access the media path you may use the button **"Open media data path"**. The media path may be changed in the **"Popular"** options if necessary.

For more information on backup, refer to the chapter 7.5.3.1 of this manual.

2.2.3   Restore Options

In case of loss of data, a computer fault or damage to the database, the backup is used to restore the database, including all archives. Select a backup from the list and click **"Restore now"**.

2.2.4   Archive Options

The maximum size of the active database is 10 GB, therefore, an archive is created once this size is reached. The settings in this tab allow to define an automatic procedure for archiving which is preferable to waiting until the maximum possible value is reached because they allow a defined and traceable data handling.

Archived database entries are still listed in the current database and can be viewed as any data. Once selected, they are retrieved from the archive and shown in current database. This procedure is handled automatically by RheoCompass™, a user intervention is not necessary.

To use regular archiving enable the option **"Automatically archive every..."** and enter the number of days. This number is usually chosen according to the amount of data that are created each day. Another option is to archive projects after a certain time. Older database items are archived automatically, if this archiving option has been enabled.

If the software is use extensively, the archiving dependent on the size of the database may be activated.

The available archives can be viewed in the list view called 'Project archives' or 'Logbook (audit trail) archives'.

For more information about the archiving options refer to chapter 7.5.3.2 of this manual. Note: The database used by RheoCompass™ is based on Microsoft SQL server. The Studio Management Express software allows direct handling of RheoCompass™ database and archives. For information on the SQL server and software please see the documentation from Microsoft Corporation.

3 Setup

The "Setup" area of RheoCompass™ contains all functions necessary for the general setup. You can create measuring set configurations and moving profiles as well as create or edit accessories and measuring systems. The user administration is available in this area as well.

3.1 Measuring Set
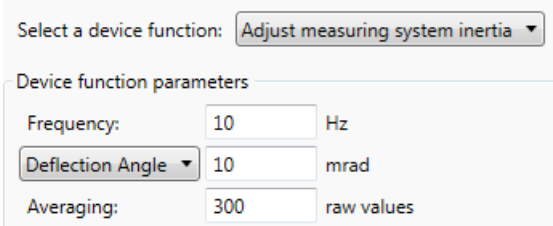
A measuring set consists of the device, its moving profile, if applicable, and all connected peripherals. The chosen settings are stored in the **Setup, configurations** category under a user defined name and can be selected in the ribbon with a single click to activate the configuration with all settings.

3.1.1 Use the Ribbon Measuring Set To:

- select a predefined configuration

- disconnect a selected configuration

- check communication in case of any issue

Click **Start a Service Function** from the **Ribbon Measuring Set, Service** to start any of the service functions:

Adjust drive inertia	Use this function to adjust the **Drive inertia** of the device. The drive inertia is adjusted while no measuring system is connected to the quick-connect coupling. It is strongly advisable to adjust the inertia using the default parameter settings: Select a device function: Adjust drive inertia Device function parameters Frequency: 10 Hz Deflection Angle 10 mrad Averaging: 300 raw values The drive inertia is stored in the device and not in the software. Re-adjust all measuring systems after any drive inertia adjustment.

Adjust measuring system inertia	Use this function to adjust the **Measuring system inertia**. It is advisable to use the default parameter settings for adjusting the inertia except for the magnetic coupling of the pressure cell.
	Select a device function: Adjust measuring system inertia ▾ Device function parameters Frequency: 10 Hz Deflection Angle ▾ 10 mrad Averaging: 300 raw values
	The **Measuring system inertia** is stored in the software. Special case: Use 1 Hz and 100 mrad for adjusting the inertia of the magnetic coupling (pressure cell).
Adjust motor	Use this function to **Adjust the motor** of the rheometer.
Download firmware	Use this function to **Download** the latest firmware to the device.
Service report	Use this function to create a **Service report**. Make sure the device is on and initialized.
Set PT100 input offset and span	Use this function to define the **Offset** and **Span** of any PT100 sensor connected to the PT100 port of the MCR. Offset and Span are stored in the memory of the MCR and not in the software. **Important note**: The Offset and Span are used for any PT100 connected to the PT100 port, once defined. Check that the parameters comply with the PT100 currently being used.
Set thermocouple input offset and span	Use this function to define the **Offset** and **Span** of any **Thermocouple** sensor connected to the **TE port** of the MCR. Offset and Span are stored in the memory of the MCR and not in the software. **Important note**: The Offset and Span are used for any thermocouple connected to the TE port, once defined. Check that the parameters comply with the thermocouple currently being used.
Set start angle	Use this function for **Defining a start angle** to define the position of the quick-connect coupling at test start. The function can be used to ensure the mark on the coupling is facing the front. This is handy when using a UXF fixture or any other measuring system requiring a predefined position. While this function is used to **Define the user angle**, another **Device action** should follow to **Move to the angle**. This is done by the **Move to measuring position** command.
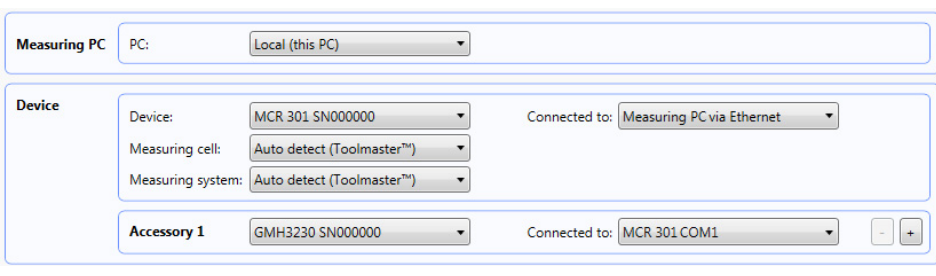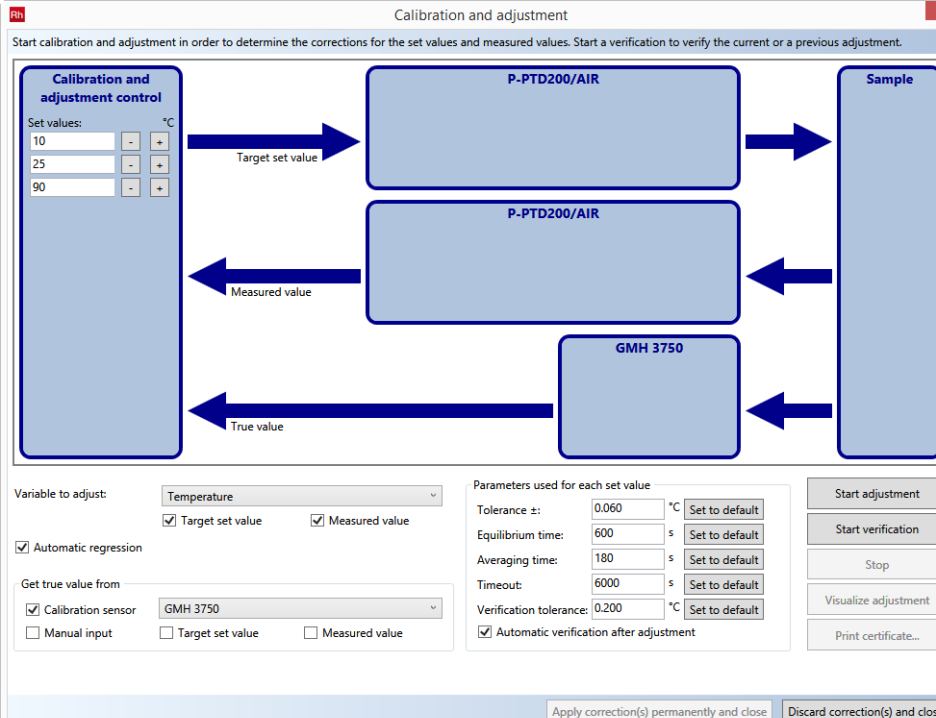
Click **Start measuring set function** to start a temperature calibration.

You can either select a calibration sensor or enter the true sample temperature manually. Verification is optional but it is advisable to check that the adjustment is OK. Define at least three set values.

It might be necessary to select a PT100 or a GMH accessory in the selected configuration. To install the PT100, click **<Setup>, <Accessories>, Ribbon Setup, New, Sensor (Connected to PT100 or Connected to COM), Item name**.

Start the measuring-set function and define the values to be adjusted. All further steps proceed fully automatically and are visualized in a graphical interface. The calibration polynomial correction is stored in the accessory.

Any calibration is stored in the category <Setup>, <Measuring set>, <Calibrations> for retrieval (see chapter 3.1.4).

Configuration with calibration sensor GMH3230	**Measuring PC** — PC: Local (this PC) **Device** — Device: MCR 301 SN000000 — Connected to: Measuring PC via Ethernet Measuring cell: Auto detect (Toolmaster™) Measuring system: Auto detect (Toolmaster™) **Accessory 1** — GMH3230 SN000000 — Connected to: MCR 301 COM1
Calibration dialog with GMH sensor, main set value 25 °C and two additional values	Calibration and adjustment Start calibration and adjustment in order to determine the corrections for the set values and measured values. Start a verification to verify the current or a previous adjustment. **Calibration and adjustment control** — Set values: 10, 25, 90 °C — Target set value → P-PTD200/AIR → Sample Measured value ← P-PTD200/AIR ← True value ← GMH 3750 ← Variable to adjust: Temperature — ☑ Target set value ☑ Measured value — ☑ Automatic regression Get true value from — ☑ Calibration sensor GMH 3750 — ☐ Manual input ☐ Target set value ☐ Measured value Parameters used for each set value — Tolerance ±: 0.060 °C [Set to default], Equilibrium time: 600 s [Set to default], Averaging time: 180 s [Set to default], Timeout: 6000 s [Set to default], Verification tolerance: 0.200 °C [Set to default], ☑ Automatic verification after adjustment [Start adjustment] [Start verification] [Stop] [Visualize adjustment] [Print certificate...] [Apply correction(s) permanently and close] [Discard correction(s) and close]

Calibration dialog with manual input, main set value 25 °C and two additional values	

3.1.2 Configurations

3.1.2.1 Working with Configurations

To create a new configuration, make sure that the ribbon **"Setup"** is selected and click **"New"** in that ribbon. Select the type, if appropriate, and click **"Create new item with default settings"**. This will generate an empty configuration for which you need to enter a description and select a moving profile. Further, you need to define which instrument and peripheral equipment are to be part of this configuration. To actually use this configuration, select it in the ribbon **"Measuring Set"**.

If the new configuration is very similar to an existing one, highlight that configuration in the presentation panel and click **"Duplicate"** in the **"Setup"** ribbon. Then make the required changes to the copy.

The button **"Delete"** in the **"Setup"** ribbon will permanently remove the highlighted configuration from the list of configurations.

3.1.2.2 Configurations – Name, Info

The **"Configuration name"** is a required entry; this text allows to identify the configuration (instrument setup) in other places in RheoCompass™. Therefore, choose a name that allows easy recognition.

The **"Location"** and **"Description"** boxes can be used to enter additional information about the current configuration.

Select the **"Default moving profile"** from the list of available profiles. For detailed information about the moving profiles, please see *Chapter 3.1.3, "Moving Profiles"*.

3.1.2.3   Configurations – Hardware Configuration

The default setting for the **"Measuring PC"** is the setting **"Local (this PC)"**. The setting **"Remote"** is only used for a server-based installation.

The device is selected automatically with the installation of the license, if RheoCompass™ is installed as a single license version. If you are using a multi version, please select the device with the correct serial number from the list **"Device"**.

The connection between computer and device is selected in the **"Connected to"** list. The type and number of the available connections depends on the settings that have been made for the device. For detailed information on selecting a USB or RS232 connection, see *Chapter 3.1.2.4, "USB or RS232 Connection"*. If the device is connected with an Ethernet cable (direct connection or via a company network), select the option **"Measuring PC via Ethernet"**. Detailed information about the Ethernet (LAN) connection is available at *Chapter 3.1.2.5, "Ethernet (LAN) Connection"*.

Unless you are using a measuring system, measuring cell or accessory without Toolmaster™ (automatic recognition), no further settings are necessary.

Manual Configuration>>

To use a measuring system, measuring cell or accessory that is not equipped with the Toolmaster™ select it from the drop-down list. For an accessory you need to select the connection to the device as well. This can be an RS232 connection or one of the analog output connectors of the device. Once the accessory is selected, the correct connection types are listed automatically.

For the installation of non-Toolmaster™ devices, please see the relevant help topic (accessory or measuring system). There, you will also find detailed information about the settings and types that are available.

3.1.2.4   USB or RS232 Connection

1. Click the drop-down list next to **"Connected to"** and select the USB or RS232 port to which the instrument is connected.

2. In case you need to change the settings for an RS232 port, go to **"Measuring set components"** in the navigation and highlight the entry **"Devices"**. The settings for the RS232 port do not normally need to be changed. Incorrect settings may result in difficulties in the communication between instrument and software.

3. Select the tab **"Connection"** and change the setting for **"Connection to measuring PC"** to **"COM"**.

4. Edit the RS232 settings.

5. Select the ribbon "Measuring Set" and change the current configuration to **"None"**.

6. Select the configuration that you want to use.

3.1.2.5 Ethernet (LAN) Connection

1. To change from USB/RS232 connection to an Ethernet connection, go to **"Measuring set components"** in the navigation and highlight the entry **"Devices"**.

2. If there are several devices listed in the presentation pane, select the one for which you want to select the Ethernet connection. Then select the tab **"Connection"**.

3. Select **"LAN"** from the list **"Connection to measuring PC"**, if it is not selected already.

4. Wait for the software to scan for and list all devices available in the network.

5. Select the device that you want to use in the list and click **"Use Device"**. In case the device shows **"Err"** in the status column, please see *Chapter 3.2.1.4, "Devices – Device Network Administration"*.

6. If the device shows **"OK"** for the status, select the ribbon **"Measuring Set"** and change the current configuration to **"None"**.

7. Select the configuration that you want to use.

3.1.3 Moving Profiles

The moving profiles contain a detailed description of velocity, force and limiting values that are used for going to the measuring position, waiting position or loading position. It further contains the settings and limiting values that are used during a measurement and for the zero-gap setting.

A moving profile is part of a measuring set but can be selected in a test definition as well, if required. RheoCompass™ includes a number of predefined moving profiles for various samples and measuring cells.

To create a new moving profile or duplicate an existing one, use the relevant button in the ribbon "Setup". To delete a moving profile, click the "Delete" button.

3.1.3.1 Creating a New Moving Profile

To create a new moving profile, make sure that the ribbon **"Setup"** is selected and click **"New"** in that ribbon. Select the correct device group and select one of the templates in the list. This will generate a moving profile with default settings which can be edited in the separate tabs. To use the moving profile, select it in a suitable configuration (see *Chapter 3.1.2.2, "Configurations – Name, Info"*) and in the **Control panel** of the currently selected rheometer.

The button **"Delete"** in the **"Setup"** ribbon will permanently remove the highlighted moving profile from the database.

3.1.3.2 Moving Profiles – Name, Info

The entry for **"Profile name"** identifies the profile in the list of available profile; it is a required entry. The **"Description"** contains additional information and is optional. It can, for example, be used to enter information about the sample type for which the moving profile should be used.

A **Movement profile** can be defined for one or more **Device groups**. Device groups can have the following properties:

ROT = Motor for angular movement
F = Sensor for measuring forces in axial direction
LIFT = Lift motor
LIN = Motor for linear motion

For example, an MCR 302 belongs to the device group ROT+F+LIFT.

The **Device group** of the detected rheometer is automatically selected. All other views of the **Moving profile** show settings for the selected **Device group**. To select the settings of another **Device group**, the '**Auto detect**' option must be removed.

3.1.3.3 Application Mode:

The **Moving profiles** are filtered by the **Application mode** selected in the **Home** ribbon. Assign one or more **Application modes** to the **Moving profile**.
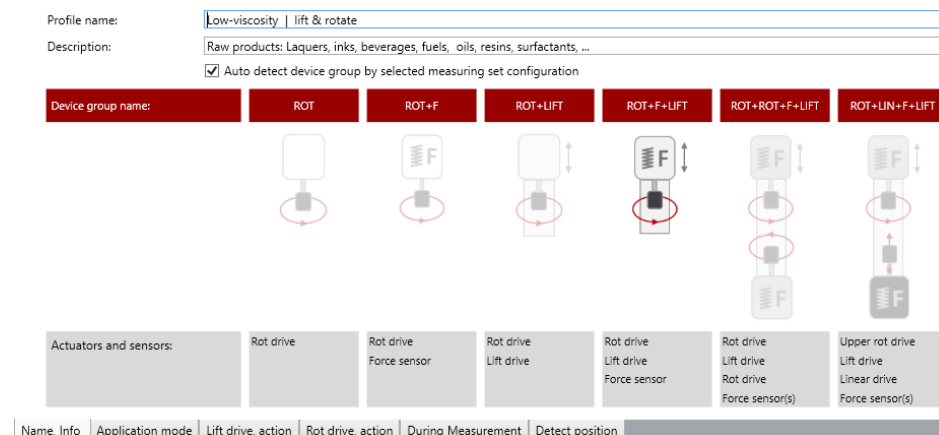
Fig. 3 - 2   ***Name, Info*** *dialog with device groups and preselected device group ROT+F+LIFT.*

3.1.3.4 Lift Drive, Action

The **"Lift drive, action** settings" are valid in the range given by the minimum and maximum position values. The profile settings define the velocity and force values. Between the steps defined by the position values, the velocity and force will be ramped linearly. If the option **"Continue lift drive control after positioning"** is activated, the settings will be used after the trimming or measuring position has been reached.
The option **"Continue lift drive control after positioning"** is very rarely used for the direction **Lift drive, move up.** See use case scenarios for the direction **Lift drive, move down**.

Default waiting position:

The default waiting position is used to allow e.g. thermal equilibrium or a rest time for the sample. The position value should therefore be close to the sample height to be able to close the measuring chamber. A suitable value is 5 mm.

Default loading position:

The default loading position is used for disconnecting and cleaning the measuring system. Make sure the position is selected wisely to avoid the measuring system to touch the hood of the measuring cell. A safe value for most cells is 30 mm.

Scenario 1: I want the system to go to the default gap with controlled force to avoid destroying the sample structure.

Select the setting "Set gap" to go to the target gap. In the profile, check that the velocity at a position close to the sample height is in the range of 50–500 mm/s and set a force value in the range of 2–5 N for sensitive materials. The velocity and force value may need to be adapted to the sample properties. When going to

the measuring position, the instrument will now reduce the velocity as much as necessary to keep the measured force at the target value (+- hysteresis value). Once the target gap has been reached, the instrument is ready for measurement. If the target gap cannot be reached within the time specified as force control timeout, an error message will be shown. This method is suitable for all measuring system types.

Scenario 2: I want the movement to stop as soon as a defined force value is measured; this value should be kept until the start of the measurement.

Select the setting "Set force". In the profile, check that the velocity at a position close to the sample height is in the range of 50–500 mm/s and enter the required force value. The more solid-like the sample, the smaller the velocity should be and the higher the force. A maximum value of 5 to 10 N is recommended for solid materials. The option "Continue lift drive control..." should only be enabled, if the force needs to be kept constant before the start of the measurement. For soft materials that show a quick relaxation, the option should be disabled. This method is only suitable for parallel plate systems, because the gap is not defined; the measured gap, however, will be used for the calculations during the measurement.

Scenario 3: I want the measuring system to reach the target gap as fast as possible.

Select the setting "Set gap" and delete all lines in the profile except the position 0 mm and 125 mm. Enter the maximum possible speed of the device and a force of 40 N for both lines.

3.1.3.5   Rot Drive, Action

The **"Rot drive, action** settings" allow to lock the measuring system during and after movement of the **Lift drive** either at any position or at a defined angle of the **Rot drive**. Further, it is possible to apply a rotation to the **Rot drive** during the movement of the **Lift drive** and limit torque or speed, if required. Enable the option **Move to zero-angle and lock drive** in case of extensional measurements with a **3PB** or **Cantilever** type measuring system. The actions can be defined separately for an upward or downward movement.

Select the operation mode and enter the torque and speed value, if necessary. A value of 0 mNm means that the available maximum of the device will be used. The recommended setting is to lock the **Rot drive**, using either "Lock drive at current angle" or "Move to user start angle and lock drive". The latter option may be useful to increase repeatability for oscillatory measurements at very low torque and deflection angle values. If the option "Continue measuring drive control after positioning", the selected mode will continue to be used after the device has reached the trimming or measuring position.

This is not normally used for moving up. The default mode for moving up is **"No setting"**; for automated lifting of the measuring system after a measurement, it is recommended to use a rotation at 5 to 10 rpm to avoid a force overload.

3.1.3.6   During Measurement

The available settings can vary depending on the selected device group, e.g. because the device has a normal force sensor.

The **"Lift drive settings"** are valid in the range given by the minimum and maximum position values. The profile settings define the velocity and normal force values that are used during the measurement. Between the steps defined by the position values, the velocity and normal force will be ramped linearly.

Any settings that are made in the measurement action in a test take precedence over the settings in the moving profile.

- If force value is set in the measurement, for example, this value is the target value, while the velocity is used as a limit value.

- If a target gap is set, it is in most cases recommended, to significantly increase the velocity value, to make sure that the required gap value is reached within the interval duration.

3.1.3.7   Detect Position

The available settings can vary depending on the selected device group, e.g.   because the device has a force sensor.

The settings for detection positions can affect the accuracy of all gap setting and should therefore not be changed.

<u>Zero-gap for air-bearing rheometers:</u>

The default mode for all air bearing instruments is the detection of the zero-gap position using the normal force, for ball bearing instruments, the torque detection has to be used.

The movement to the zero position starts with the velocity given in the field "High velocity" and switches to the slow velocity speed at the gap given in "Velocity switching position". If the option "Force detection" has been selected, the measuring system will move down until a force higher than the **Force for zero-gap** setting is measured. Then the **Lift drive** will move up until the value given for **"Force for zero-gap setting"** is measured. This is the zero position which is used for all gap setting until the next zero-gap procedure is started.

<u>Zero-gap for ball bearing rheometers:</u>

If the option "Torque detection" has been selected, the measuring system will move down with a low rotational speed until the surface of the lower plate is detected by an increase in the torque necessary to maintain the rotational speed due to the friction between upper and lower system. After contact, the **Lift drive** will move up until the measuring system can rotate freely again and use that

position as the zero-gap value. The torque detection mode can be affected adversely, if the measuring system or the lower plate has been cleaned insufficiently.

The option "Move to measuring position..." should always be activated, to avoid a contact between measuring system and lower plate during a temperature increase.

Zero-Angle:

The parameter **Zero-angle tolerance** is used for detecting the zero-angle of 3PB or Cantilever type measuring systems and should not be changed. This action is triggered by the function **Zero-gap**.

Finding the sample:

The movement for finding the position of the sample starts with a high velocity and switches to the **Slow velocity for finding position** at the gap given in **Velocity switching position for finding position** until the **Force for finding position** is reached. The **Force for finding position** should be set depending on the stiffness of the sample.

3.1.4   Calibration Management

All previous calibrations are listed in the category <**Setup**>, <**Measuring set**>, <**Calibrations**>.

To restore a previous calibration, select it in the list and click **Apply** in the ribbon '**Setup, calibration**'. The set of calibration parameters is then applied to the referring accessory.

To create a certificate from the stored calibration select the <**Calibrations**> category. In the ribbon '**Setup, calibration**' there are two functions:

•   Print certificate: Print certificate for the selected calibration

•   Export certificate: Export certificate for the selected calibration

Open the '**Details pane**' to see all the calibration parameters selected in the list view above.

3.2   Measuring Set Components

Measuring set components are all hardware items that are required to set up a configuration: devices, accessories and measuring systems. Each of these components has defined properties that can be edited or viewed in the corresponding tabs. The available items of each category are listed in the presentation pane once the entry has been highlighted under "Measuring set components".

3.2.1   Devices

"Devices" includes all measuring devices that have been installed to the RheoCompass™ software. The number of available devices depends on the software license.

To create a new device or duplicate an existing one, use the relevant button in the ribbon "Setup". To delete a device, click the "Delete" button.

3.2.1.1   Creating a New Device

A new device can be created using the button **"New"** in the **"Setup"** ribbon, but as this requires a license, neither this function nor the duplication should be used.

3.2.1.2   Devices – Name, Info

The tab contains the name, usually the device type, and the serial number of the device currently highlighted in the presentation pane. Additionally an image can be selected of the type *.bmp, *.jpg, *.gif or *.tif. For the **"Location"** and **"Description"** information can be entered that makes it easier to identify a device, if more than one is installed in the software. This is especially useful, if several devices are controlled through the LAN connection.

3.2.1.3   Devices – Connection

Select the connection type (USB or LAN) that you want to edit and make additional settings, if required. The available connection types are dependent on the type of the selected device. Please note that this tab is only used to edit the communication settings; the connection type that is actually used for the device needs to be selected in the configuration (see *Chapter 3.1.2.3, "Configurations – Hardware Configuration"*).

For the **USB** connection, select the correct USB device from the list that is shown once the connection type has been selected from the list.

If the **LAN** connection has been selected, the software will list the devices found the in the network. Highlight the device in the list and click **"Use device"**. Settings for the LAN connection may be changed in the tab **"Device Network Administration"**.

For the serial connection (**COM**) the software contains default parameters for each device type which should not be changed. The baud rate may be reduced in case of communication problems. If the value is changed in the software, it needs to be changed on the device as well. As these changes influence the overall performance of the communication, it is recommended to contact Anton Paar or our local distributor in advance.

The option **"Communicate with device in recovery mode"** is only used in case the firmware download to a device has failed. If that event occurs, the device can no longer boot up correctly and therefore, communication to the device is not possible in the usual way. The recovery mode allows communication with the instrument without loading the firmware.

The recovery mode has to be enabled both in the software and on the instrument. First, activate the recovery mode option in the software. Now disconnect the USB or LAN cable. Then switch on the instrument while repeatedly pressing the button 'Menu' on the front panel of the device. Next reconnect the USB or LAN cable. The instrument display should show version number, date, time and 'Boot Firmware Active'. Now, you can download the firmware under **"Measuring set > Service > Start service function"**. Please make sure that the instrument remains in recovery mode once communication with the software is established. In case, the device starts to boot, repeat the procedure described in this section.

After the download has been finished remember to uncheck the recovery mode option.

3.2.1.4   Devices – Device Network Administration

The Ethernet (LAN) connection is set in the tab "Device Network Administration" under "Measuring set components" and "Devices".

The instrument can either be connected to the network or directly to the computer's network interface card. In case the computer is connected to the network as well, a second interface card has to be installed in the computer. Further, the TCP/IP protocol needs to be installed on the computer. If the instrument is connected to the company network, the assistance of the network administrator will be required.

For a direct connection between instrument and computer use the crossover patch cable, for a connection to the network use the standard patch cable. Both cables are delivered with the instrument.

1. Go to the network settings of your computer and check the properties of the TCP/IP protocol. Make a note of the IP number, the subnet mask and the IP number of the standard gateway. If these are not set and the computer is not connected to a network, you may use the following settings

    IP number: 192.168.21.5
    Subnet mask: 255.255.255.0
    Standard gateway: 192.168.21.10

TIP   If the computer is connected to a network, ask the administrator for information on the TCP/IP settings.

2. Make sure that the device is set to use the Ethernet connection for communication and click **"Refresh list"** to scan for available devices. If the list shows **"OK"** in the **"State"** column, you do not need to change any settings, but can continue with step 5.

3. If the device is connected directly to the computer, you may use the following settings:

    IP number: 192.168.21.7

    Subnet mask: 255.255.255.0

    Standard gateway: 192.168.21.10

TIP   If both device and computer are connected to a network, please ask the administrator for the available settings. The software can work with both static and dynamic (DHCP) IP-addresses.

4. Once you have made the required changes to the settings, click **"Apply settings to device"** and wait for the list to become active again. The **"State"** column should now show **"OK"** for the device.

5. Switch to the tab **"Connection"** and find the device for which you have just edited the settings in the list. Click **"Use device"**.

6. If the device shows **"OK"** for the status, select the ribbon "Measuring Set" and change the current configuration to **"None"**.

7. Select the configuration that you want to use.

3.2.1.5   Devices – Adjustments

Depending on the device type, this tab shows the motor adjustments stored on the device and the settings for the adjustment. The adjustment itself is carried out in the **"Start measuring set function"** in the ribbon **"Measuring Set"**.

The instrument is delivered with a default motor adjustment (initial adjustment). To measure very exact data, especially at low torque values, you should carry out and save the motor adjustment for each measurement system you are using. If a measuring system or measuring system type is used frequently, the motor adjustment for this system can be set as the default by clicking "Define as Optional Adjustment". The initial adjustment respectively the optional adjustment is used for all measuring systems for which no motor adjustment is stored.

3.2.1.6   Devices – Corrections

The devices of the MCR series allow, depending on the type, to set the compliance value. This is the vertical compliance of the mechanics and air bearing which is taken into account for any normal force value different from zero. The value should not be changed, respectively the setting should be left on "automatic" unless you have a specific reason for manually editing this value or are instructed to do so by Anton Paar.

3.2.1.7 Devices – Settings

The tab shows the available options for the selected device as well as their default settings. Here, you can check e.g. whether your device allows TruStrain™ measurements or the recording of sine waves during oscillation.

3.2.2 Accessories

"Accessories" includes all peripheral equipment that can be connected in any way to a device. These are e.g. temperature control devices such as a Peltier plate, controllers or analog devices.

Most accessories are recognized by the Toolmaster™ system, therefore, the manual installation is not necessary in most cases. For details on the manual installation see *Chapter 3.2.2.1, "Creating or Editing an Accessory"*.

3.2.2.1 Creating or Editing an Accessory

Some of the accessory data are essential for the correct functioning of the accessory, the gap setting and the reliability of the measurement results. Always make sure to enter correct data when editing or creating an accessory. Incorrect data may result in incorrect measurement values or damage to the equipment.

To create a new accessory, make sure that the ribbon **"Setup"** is selected and click **"New"** in that ribbon. Select the required accessory type and click **"Create"**. This will generate an accessory of the selected type without settings. These need to be set manually in all available tabs. For information on selecting the accessory in a configuration see *Chapter 3.1.2.3, "Configurations – Hardware Configuration"*.

If the new accessory is similar to an existing one, highlight that accessory in the presentation panel and click **"Duplicate"** in the **"Setup"** ribbon. Then make the required changes to the copy.

The button **"Delete"** in the **"Setup"** ribbon will permanently remove the highlighted accessory from the database.

To edit an accessory, select it in the list and make the changes to the settings in the relevant tab.

TwinDrive speed balance

The speed balance adjustment is only available for devices with an upper and lower drive motor unit (TwinDrive). It allows to set the percentage of control for both motors.

3.2.2.2   Accessories – Name, Info

The tab shows the name and serial number of the selected accessory. All entries in this tab as well as the image can be edited according to requirements. The additional information about type and, if applicable, connection settings can be edited under *Chapter 3.2.2.4, "Accessories – Operational Settings"*.

3.2.2.3   Accessories – Variables, Value Ranges

The tab shows the range, usually the temperature range, for which the accessory can be used. The values are read from the Toolmaster™, if available. Toolmaster™ data can be edited but limit values cannot be exceeded during operation for safety reasons, even if changed here.

As the majority of accessories is used to control the temperature this is the default variable except for a number of special accessories that are available from Anton Paar, such as power supply units for special devices. If the variable is grayed out, it cannot be changed. This is the case for **all measuring cells** and **temperature sensors** (Pt100, thermocouple and external thermometers with RS232 connection).

For both **controller** types and for the converter, the set value can be selected from the drop-down list. When using a controller, which is connected to the serial port of the device or the computer, make sure that the communication protocol is available in the operational settings tab. Only controllers with a known protocol may be used.

For the **converter** accessory, the set variable can be selected freely from the list, the value that is actually sent to the accessory is always the voltage sent from the analog connector of the rheometer. This voltage range can be edited within the limits of the rheometer, if required by the accessory. The set variable on the left hand side of the tab is the variable that is actually shown in the measuring window in the test definition. Here, you can set the range defined by the manufacturer of the accessory.

The accessories **TwinDrive speed balance adjuster**, **Switch** (analog) and Switch (**relay**) do not contain any variables that can be modified; the voltage range of the analog switch may be adjusted according to the requirements of the connected device. Make sure to observe the voltage limits of the rheometer which can be found in the respective instruction manual.

The **signal spy** accessory is selected to enable the output of certain raw values from the instrument's electronics.

3.2.2.4   Accessories – Operational Settings

The operational settings shown in this tab depend on the selected accessory type. The parameters do not normally need to be changed, unless you are using a system that is not predefined in the software or not recognized by the

Toolmaster™ function. Modifications may be necessary for special configurations. In case you need more information on the settings than provided below, please contact the Anton Paar support or our local representative.

Sensors

The settings for the sensor do not normally need to be changed. They define which of the temperature values is shown or used for controlling the sample temperature in case several values are available. If you point the mouse to the exclamation mark next to the entry field, additional information for the settings is shown.

Controller Mode

For accessories with an RS232 connection, the controller mode area shows the communication settings such as baud rate, data-bit, stop bit and so on. These parameters are set correctly, once the protocol has been selected from the drop-down list. Changes are not normally required.

For measuring cells that are connected to the device, the mode defines which of the connected accessories to use, in case more than one is connected. The setting should not be changed unless you are instructed to do so by Anton Paar or our local representative.

Geometrical Dimensions

The flange height is used for all measuring cells as these devices are mounted directly into the rheometer. The value is used for all position settings and should not be changed.

Cell Settings

Select the measuring system type that matches the measuring cell type from the drop-down list. An incorrect selection will lead to an error message at the start of a device action to avoid e.g. a crash between measuring system and cell.

Function

All accessories that feed back values to the device may be used for calibration. If this option is activated, the relevant accessory can be selected in the calibration procedure. Most common is the temperature calibration using a Pt100 or external thermometer for another accessory, but other variables may be used as well, depending on the accessory.

Peltier

The option is shown for measuring cells that may contain Peltier elements and for controllers to which Peltier systems may be connected. Enable the option only, if a Peltier system is used.

Degauss

The option is only shown for devices that use the current I as the set value. An example is the power supply for the magnetorheological device.

3.2.2.5   Accessories – Corrections

The available corrections depend on the type of the selected accessory. Except for the correction of the set and measured value, the values do not normally need to be changed by the user.

Correction of Set / Measured Value>>

Values are entered here, if a calibration e.g. of the temperature has been carried out. The software includes an automatic calibration routine which sets a number of user-defined temperature values, measures the real sample temperature values and calculates the coefficents using a polynomial fit. The coefficents are then entered automatically here. Depending on the type of accessory, on the set or measured values may be available.

Other Corrections>>

The additional **torsional compliance** of the measuring system is mainly relevant for accessories that have a lower shaft, for lower plates, the value is negligible. The torsional compliance can contribute to the total deflection measured by the position sensor of the rheometer. Therefore, it needs to be known and taken into account to make sure that only the deformation of the sample is used for the calculation of the measurement results.
Hood temperature **Offset** and **factor** are used for measuring cells consisting of lower and upper system, typically plate and hood. The temperature of the upper system is controlled as a function of the lower one to avoid temperature gradients in the sample area.

Automatic Gap Control (AGC)>>

The AGC coefficients make sure that the thermal expansion of the accessory is taken into account during measurements with varying temperatures. The AGC coefficient is used in all measurements unless the accessory is equipped with the TruGap™ function which directly measures the real gap at all times.

3.2.2.6   Accessories – Status

The status information describes, how an accessory has been created. The Toolmaster™ settings should not be changed. The "Re-Read" option will overwrite all manual changes that have been made to an accessory with Toolmaster™ after the first installation. It should therefore be used with great care.

3.2.3   Measuring Systems

"Measuring systems" lists all measuring systems that are currently installed in the software.

3.2.3.1   Creating or Editing a Measuring System

Some of the measuring system data are essential for the correct functioning of the accessory, the gap setting and the reliability of the measurement results. Always make sure to enter correct data when editing or creating a measuring system. Incorrect data may result in incorrect measurement values or damage to the equipment.

To create a new measuring system, make sure that the ribbon **"Setup"** is selected and click **"New"** in that ribbon. Select the required measuring system type and click **"Create"**. This will generate a measuring system of the selected type without settings. These need to be set manually in all available tabs. For information on selecting the measuring system in a configuration see *Chapter 3.1.2.3, "Configurations – Hardware Configuration"*.

If the new measuring system is similar to an existing one, highlight that measuring system in the presentation panel and click **"Duplicate"** in the **"Setup"** ribbon. Then make the required changes to the copy. To edit a measuring system, select it in the list and make the changes.

The button **"Delete"** in the **"Setup"** ribbon will permanently remove the highlighted measuring system from the database.

3.2.3.2   Measuring Systems – Name, Info

The tab shows the name and serial number of the selected measuring system. All entries in this tab as well as the image can be edited according to requirements. The additional information about type and other settings can be edited in the other tabs.

3.2.3.3   Measuring Systems – Components

This setting is only relevant for devices with an upper and lower motor. Select the upper and lower system from the list.

3.2.3.4   Measuring Systems – Dimensions, Factors

This tab contains the mechanical properties of the measuring system such as the diameter, cone angle, effective length and so on. The available entry fields depend on the selected measuring system type. For measuring systems delivered by Anton Paar, the values are stored on the Toolmaster™, if available, and can be checked on the accompanying data sheet.

The **CSS factor** is used to calculate the shear stress from the instrument's torque: shear stress = torque x CSS factor. The factor can be given as Pa/Nm or Pa/mNm or as a relative stress factor. Please make sure that you have selected the correct option as given on the measuring system's data sheet if you need to compare values.

The **CSR factor** is used to calculate the shear rate from the instrument's rotational speed: shear rate = rotational speed x CSR factor. The shear rate factor can be given in min/s or s/s. Please make sure that you have selected the correct option as given on the measuring system's data sheet if you need to compare values.

The **calculation mode** shows the standards, if applicable, that describe the method which is used for the calculation of the CSS and CSR factor from the geometrical dimensions of the measuring system.

3.2.3.5   Measuring Systems – Positioning

The **active length** value is the length of the measuring system from the lower end of the measuring system to the end of the shaft (lower end of the coupling). The **positioning length** is only used for cylinder systems to make sure they are positioned correctly in the cylinder cup. For all other measuring systems, the values are usually equal. The option for **zero-gap** is activated for e.g. plates, cones or Mooney-Ewart cylinders.

If the **trim position** is enabled (default setting for cones and plates) the gap motor stops at a defined distance from the measuring position to allow the user to remove excess sample. The default value for this distance is shown beneath the selection. If 'User defined' is selected, the value can be changed; if 'None' is selected, the trim position is not used (not recommended). If the value is not shown, the measuring system does not use the trim position, e.g. concentric cylinders.

3.2.3.6   Measuring Systems – Corrections

The **moment of inertia** needs to be determined before you can use the measuring system (see the device driver manual for your instrument). The correct determination of the moment of inertia is important for correct results in oscillatory measurements and it is also needed for the speed control.

The **torsional compliance** is a measure of the 'stiffness' of the measuring system. The torsional compliance can contribute to the total deflection measured by the position sensor of the rheometer. Therefore, it needs to be known and taken into account to make sure that only the deformation of the sample is used for the calculation of the measurement results.

The **adjustment offset K_c** may be used to adjust the measured viscosity value to the nominal value of a reference material. This offset value needs to be set with great care as it will influence all measurements done with that measuring system. The value is entered as a percentage which is calculated from the difference between measured and nominal value. To correct for too high readings, enter a negative value; to increase the measured value a positive one.

The options for **mechanical bearing** and **magnetic coupling** need to be enabled for measuring systems with these properties such as the pressure cell.

The **AGC coefficient** corresponds to the thermal expansion of the measuring system. It is used to compensate for the change in the measuring system's length during temperature changes. It is especially important to enter the coefficient if you are measuring with temperature gradients or several temperatures in one measurement. The AGC coefficient is used in all measurements unless the measuring system is equipped with the TruGap™ function which directly measures the sample gap at all times.

3.2.3.7 Measuring Systems – Limits

Limit values can be entered for the temperature range for which a measuring system may be used as well as the maximum rotational speed or torque. For measuring systems with Toolmaster™ the values stored there will always override the software settings for safety reasons. Limit values should not be changed unless you are instructed to do so by Anton Paar or our local representative.

3.2.3.8 Measuring Systems – Status

The status information describes, how a measuring system has been created. The Toolmaster™ settings should not be changed. The "Re-Read" option will overwrite all manual changes that have been made to a measuring system with Toolmaster™ after the first installation. It should therefore be used with great care.

3.3 User Administration

In the user administration, you can create both roles (groups) and users (single users) as well as assign detailed rights to both.

3.3.1 Roles

The roles allow to define a frame or group to which a number of users may be assigned. The access rights for the users do then not need to be defined separately as all users with the same role will have the same access rights.

To add a new role, duplicate an existing one by clicking "**Duplicate**" in the ribbon "**Setup**" or click "**New**"... in the ribbon bar **"Role"** in the **"Setup"** ribbon and enter a name and description. After the role has been created, you need to edit the permissions in the **"Permissions"** tab. The default setting for a new role is **"Deny"** for all functions.

To add users to a role, click **"Add user"** in the in the ribbon bar **"Role"** in the **"Setup"** ribbon and select the user from the list. To remove a user, highlight the role in the list and select the tab **"Members"**; then click **"Remove user"** in the ribbon bar **"Role"** in the **"Setup"** ribbon.

A role is deleted by highlighting it in the presentation pane and clicking **"Delete"** in the ribbon bar **"Role"** in the **"Setup"** ribbon.

3.3.2 Users

Users are single persons to which defined access rights in the software may be assigned. Users may be added to one or several roles.

To add a new user, click **"New"** in the ribbon bar **"User"** in the **"Setup"** ribbon and enter a name, description and password. After the user has been created, you need to either edit the permissions in the **"Effective Permissions"** tab or assign a role membership. The default setting for a new user is **"Deny"** for all functions.

To assign a role to a user, click **"Add role membership"** in the in the ribbon bar **"User"** in the **"Setup"** ribbon and select the role from the list. Once a role membership has been assigned, the user will have the permissions of that role. If several roles are assigned to a user, the user will have the access rights of the role with the highest level.

To remove a role membership, highlight the user in the list and select the tab **"Role Memberships"**; then click **"Remove role membership"** in the ribbon bar **"User"** in the **"Setup"** ribbon.

A user is deleted by highlighting it in the presentation pane and clicking **"Delete"** in the ribbon bar **"User"** in the **"Setup"** ribbon.

4 RheoFinder
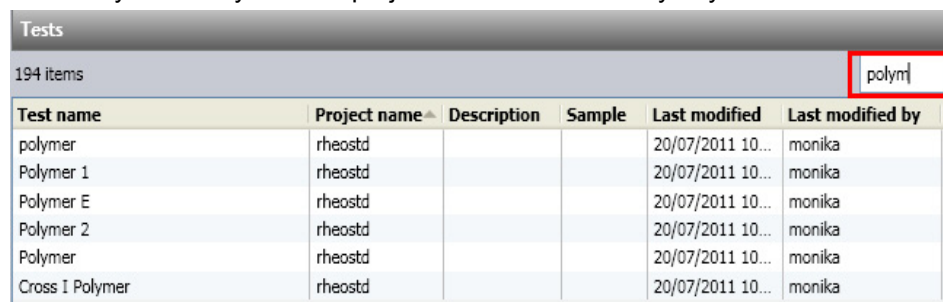
The RheoFinder is your window to the SQL Database where all RheoCompass™ data is stored.

All elements of the RheoFinder such as projects, tests and templates and all items of the Setup category such as configurations, devices, accessories, measuring systems are stored in one Microsoft SQL 2012 Database which is installed together with the RheoCompass™ software.

Use the RheoFinder to edit or retrieve and organize your data. Items that belong to the general configuration of the software, such as devices, accessories or measuring systems, can be found in **"Setup"**.

To show data of a certain category, highlight the category in the navigation. The items will be shown in the presentation pane. To sort them differently, click any of the headers in the table in the presentation pane.

To quickly find a particular item, enter the name or part of it into the search field. The database will automatically update the view to show only items that contain the search term in their name. Use the additional filter "Show my projects only" or "Show my tests only" to hide projects or tests created by any other user.

Tests					
194 items					polym
Test name	Project name▲	Description	Sample	Last modified	Last modified by
polymer	rheostd			20/07/2011 10...	monika
Polymer 1	rheostd			20/07/2011 10...	monika
Polymer E	rheostd			20/07/2011 10...	monika
Polymer 2	rheostd			20/07/2011 10...	monika
Polymer	rheostd			20/07/2011 10...	monika
Cross I Polymer	rheostd			20/07/2011 10...	monika

Fig. 4 - 1   Search field for the database (RheoFinder)

4.1   Database Import and Export

The data export and import allows any item of the RheoFinder or Setup category to be exported or imported as a single file.

Also refer to the chapter 2.1.5 of this manual for region dependent ASCII import and export settings.

4.1.1   Exporting Data Items from the Database

1. To **export an item** from the RheoFinder, select the appropriate data type in the navigation and highlight the entry (item) that you want to export from the list in the presentation pane.

2. Activate the **"Home"** ribbon by clicking **"Home"** in the menu.

3. Click the **"Export"** button in the ribbon bar **"Import, Export"**.

4. Select the file location, if different from the default location, enter the file name and save. All exported files have a RheoCompass specific file extension, are compressed and based on the XML file format.

The exported file can be stored in any location and send by mail as an attachment.

HINT: The export of measurement data from a table can be done automatically by using the **"Export"** action in a test definition or manually by highlighting the required data range in the table and using the **"Export"** button in the **"Home"** ribbon.

4.1.2 Importing Items to the Database

For **data import**, go to the **"Home"** ribbon and click **"Import"**. Select the file location and the file. The software will automatically recognize the data type and list it in the appropriate category.

HINT: Import of external data of xml-type is also possible within a project. Further, csv- and txt-files can be imported. For a proper display of imported data, the variable name and unit have to match the settings in RheoCompass™.

4.2 Project Data

Project data are the projects themselves and all data that are linked to a project or contained in a project, such as tests, videos and images. Both projects and tests may be opened from the RheoFinder with a double-click on the name or by using the button **"Open"** under **"RheoFinder > Item"**.

4.2.1 Projects

The details pane shows the information entered for the template, if available, and any data entered during the creation of the project. To edit the properties of a project, highlight it in the RheoFinder and click **"Edit"** in **"RheoFinder > Item"**. Once you are finished, click **"Save"** or discard the changes with **"Cancel"**.

To keep users from collecting an unlimited amount of data in one single project, you may enable the option **"Limit test number"** and enter a suitable maximum number of tests per project that is created from this template.

To start or close the project automatically, activate the respective option in the tab **"Automation"**.

By default, all new templates are shown for all **Test types** in the cover flow under **My Apps**. If you want to assign a project template to certain categories, go to the tab **Test types** and **Tags**. The "**Filter by test type**" is also used within the opened project to filter the list of new windows as well as analysis macros by test type.

4.2.2 Tests

Each tests stored in the RheoFinder contains detailed settings about the method that has been used to generate the data. Click **RheoFinder**, **Edit** to edit the properties of a test such as **Name, Info** or **Additional Infos**.

The tabs **"Name, Info"** and **"Additional Info"** contain the name a test has been given during execution as well as all input data defined in the "Start" action. Further, date and time of the test are stored.

The tab **"Test definition"** shows all actions that have been used for the test, under **"Text data"** the analysis results contained in the test are shown. If report window has been available for the test, a minimized view of this is shown in the tab **"Report snapshot"**.

4.2.3 Videos and Pictures

For videos and images, the RheoFinder shows the name of the file and the date of the last modification of the file. The name and an additional description can be edited. To do this, highlight the entry and edit the data in the details Pane. The default location of the files can be changed in the software options in the application menu (see also *Chapter 2.1, "Popular Options"*).

4.2.4 Importing Rheoplus Data

In general, there are two ways of reconstructing an ORX workbook:

1. Use any RheoCompass project template from the **My Apps, More** page and **Add** the **Tests** imported from the ORX.

   Next, **Replace** the **Test definition** therein with the test definition of Rheoplus (see *4.2.4.4, "Assign Imported Tests to the Standard Project Template"*).

2. Use the imported project and add the missing windows (see *4.2.4.3, "Directly Open the Imported Project"*).

4.2.4.1 Prepare ORX Data

Before you start importing any ORX workbook, make sure to sort the data within the ORX workbook first:

- Sort the data by test type; e.g. Amplitude_sweep.orx, Frequency_sweep.orx, FlowCurve.orx

- It is not strictly necessary to sort the data by test type but it makes it easier to re-define the Rheoplus-workbooks as RheoCompass-Projects

4.2.4.2 Importing ORX Workbooks

To import Workbooks (*.orx) from Rheoplus or Datapools (*.mph) from US200, proceed as follows:

1. Click <**RheoFinder**>, <**Projects**>, **Home**, **Import from Rheoplus**

2. Select a single file or multiple ORX or MPH files, or even a folder to be imported at once

   A new project file will be created containing all measuring data and the test definition (measurement window) of the ORX file.

3. To add the **Test type** to the imported file click **Home**, **RheoFinder**, **Edit**

   The project is now in edit mode, which allows the properties of the project to be set:

   • open the Details pane and select the tab <Test type>
   • assign a test type
   • to close the edit mode click Home, RheoFinder, Save

4.2.4.3 Directly Open the Imported Project

Open the new project and define / add missing items such as diagrams and tables.

Opening the project makes all ORX measurements available, as well as the measurement definition. Diagrams, tables and analysis windows are not taken over but can be easily added (see the following sections).

The Measurement Window of Rheoplus:

Items of the measurement window are automatically converted into RheoCompass actions, as shown in *Table 4.1:* and *Fig. 4 - 2*.

To change the tab name of the test definition, double-click the tab 'View 1' and change the name into 'Test'

Table 4.1: Conversion from Rheoplus to RheoCompass

Rheoplus / US200	RheoCompass
Temperature settings	Device
Waiting before starting	Wait
Measurement window	Measurement
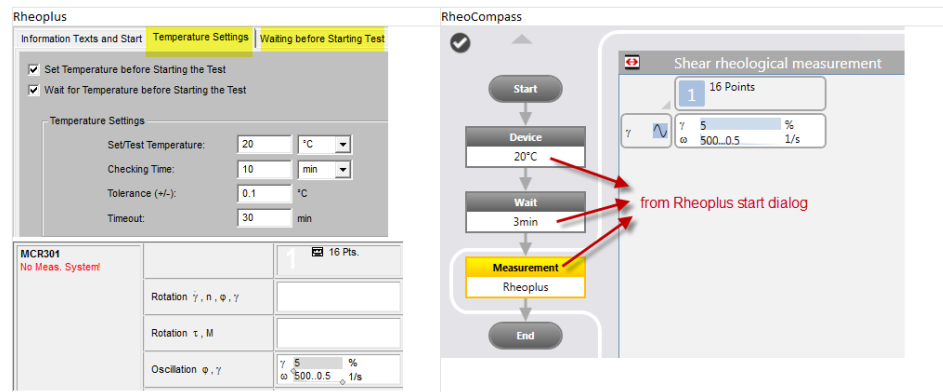
Fig. 4 - 2   Conversion from Rheoplus to RheoCompass in detail

How to create the missing diagram(s):

1. Click on the second tab 'View 2'

2. Add an empty diagram from the **Window** ribbon

3. **Select any measurement**

4. Click **Quick Curve** in the ribbon

    The diagram will adapt the axis settings to the selected curve

5. Alternatively a predefined diagram window with the same test type can be selected in **Window, New diagram**

6. To change the tab name, double-click the tab 'View 2'

How to create the missing table:

1. Click on the second tab 'View 2' or select a separate tab for the table 'View 3'

2. Add a predefined table from **Window, New table**

3. To change the tab name double-click the tab 'View 3'

Auto-display:

Define the data to be displayed automatically while a test is running:

To make sure a new test is displayed automatically, use the setting for Auto-display. This is an individual setting for each window.

4.2.4.4   Assign Imported Tests to the Standard Project Template

Alternatively, open any Anton Paar **Project template** from the **My Apps, More** page and **Add** the imported tests using the function **Home, Test, Add**.

This opens up a ready-to-use RheoCompass project with all settings and windows. The tests are added manually by using the ribbon function **Add**.

To replace the default **Test definition** therein with any test definition stored in the imported ORX tests, click **Test, Replace test definition by test**:

4.3 Templates

Templates are available for complete projects, macros, procedures, views, schemes and windows of type diagram, table or report. A view can contain one or multiple windows of different types. The project templates are shown in the App Manager in the category "N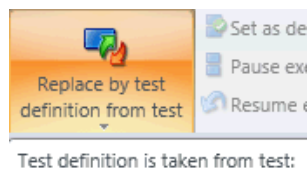ew project". The other templates are shown as a list to select from when you create a new window or view. All templates are filtered by test type. To change or assign a test type, edit the template in the RheoFinder.

4.3.1 Project Templates

New project templates are generated from existing projects or project templates.

1. To create a **new project template from a project**, open an existing project or project template, e.g. one of the project templates from the My Apps category.

2. Move data that you want to keep with the project template to **"References"**. To do this highlight the test you want to move and go to the **"Home"** ribbon. In the ribbon bar **"Test, Result"** click the button **"Move to references"**. Only tests in the reference area will be stored with the project template.

3. Go to the home button. Select **"Save as > Save as project template"** from the application menu. Enter a name for the project template and click **"Save"**.

4. If necessary, move back the test from the references to the list of tests with **"Move to project tests"**. In case you want to make further changes to the project template, continue with the next step, otherwise skip to step 7.

5. Close the currently opened project.

6. Go to the RheoFinder and select **"Project templates"** in the category **"Templates"**. Find the new template in the list and highlight it. Click **Edit** in the **Ribbon RheoFinder** to open the project template in edit mode.

7. Make all required changes to the project template and click **Rh, Close** to save and close the project template.

8. Enter any additional information you might require in the details Pane. For automatic naming of the projects generated from this project template, enter a text and/or placeholders in the field **"Project name"**. For example, enter a suitable name and the placeholder for consecutive numbers.
    To keep users from collecting an unlimited amount of data in one single project, you may enable the option **"Limit test number"** and enter a suitable maximum number of tests per project that is created from this template.

9. To start or close the project automatically, activate the respective option in the tab **"Automation"**.

By default, all new project templates are shown in the category **My Apps**. **"Test types** and **Tags"**.

4.3.2   Using the Project Templates

To create a new project click the **My Apps** category in the navigation. This will display the App Manager. To create a new project select the **My Apps** category in the Navigation pane and click **More Apps** in the **App Manager**. Next click the red name of the project template to open up the template of your choice. For more information please refer to the manual **Getting started**.

4.3.3   Window, Scheme and View Templates

Templates can be created separately for automation windows, diagram windows, report windows, table windows and schemes, as well as views. The view may contain any of the presentation windows or a test definition. A test definition can only be saved as a view.

Ensure that the window or view has all the required properties and click **"Save as template"** in the ribbon bar **"Window"** or **"View"** respectively. The ribbon bars can be found in the ribbon **"Window"**.

By default, all new templates are shown for all test types. If you want to assign a template to a certain test type, go to the tab **"Test types** and **Tags"**.

Using Window and View Templates

The view or window template can be selected in the list that is shown, if you press the button **"New View"** in the ribbon bar **"View"** or **"New xx"** (xx = type of window) in the ribbon bar **"Window"** of the project.

In case, the template you are looking for is not shown, enable the option **"Show incompatible..."**.

4.3.4   Scheme Templates

Scheme templates are used in the diagram. The scheme defines the sequence of colors and markers. In the **Scheme templates** category, a matrix of colors and markers can be defined for the tests and variables shown in the diagram.

4.4   Recycle Bin

The recycle bin contains all projects and tests that have been deleted during the operation of RheoCompass™. It is not emptied automatically to avoid accidental loss of data. To restore any test or project, select the recycle bin in the navigation and highlight the item in the list. Then click **"Restore selected"** in the ribbon bar **"Recycle Bin"**.

The button **"Empty recycle bin"** deletes all items in the recycle bin. Items deleted from the recycle bin cannot be retrieved. The recycle bin should be emptied regularly.

4.5   Procedures

The **Procedure** action is used to combine multiple actions in one. Thus, frequently used actions can be combined in a single procedure to prepare a test or to finish a test. It is a kind of "black box" containing multiple steps.

Use the **Procedure designer** to define a procedure. To update the local copy of the procedure in a test definition, click the ribbon button **Test, Procedure, Replace by original**.

For more information on **Procedures**, see the chapter **Short instruction for the Procedure**.

1. Creating a Procedure Using the Procedure Designer:
Close any open projects before opening the procedure designer. To create a procedure independently of a project, go to the RheoFinder and highlight the entry **"Procedures (for tests)"** in the category **"Procedures and Macros"**. If you do not see this category, click **"More..."** to expand the navigation pane. Click **"New"** in **"RheoFinder > Item"**. Enter a name for the procedure in the details pane and add the actions as required. Instead of single actions, the entries listed under **"Measurement and Preparation Templates"** or **"Analysis Templates"** may be used. Make sure to edit the actions as well. Once you are done, return to the ribbon **"RheoFinder"** and click **"Save"** in the ribbon bar **"Item"**. If you click **"Cancel"**, all changes will be discarded, but the new procedure is stored in the database. In some cases it may be necessary to allow the user to select one or several parameters to make sure that the procedure is executed correctly in a test. To give the user access to a parameter, go to the tab "**Details Visibility**" and define the **Visibility** of the **Procedure parameter**.

2. Creating a Procedure from a Project:

To save a test definition as a procedure, select the ribbon **"Test"** in the open project and click **"Save as procedure"** in the ribbon bar **"Action"**. Then enter a name for the new procedure and click **"Save"**. The dialog box shows the procedures that are already available in the database. To edit the procedure or its properties, go to the RheoFinder. Saving single actions of a test definition is not supported. Use the **Procedure designer** (see 1.) for editing procedures.

Assigning:

By default, all new procedures are shown for all test types. If you want to assign a procedure to a certain test type, go to the tab **"Test types"**.

Using:

To add a procedure to a test definition switch to the toolbox in the navigation, if this is not already selected. Then click **"Measurement and Preparation Procedures"** and drag the procedure into the correct place in the test definition. You may also use the button **"Insert"** in **"Test > Action"** instead. In case you do not see the procedure you are looking for, enable the option **"Show incompatible procedures and actions"**. To limit the number of items shown to those that you have created, change to **"Show user-defined items"** in the drop-down list above the option.

4.6   Macros

The **Macro** action is used to combine analysis steps. It is a kind of "black box" containing multiple **Analysis steps**.

Use the **Macro designer** in the **RheoFinder** to define a new macro or to edit any existing macro.

To update a local copy of the macro which is part of a test definition open the referring project and click the ribbon button **Analysis**, **Analysis Macro**, **Replace by original**. The **Macro** in the **Test definition** is then replaced by the **Macro** listed in the **RheoFinder** with the same **Name** and **ID**.

For more information on **Macros**, see the chapter **Short instruction for the Macro**.

4.6.1   Macro Details (Tab Macro in Editing Mode)

The tab **"Name, Info"** allows to enter the name for the macro which is used in all lists and also for the selection of the macro in a test.

The information in the text field in the tab **"Macro Info"** is shown when the user points the mouse to the macro itself or the input data arrow and the output data arrow respectively. Use these fields to provide additional information to the user about what the function of the macro or what data it calculates.

In general, a macro is working like a "black box" but in some cases it may be necessary to allow the user to select one or several parameters to make sure that the macro is executed correctly in a test. To give the user access to a parameter, go to the tab **"Visible Parameters"**, click the plus sign and select both analysis step and variable. To delete a visible parameter, click the minus sign next to the relevant line.

For a macro, automatic naming of the result data series is recommended. This setting is made in the tab **"Result Name"**. Enter the text, a placeholder or a combination of both in the text field. To select a placeholder, click the button {}, highlight the required placeholder and click **<Insert>**.

The settings in the tab **"Diagram variables"** allow to predefine the variables that are used for the analysis result, if the function **"Quick Curve"** is used. Select the variables from the list. To add more variables, use the plus sign; to remove a variable, click the minus sign next to the line that you wish to delete.

To edit an existing macro, double-click the entry in the RheoFinder.

4.6.2   Handling

1. Creating a Macro Using the Macro Designer:
To create a macro independently of a project, go to the RheoFinder and highlight the entry **"Macros"** in the category **"Procedures and Macros"**. If you do not see this category, click **"More..."** to expand the navigation pane. Click **"New"** in **"RheoFinder > Item"**. Enter a name for the macro in the details pane and add the analysis steps as required. Once you are done, return to the ribbon **"RheoFinder"** and click **"Save"** in the ribbon bar **"Item"**. If you click **"Cancel"**, all changes will be discarded, but the new macro is stored in the database.

2. Creating a Macro from a Project:
To create a macro from certain Analysis steps contained in a Test definition of a Project, select single steps and hold the Shift or CTRL key. Now select the ribbon **"Analysis"** in the open project and click **"Save as macro"** in the ribbon bar **"Analysis Step"**. Then enter a name for the new macro and click **"Save"**. The dialog box shows the macros that are already available in the database. To edit the macro or its properties, go to the RheoFinder and open the Macro in the Procedure designer.

Assigning:
By default, a new macro is shown for all test types. If you want to assign a macro to certain test types, go to the tab **"Test types"**.

The macro group is selected in the tab **"Name, Info"**. Click the drop-down list **"Analysis Group"** and select the entry most suitable for the new macro. The group is useful to limit the number of macros shown for selection in a test.

Using:
A macro is inserted into an analysis action in the same way as an analysis method. If the analysis already contains one step or several, highlight the step

that should be before or after the one that you want to add. Click **"Insert before"** or **"Insert after"** and select the macro from the list. To limit the number of methods and macros in the list, click the drop-down list **"Analysis groups"** and select the suitable group. In case you do not see the macro you are looking for, enable the option **"Show incompatible procedures and actions"**.

4.7   Job Lists

The **Job list** is a tool for **Automation** of measurements which allows to combine different **Projects** with different **Tests types** and **Test definitions**. Use the **Job list** to execute a list of predefined projects automatically one after the other.

To add a new Job list item

- Select the category <**Job lists**> in the **RheoFinder**

- Click New in the ribbon **RheoFinder**

- Change the **Name, Info** of the new job accordingly in the **Details pane**

- Double click the new list entry to open the Job list.

Common parameter are defined by clicking the header called **Common**. These settings are used for all steps.

To define actions before or after a job click the button in the Job list.

After setting up the common parameter insert one or multiple steps to define the Project template being used for the test execution, the project name and the test name created therefrom. Pre-Job and Post-job actions can be defined for each individual step. Use the ribbon buttons **Move up, Move down** or **Delete** to edit the steps.

To start a job click the button **Start** job list in the ribbon **Job list**, **Operation** and to **Stop** the Job list click the **Stop** button accordingly.

4.8   Logbook (Audit Trail)

The logbook (audit trail) lists all events that occur in the software, the type of events that are stored in the logbook can be set in *Chapter 2.2.1, "Logging Options"*.

To control the amount of information shown in the logbook, use the options and the drop-down list in the ribbon bar **"Filter"** in the **"Logbook"** ribbon. For more information on logbook (audit trail) have a look at *Chapter 10.7, "Logbook (Audit Trail)"* of this manual.

4.9 Filters

Filters allow to search the RheoFinder -by data type- using well-defined properties of the items you are looking for.

4.9.1 Finding Data in the RheoFinder

The RheoFinder allows a detailed search for the various data types of the software. For a quick search, highlight the data type, e.g. "Projects" in the RheoFinder and enter the search term into the field in the upper right corner of the navigation pane. The software will automatically show entries that contain the search term in their name.

Instead of entering the search term, you may select a predefined filter from the drop-down list next to the search field. The drop-down list only shows those filters that have been created for the data type in question. To create a new filter, click the button **"New Filter"**. Filters may be created for any of the data-types listed in the RheoFinder as well as for **"Setup"** items or properties set inside a project. It is, for example, possible to filter for all projects that have been used with a certain configuration or apply a filter directly when opening a project.

4.9.2 Creating a Filter

1. If you are already viewing the list of items that you want to filter, click the drop-down list of the search field in the upper right corner of the presentation pane and click **"New Filter"**.
    To create a filter for any data type, click "More" in the navigation pane and find the entry **"Filters"**. Highlight the entry and click **"New"** in the **"RheoFinder"** ribbon bar. Then select the data type or property and click **<OK>**.

2. Enter a name and, if required, an additional description for the new filter. The application area for the filter is shown next to the name. This information will later be listed in the presentation pane.

3. Select from the drop-down list whether all or any of the conditions (rule groups) should be matched whenever the filter is used. If you select **"All"**, the filter will only display those items that fulfill all conditions; if **"One"** is selected, the filter will list the items that have at least one of the defined properties.

4. To filter for single properties, e.g. part of the test name and the operator name, one set of rule groups is sufficient. Select the filter criterion and the rule from the list and enter the text you want to search for. As with the rule groups, select whether the filter should look for all or any criterion.

5. Click the +-sign to add a second rule or criterion, if required. If you do not need more filter levels, you are done now. Otherwise, continue with the following step.

6. To set up nested filters, use the rule groups additionally to the filter rules. For each rule group, set up the filter rules as described above. Click the +-sign to the very right in the details Pane to add another rule group to the filter.

4.10 App Manager

Use the **App Manager** in the category **My Apps** to find the project template that best suits your needs. Simply filter the wide number of available default and user-defined templates by **My Apps, More Apps, Examples or Verification & Adjustment templates**.

The **App Manager** finds the perfect template for your application – based on your individual input.

To show project templates for specific applications, use the ribbon category from the ribbon category **Home, App Manager**.

Place the mouse pointer on the 'Application mode' item to see a tooltip with further information.

5   The Actions

The actions are the components of a test definition. Depending on the settings, they are carried out one after the other during the execution of a test or accessed, if certain conditions are fulfilled during the test.

The test definition can contain any number of actions in any required combination. For quality control or routine purposes, the test definition can contain the full description of all steps from the initialization of the device to the final printout of the measurement report.

Each action shows the function name, e.g. "Measurement", and a text field that can be edited to give the user more information. Further, each action shows a quick info whose contents can also be edited, if required.

5.1   Action Start

The **Start** action is used to enter **Information** about the test and to start the test using the **Start test** icon.

Special settings in the details pane:

1. In <**Name, Info**> the **Name of the action** and the **Info** shown when the mouse cursor is over the action should be defined.

2. In <**Picture, title, buttons**> the following items can be defined:

    1. **Picture** to be shown in the bubble of the action

    2. **Title text** of the action

    3. **Buttons**

        a. **Abort test**: Show this button to allow any user to abort a test

        b. **Skip**: Show this button to allow any user to skip the **Current action** and proceed with the next action

        c. **Continue**: Show this button to prompt any user to press the button continue in order to execute the defined function. Use case: Wait for Continue until moving to the measuring position.

3. In <**Instruction**> an instruction is defined to be displayed in the bubble during runtime.

4. In <**Test name input**> a name for the current test is defined.

    • Use an **Empty name field** in the **Details** pane if the **Name changes each time** you open the project for further measurements. The name being used for the last time is remembered within one session.

• Use a **predefined name** in the **Details** pane if the first part of the name is always the same.

Example(s):

Default test name in **Details pane**	**Behavior** at test start
Empty	1st test: The edit field is empty and the user does not enter a name. The test name **Test 1** is being used. 2nd test: The name from the previous test is taken over and a consecutive number is added -> **Test 2** 3rd test: The name from the previous test is taken over and a consecutive number is added -> **Test 3** ...
Empty	1st test: The edit field is empty and the user enters a name, e.g. **abc**. The test name **abc 1** is being used. 2nd test: The name from the previous test is taken over and a consecutive number is added -> **abc 2** 3rd test: The user enters a new name **Coating abc 1**. The name is taken over and a consecutive number is added -> **Coating abc 1** 4th test: The name from the previous test is taken over and a consecutive number is added -> **Coating abc 2** ...
Predefined name; e.g., **Creme**	1st test: The edit field contains the name Creme and the user does not change this name. The test name **Creme 1** is being used. 2nd test: The predefined name is taken over is taken over and a consecutive number is added -> **Creme 2** 3rd test: The predefined name is taken over is taken over and a consecutive number is added -> **Creme 3** …
Predefined name; e.g., **Creme**	1st test: The edit field contains the name Creme and the user changes the name into Creme white. The test name **Creme white 1** is being used. 2nd test: The predefined name is taken over and a consecutive number is added -> **Creme 2** 3rd test: The predefined name is taken over and a consecutive number is added -> **Creme 3** …

5. In <**Additional inputs**> any additional input parameter can be defined to be show in the bubble of the start action.

Parameter settings of the additional inputs:

Checkmark	Meaning
☑ ☐ ☐	Input field is shown at runtime

Checkmark	Meaning
	User can change input at runtime
	Input is required; field must not be empty

By default the following additional inputs are predefined in most project templates:

1. Name of the test

2. Operator

3. Sample

4. Batch no.

5. Description

Fig. 5 - 1   Additional inputs in the start dialog

Use the **Action Input** to add any additional input at any position in the test definition.

5.2   Action Measurement

The **Measurement** action is used to define the measuring profile. In combination with a Start and an End action this is the core of a test definition.
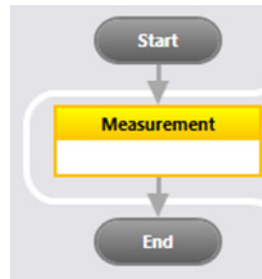
Fig. 5 - 2   Basic test definition

Most functions of the Measurement action are found in the **Ribbon Measurement**. Move the mouse point over the ribbon item for additional information about the ribbon function.

Test Type of the Project or Project Template

Each project has a property called **Test type**. The Test type is used to provide macros, diagrams, tables and other items compatible to the Test type. The Test type is taken from the **Project template**. To edit the Test type, select **<RheoFinder>, <Projects>, Ribbon RheoFinder, Item, Edit, Details pane, <Test type>** and select the Test type according to the settings in the Measurement action. It is advisable not to change the Test type of an existing project. For defining a new or user-defined Test, open a new Project template, e.g. <New Project>, '* Any test type | Empty project'.

Add or Delete Set Variable to the Measurement Action

To **Add** or **Delete** a Set variable select any variable and click **Ribbon Measurement, Set Variable, Add** or **Delete**. Typical variables that can be added to an existing Test type without changing the meaning of the Test type are accessory variables such as:

- Temperature
- Voltage
- Humidity
- Gap
- Normal force

Intervals

To **Add** a new interval, click **Ribbon function Measurement, Interval Insert** or **Append**. To **Delete** an interval select the specific interval and click **Ribbon function Measurement, Interval, Delete**. To **Move** intervals, use the **Move right** and **Move left** buttons in **Ribbon Measurement, Interval**.

In RheoCompass, complex measuring jobs are often defined in a vertical workflow by combining several measurement actions with a more comfortable data structure. Each result is identified by the name of the measurement action.
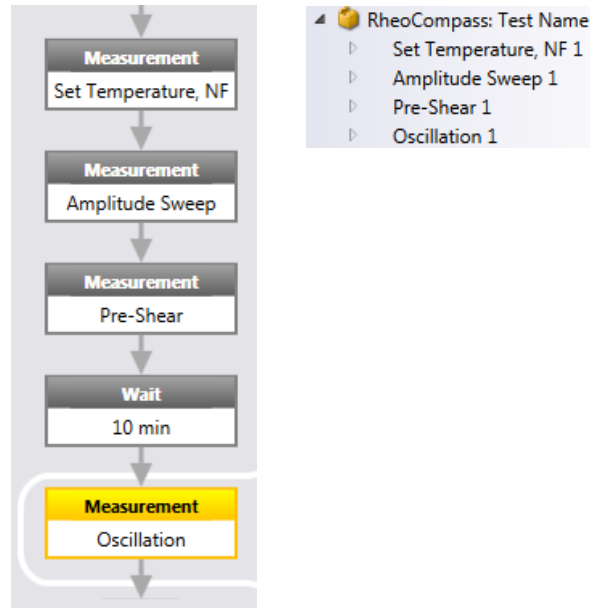

Fig. 5 - 3   Combined measurement actions

In contrast, in Rheoplus multiple measuring jobs were combined in intervals by using a horizontal workflow. The main issue here was that the user needed to separate the data for presentation and analysis, although it was not clear which interval contained which measuring data. Further data processing was essential for separating the intervals for post analysis.

Table 5.2: Measurement with many intervals

Settings in the Details Pane

Name, Info

To define the Name of a Measurement action select the **Details pane** and **Name, Info**. **Results** are identified by the name of the **Measurement action**.

5.2.1 Set Values

Measuring Profile

Select the tab **Set values** to define the values of the set variables and the profile type, such as:

• Constant

  • A constant set value is controlled over time; typically used in a time test or step test

• Linear ramp

  • A value is increased from the initial value to the final value in x steps, where x is the number of measuring points. The measuring points are evenly distributed in a linear interpolation between the initial and final values. Rheological settings are stepwise settings.

• Logarithmic ramp

  • A value is increased from the initial value to the final value in x steps, where x is the number of measuring points. The measuring points are distributed in a logarithmic interpolation between the initial and final values. Rheological settings are stepwise settings.

• Value list

  • To define a fixed number of values such as a shear rate of 1, 5 and 10 s^{-1}, use the value list.

TIP: *Use the same number of measuring points as the number of values in the list. Otherwise the values will be interpolated accordingly, which is not the expected behavior.*
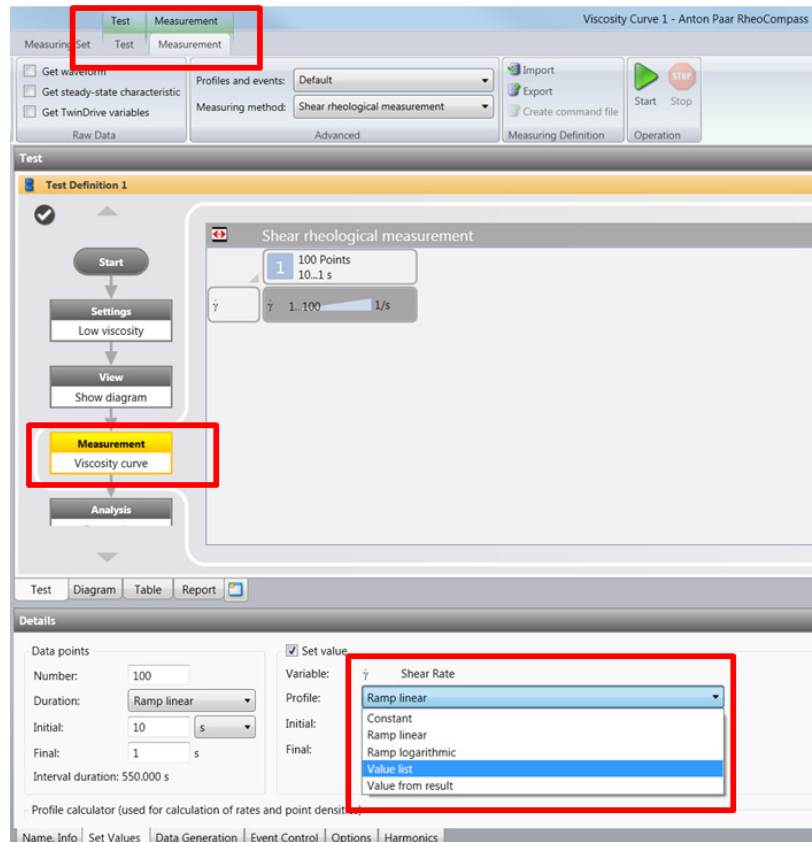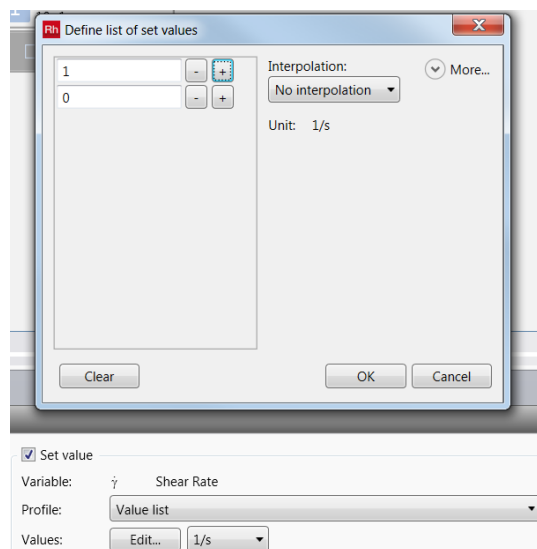

Fig. 5 - 4   Measurement

Fig. 5 - 5   Value list

- Value from result

  - Use the value from result to define the set value based on an analysis result.
  - Example:
  - Measurement, amplitude sweep
  - Analysis, LVE-range with proposal for shear-strain setting
  - Measurement, frequency sweep with strain selected as value from result

⌃ Frequency sweep | Auto-LVE
Measurement of the frequency sweep:
- Auto determination of the lve based on an amplitude sweep
- The lve-range result is used to perform a frequency sweep after a sufficient waiting time
- For sensitive samples this test may not work because of permanent destruction after the amplitude sweep
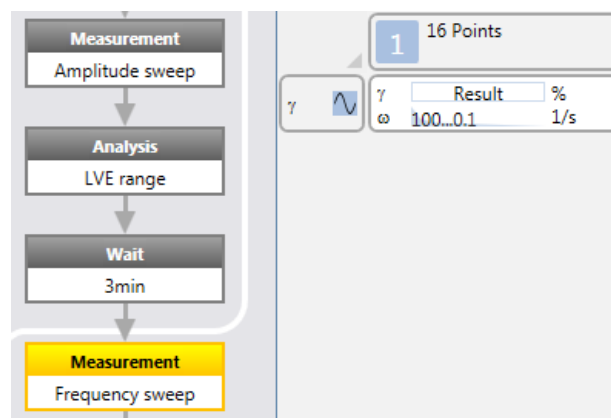
Fig. 5 - 6   Project template

Fig. 5 - 7   Test definition

Fig. 5 - 8   Value from result

5.2.1.1   Additional Settings

TwinDrive Mode

Select the tab **Set values** and click the expander **Additional settings** to define the **Twin drive mode** for the set variables used in this interval. Use the [+] symbol to add any **Additional setting**.

There are two TwinDrive modes:

• In **Separate motor transducer** mode, the upper drive is brought to a fixed position and operated solely as a torque or force transducer, while the lower drive is used as an actuator.

• In **Counter-movement** mode, the set variable of type '**Shear**' or '**Extension**' is achieved by a counter movement of the two drives in opposing directions.

If <None> is selected, the **fall-back** mode is **Separate motor transducer** if not otherwise defined in a **Setting** action.

5.2.2 Duration and Data Generation

Select the tab **Set values** to define the **Number of measuring points**, the **measuring-point duration** and the **Set value**.

Here are some examples of setting the measuring-point duration and data generation:

5.2.2.1 Rotational Tests, Standard Setting

• Settings used for **Steady (rotational)** measurements with **Constant** measuring-point duration
• **Duration**: constant, automatic data generation
• Example:

Fig. 5 - 9   Fixed measuring-point duration: A measuring point is generated after 10 s (example)

Fig. 5 - 10   Automatic data generation

• **Adjusting time**:
- Automatic (recommended): With "automatic adjusting time", the set shear rate is adjusted as quickly as possible and kept constant until the measuring point is generated. The maximum adjusting time is limited to 30 % of the measuring-point duration if > 0.1 s. For measuring-point durations < 0.1 s the maximum adjusting time is 0 s. Without any time setting the maximum adjusting time is 5 s. The maximum adjusting time is automatically reduced to allow a measuring-point generation within the user-defined measuring-point duration.
• **Averaging**:
- Automatic (recommended): With "automatic" averaging, the raw data of the last 50 % of the measuring-point duration is used for building the measuring point. In this example, averaging will start after 5 s with automatic settings.

- **Objective**: The settings are recommended for most steady (rotational) measurements except for samples with transient behavior.
- Settings used for **Steady (rotational)** measurements with constant measuring-point duration
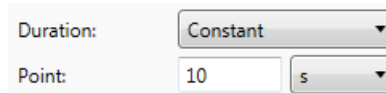- **Duration**: constant, averaging over relative point duration
- **Example**:

Fig. 5 - 11   Fixed measuring-point duration: A measuring point is generated after 10 s (example)
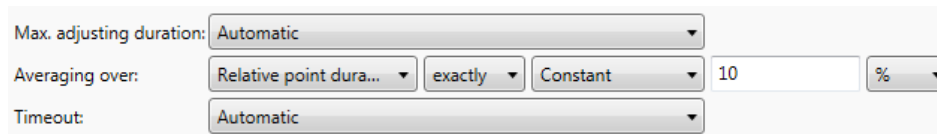

Fig. 5 - 12   Automatic data generation

- **Adjusting time**:
- Automatic (recommended): With "automatic" adjusting time, the set shear rate is adjusted as quickly as possible and kept constant until the measuring point is generated. The maximum adjusting time is limited to 30 % of the measuring-point duration if > 0.1 s. For measuring-point durations < 0.1 s, the maximum adjusting time is 0 s. Without any time setting, the maximum adjusting time is 5 s. The maximum adjusting time is automatically reduced to allow a measuring-point generation within the user-defined measuring-point duration.
- **Averaging**:
- Manual: With averaging over relative point duration, the raw data of the last 10 % of the measuring-point duration is used for building the measuring point. In this example, averaging will start after 9 s.
- **Objective**: The settings are recommended for samples showing transient behavior. For transient samples, the viscosity is a function of the time at a given constant shear rate. As a consequence, averaging should not start too early.
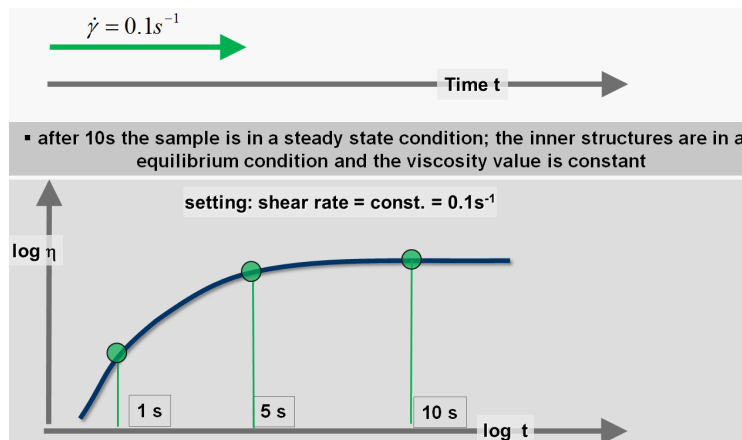

Fig. 5 - 13   Samples with transient behavior

5.2.2.2   Rotational Tests, Transient Samples, Steady-State Sensing

Settings used for rotational measurements with measuring-point duration by steady state. Use one of the predefined project templates from the '**More apps**' category of the **App Manager** to perform a test in steady-state mode.

Steady-state actions:

- A measuring point will be generated if a predefined variable (e.g., viscosity) becomes constant. Use case 1: Flow curve.

- Go to the next interval if a predefined variable (e.g., gamma) has a constant slope. Use case 2: Creep test.
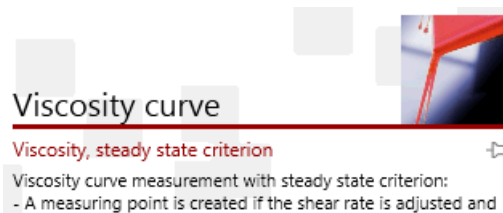
Use Case 1: Measurement of a Viscosity Curve

A measuring point is generated if the viscosity is constant.

Typical use case:

- Apply a stepwise shear-rate ramp and wait for the viscosity to become constant.
- Then generate a measuring point if the viscosity is constant.

Typical project template:

Viscosity curve

Viscosity, steady state criterion

Viscosity curve measurement with steady state criterion:
- A measuring point is created if the shear rate is adjusted and

Set variable:

Duration: by steady state

Time-out: Maximum time until a measuring point is created (if steady state is not reached)

Settings with 'Auto-detect':

Steady state

Steady State Action

Next interval	⌄

For variable: | γ Shear Strain | ⌄ |

Condition: | Constant slope | ⌄ |

☑ Auto-detect

'User-defined' settings:

Steady state

Steady State Action

Next interval	⌄

For variable: | γ Shear Strain | ⌄ |

Condition: | Constant slope | ⌄ |

☐ Auto-detect

Settings of condition

Number of points per inspection value: 3   Total inspection time: 6.000 s ⓘ

Allowance: 0.2 %

Visualization of settings:

Allowance:
Allowed deviation used for check of steady state

Number of inspection values: 2

Inspection definition:
Number of points per inspection value * Point duration

Total inspection time:
Total inspection time = Number of inspection values * Number of points per inspection value
       * Point duration
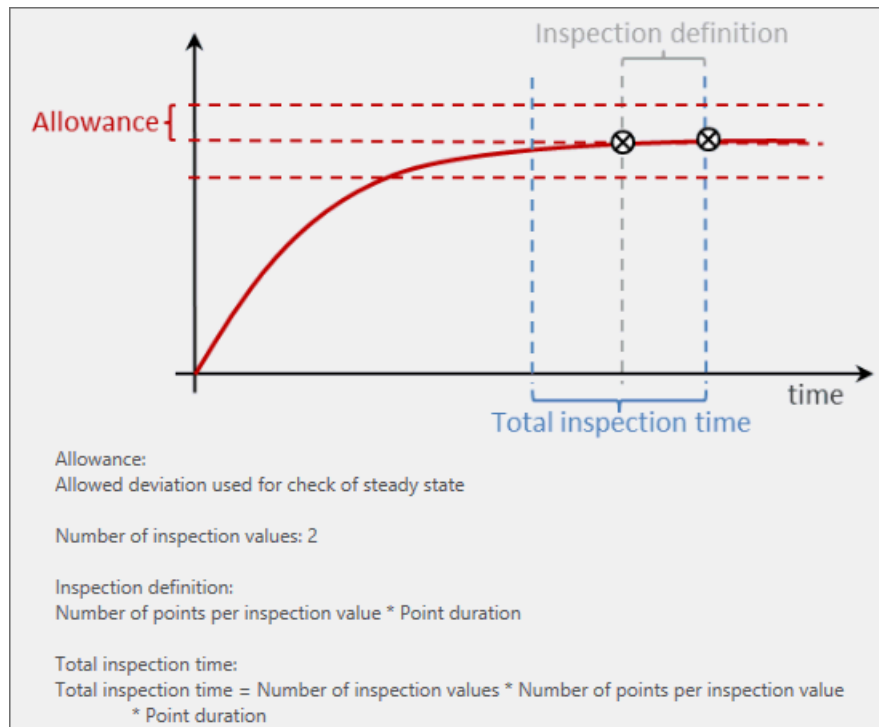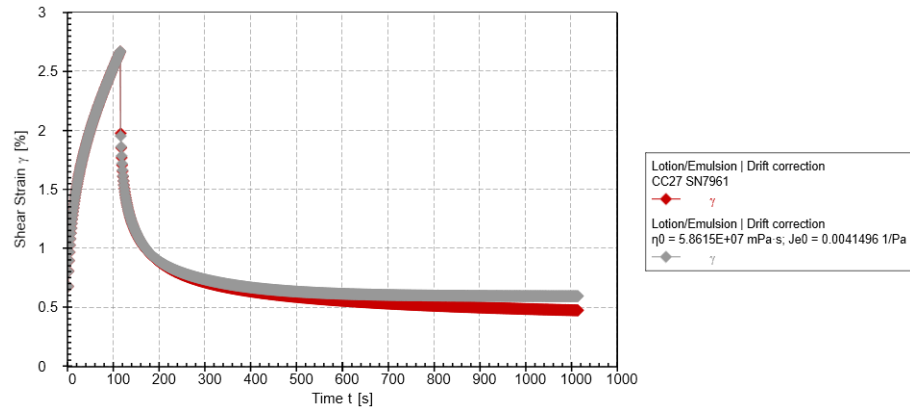
Measurement:

Use Case 2: Creep Test

Measurement of a creep test. The creep interval is finished if the slope of the shear strain becomes constant.

Typical use case:

- Apply a constant shear stress and wait for slope of the shear strain to become constant.
- Then set the current interval and step to the next interval. If this is the last interval then finalize the test.

Typical project template:

Set variable:

Duration: by steady state

Point density defined by: point duration and number of points, where the number of points depends on the steady-state duration.

Time-out: number x point duration = 1000 x 1 s = 10,000 s

Settings with 'Auto-detect':

'User-defined' settings:

Measurement:

5.2.2.3 Rotational Tests, Elastic Samples

- Settings used for **Steady (rotational)** measurements with variable measuring-point duration
- **Duration**: Logarithmic change in measuring-point duration, averaging over relative point duration
- **Example**:

Fig. 5 - 14   Fixed measuring-point duration: A measuring point is generated after 10 s (example)

Fig. 5 - 15   Automatic data generation

Fig. 5 - 16   Logarithmic shear-rate ramp

- **Adjusting time**
- Automatic (recommended): With "automatic" adjusting time, the set shear rate is adjusted as quickly as possible and kept constant until the measuring point is generated.
- **Averaging**
- Manual: With averaging over relative point duration, the raw data of the last 10 % of the measuring-point duration is used for building the measuring point. In this example, averaging will start after 90 s or 0.045 s.
- **Objective**: The settings are recommended for samples showing transient behavior and for samples showing edge effects at higher shear rates. For transient samples, the viscosity is a function of time at a given constant shear rate. As a consequence, averaging should not start too early.
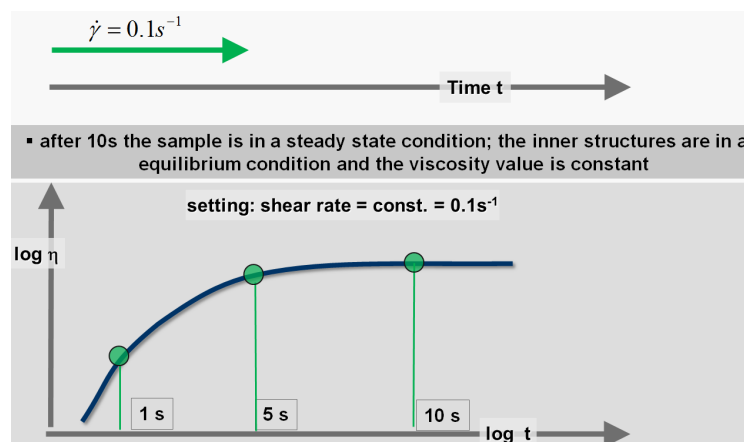

Fig. 5 - 17   Samples with transient behavior

5.2.2.4   Oscillatory Tests, Strain-Controlled

- Settings used for dynamic (oscillatory) measurements with strain control
- **Duration**:
- Amplitude and frequency sweeps: No measuring-point duration (None)
- Time and temperature sweeps: Constant measuring-point duration
  - Make sure the constant measuring-point duration is long enough to allow the adjustment of the set shear-strain value and to build a measuring point. If you are not sure about the measuring-point duration, use the following steps to calculate it:
  - The time for a single cycle is $t\_cycle = 1 / f$.
    - Example at 1 Hz: $t\_cycle = 1$ s
    - Example at 0.1 Hz: $t\_cycle = 10$ s
  - It takes several cycles to adjust the amplitude. We recommend setting a time of:
    - $t\_mp = 10 * t\_cycle$ at about 1 Hz (10 s)
    - $t\_mp = 6 * t\_cycle$ at about 0.1 Hz and below (60 s)
  - Shorter times may result in invalid or noisy measuring points. To avoid invalid points the maximum adjusting time can be set to exactly 0 s.
  - Alternative / faster solution: Beside the direct-strain amplitude controller we also offer the so-called TruStrain™ controller, which allows much higher sampling rates and therefore shorter measuring-point durations.
- **Adjusting time**: The adjustment takes as long as it is necessary to reach the set value (1 % of the set strain) or until the maximum adjusting time is reached. If the wrong type of measuring system is chosen, the timeout is activated until a measuring point is generated.
- Automatic (recommended): The automatic mode can be changed by the user but in most cases there is no improvement of the measuring data by changing the averaging to manual settings. Use the table below to get an idea of the time needed to build a measuring point. The maximum adjusting time is automatically reduced to allow a measuring-point generation within the user-defined measuring-point duration.
- Maximum adjusting time in TruStrain oscillation

Frequency	Maximum adjusting time
f > = 10 Hz	4 s within the tolerance
10 > f > = 0.5 Hz	@10 Hz: 4 s within the tolerance >0.1 Hz linear interpolated max. adjusting time @0.5 Hz: 13 s within the tolerance
0.5 Hz > f	@0.5 Hz: 13 s within the tolerance >0.0001 Hz linear interpolated max. adjusting time @0.0001 Hz: 16000 s within the tolerance

- **Averaging**: The averaging time for a data point depends very much on the set frequency.
- Automatic (recommended): The following table shows the definition being used in 'auto' mode (TruStrain). The automatic mode can be changed by the user, but in most cases there is no improvement of the measuring data by changing to manual settings.

- Periods used for averaging in TruStrain™ oscillation

Frequency [Hz]	Periods
> = 50	50
2 < = f < 50	50 periods at 50Hz in-between linear interpolation 1 Period at 2Hz
2	> 1 (linear interpolation)
< 2	1

- Example for averaging time

Frequency [Hz]	Angular frequency [rad/s]	Periods	Averaging time [s] = 1 / Frequency * Periods
100	628	50	0.5
50	314	50	1
20	125	16	0.8
10	62.8	7	0.7
5	31.4	3	0.6
2	12.5	1	0.5
1	6.28	1	1
0.5	3.14	1	2
0.2	1.25	1	5
0.1	0.628	1	10
0.01	0.0628	1	100
0.001	0.00628	1	1000 (= 16 min)
0.0001	0.000628	1	10,000 (= 2.7 h)
...	...	1	...

Example of manual settings in RheoCompass:

In some critical sample measurements, the quality of dynamic data could be improved by selecting the following manual time settings:
- 7 s for the highest frequency
- 6 periods for the lowest frequency (e.g. for 100 Hz -> 7 s and for 0.01 Hz -> 600 s in a log ramp)
- The maximum achieved tan (delta) resolution would then be >1000 (at least 3.5 decades and, in the best case, 10,000)

Data points
Number: 21
Duration: Ramp logarithmic
Initial: 7 s
Final: 600 s
Interval duration: 2979.047 s

☑ Amplitude and frequency
Variable: γ Strain (oscillating)
Profile: Constant
Value: 10 %

Variable: f Frequency
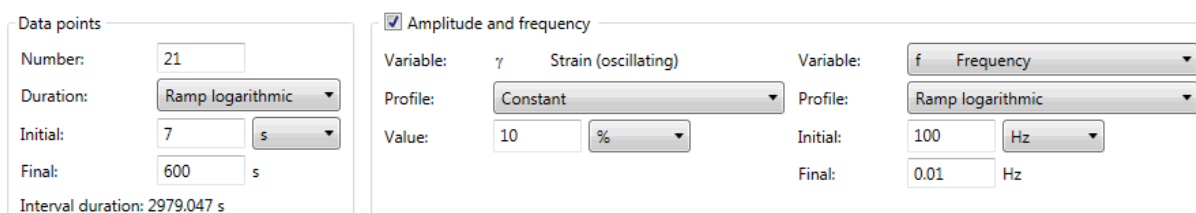Profile: Ramp logarithmic
Initial: 100 Hz
Final: 0.01 Hz

Fig. 5 - 18   Example of manual settings in RheoCompass

TIP: *More than 99 % of all samples are measured using the default settings for data generation. If you generate noisy data, check that you are using the right measuring system. Users often change the default settings of the standard Anton Paar templates, but then do not see any major improvement of the data quality. We recommend using an alternative measuring system as a first choice.*

Recommended	Use a standard template of the rheometer software
High frequency	Use a measuring system with a larger diameter, smaller cone angle (CPxx-y) or set a smaller gap (e.g. for a PPxx, set a gap of 0.5 mm instead of 1 mm; or use a PP50 or even a PP60 instead of a smaller plate).
Low frequency	Use a measuring system with a larger diameter, or choose a stress-controlled frequency sweep, which allows excellent measurements at lowest frequencies, ensuring good signal quality.
Surface	Avoid sample slip by using sandblasted (/S) or serrated measuring systems (/P3)

5.2.3   Event Control

Select the tab **Event control** to define **Reactions** and **Events**. The following events are available:

- Stop measurement execution

  - A measurement is stopped if the defined event becomes true
  - The test definition is not stopped and the test will continue with the next action

- Step forward by x interval(s)

  - Finish the current interval and start with another interval if the event becomes true

- Loop over interval(s)

  - Loop over a certain number of intervals until the event becomes true (if variable has a certain value) or for a fixed number of times (if end of interval is reached)
  - Alternative: Use the Action **Go to,** to define a looped measurement within the test definition (see *Chapter 5.7, "Action Go To"*)

- Output a message beep

Example: Event control is used to stop a measurement if a certain value is reached; for example, during a curing reaction or in a temperature sweep.

5.2.4   Options

Select the tab **Options** to define whether a temperature ramp is set as continuous or stepwise.

5.2.5 Harmonics

Select the tab **Harmonics** to define and read higher harmonics during a dynamic measurement. Examples can be found in the following project templates:
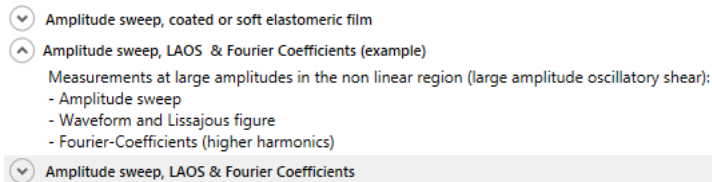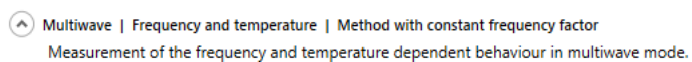

Fig. 5 - 19   LAOS template

Fig. 5 - 20   Multiwave template

5.2.6 Maximum Number of Intervals

The limitation does not come from RheoCompass, but rather from the protocol sent to the device which is limited in its memory for processing all the commands.

The maximum number of intervals a MCR can process depends on:

- **device type**

- **firmware** version

- **test type** (number of set and read variables); Example 1: Test with "n", Example 2: Test with gamma/frequency/NF/event control.

Alternative test definition:

- **test definition** with multiple **measurement actions** and **go to** action (**loop**)

- **measurement** with **Loop over intervals (Event control)**

- **joblist**

Example of an MCRxx2 with FW3.90:

Limitation for a basic measurement: 56 intervals
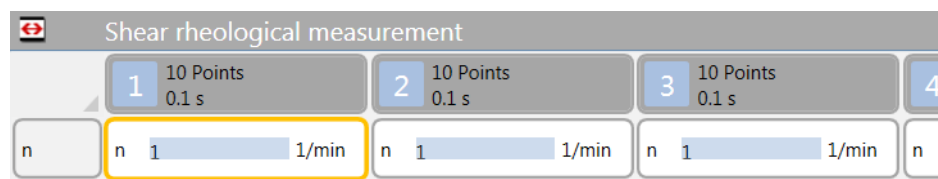
Limitation for a more complex measurement: 43 intervals
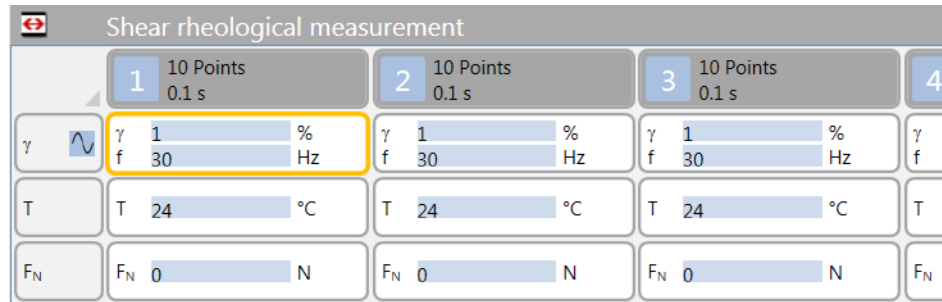
5.2.7 Definition of a Multiwave Test

In RheoCompass, in version 1.13 and later, two Multiwave templates and one example template are included in the App Manager. The templates are called Multiwave...

1. Define the base wave and the strain

Make sure the time per measuring point is at least t_MP = 6/(omega*2*PI)

2. Define the harmonics

3. Prepare a table window with the relevant physical variables of the harmonics
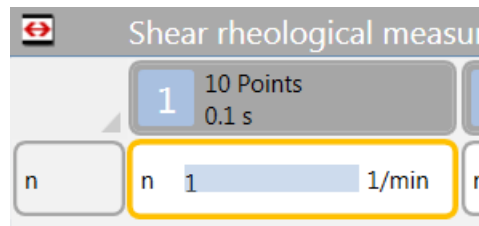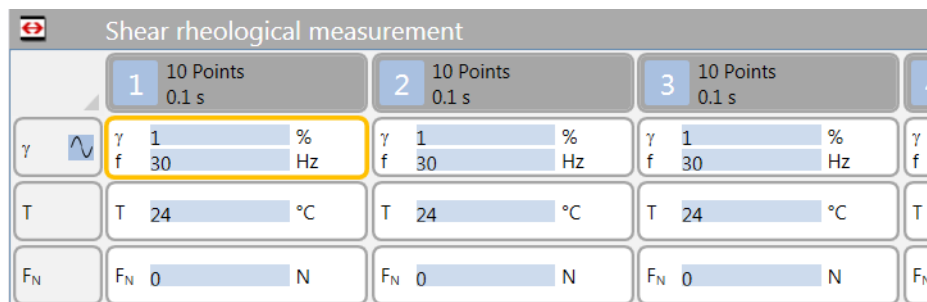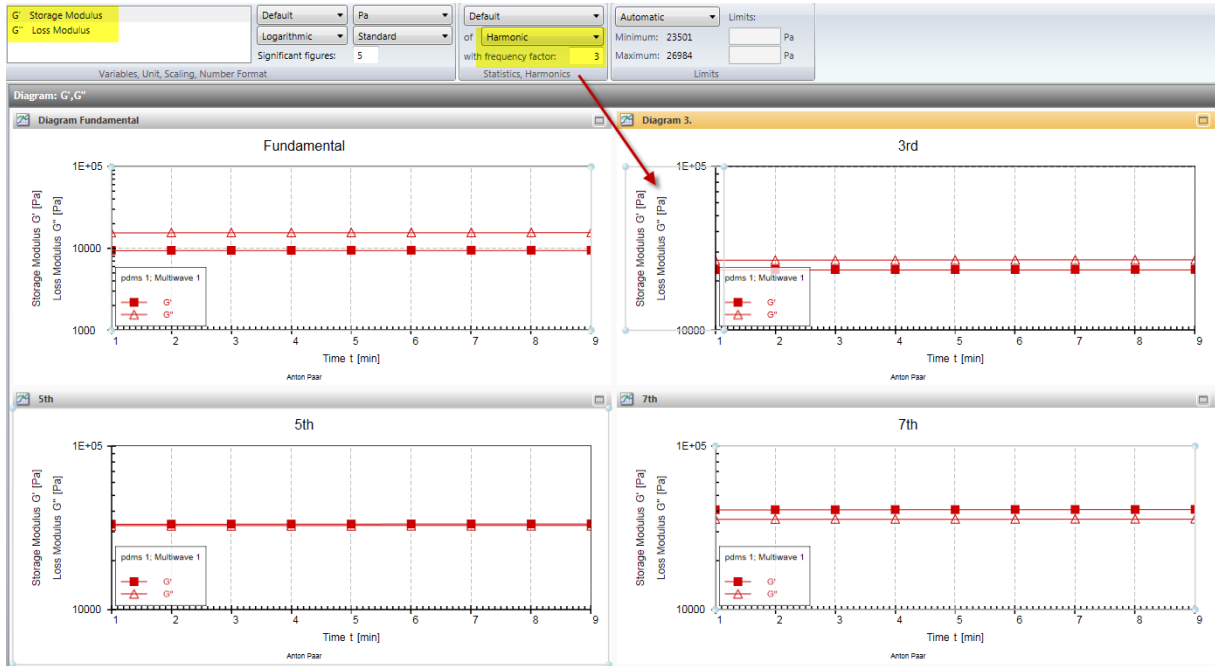
Point No.	Temperature	Angular Frequency	Storage Modulus	Loss Modulus	Angular Frequency	Storage Modulus	Loss Modulus	Angular Frequency	Storage Modulus	Loss Modulus
		Fundamental	Fundamental	Fundamental	3. Harmonic	3. Harmonic	3. Harmonic	5. Harmonic	5. Harmonic	5. Harmonic
№	T	ω	G'	G"	ω	G'	G"	ω	G'	G"
	[°C]	[rad/s]	[Pa]	[Pa]	[rad/s]	[Pa]	[Pa]	[rad/s]	[Pa]	[Pa]
1	25.83	1	9506.6	15707	3	23501	26850	5	33335	32466
2	25.84	1	9512.2	15721	3	23509	26868	5	33331	32496
3	25.85	1	9515.1	15733	3	23518	26887	5	33350	32511
4	25.86	1	9520.1	15738	3	23526	26903	5	33372	32512
5	25.87	1	9523.7	15745	3	23526	26918	5	33388	32522
6	25.87	1	9527.7	15753	3	23536	26941	5	33428	32540
7	25.88	1	9531.2	15761	3	23545	26950	5	33431	32539
8	25.89	1	9535.3	15768	3	23548	26960	5	33443	32547
9	25.91	1	9539.6	15774	3	23553	26984	5	33467	32545

4. Define additional windows for the harmonics

Further screenshots:

Diagrams with harmonics:

Tables with harmonics:

5.2.8   Creating a Value List in RheoCompass

Example: Determining the viscosity of a sample at shear rate of 1, 5 and 10s-1. How can the data be processed using RheoCompass in such a way as to provide the viscosity reading at a specified shear rate?

Open the project, click on **Measurement** ribbon, open the action **Measurement**, enlarge **Details**, open **Set values** and the **Profile** drop down and select **Value list**. A window will open and the preferred values can be typed in.

TIP   *The number of points measured should be equal to the number of values on the list. Otherwise, the values will be interpolated, which is not the expected behavior.*

Measurement:

Value list:

5.2.9 Measuring Raw Signals

There are three options for measuring raw signals using RheoCompass:

1. Use the built-in project templates to perform **LAOS measurements** providing **All types of LAOS variables**. This is the recommended **Comfort function** for **LAOS recording**.

    - There is no limitation in the number of recorded cycles.
    - Raw data is provided for the measuring point only, and not as a continuous stream. This is therefore not useful for transient waveform analysis.

• The normal force signal is not provided as LAOS data

Templates for LAOS

Some calculated variables

Lissajous figures and waveform diagrams

2. Use the built-in project template to perform **Transient LAOS measurements** with **Continuous recording** of raw variables.

• A limited number of cycles is recorded (about 4)

• A continuous stream of raw data cycles is provided (all cycles are recorded)

• The normal force signal is provided.

- Raw-data sine-wave generator and continuous measurement of **Transient LAOS** with real-time recording of all cycles, even NF. This new features does not require the Waveform license feature.

  - Auto-create with parameters
  - Waveform type (currently only sine)
  - Offset value
  - Amplitude
  - Number of values per period
  - Number of periods
  - Click on **Clear list and generate values**, which creates a list containing the automatically created sinusoidal values
  - New **Project template** Waveform, sine generator (raw data)
  - Example of four cycles with 4 x 256 data points:

Template:

Example:

Waveform generator:

Note: The number of values is limited. An error may occur at test start if the command is too long.

LAOS transient:

3. Use a Signal spy for output of Device variables at the analogue ports of an MCR with TwinDrive.

5.2.10 Definition of a Signal Spy to Read an Analogue Raw Signal

Single Drive MCR

The analogue output provides **Uncorrected device variables** which are not of any use for rheological investigations using a single drive MCR rheometer. The data is **Uncorrected** including **Inertia** and without **Stabilization**. It can not be used for any LAOS investigations. Only the data provided in RheoCompass can be used for such analysis (512 raw data points per measuring point).

TwinDrive MCR

It is advisable to use these ports only in combination with the **TwinDrive** rheometer with two **Separate motors**. The **Device variables** supported by the software are dependent on **Software** and **Device firmware** version. We recommend updating to the latest versions for full functionality.

Installation of Signal Spy

Typically the analog ports are used to **Control analogue accessories**.

For reading the **Raw data** from any motor:

-   **Install** a **Signal spy**
-   **Select** a **Device variable** with **Factor** and **Offset**
-   **Select** the **Signal spy** in the **Configuration** and assign it to one of the **Analogue ports AN1...AN4**

A **Signal spy** is used to define the **Device variable output** of a selected analog port **AN1...AN4**. The MCR offers four ports in total with a maximum of four different device variables to be assigned to these ports.

Installation of the signal spy:

Change the factor according to the signal strength:

Loss Modulus for Minimum Strain G_M'' [Pa]	Loss Modulus for Large Strain G_L'' [Pa]	Ratio for Shear Thinning Δ_{thin} [1]	Ratio for Shear Thickening Δ_{thick} [1]	Ratio for Strain Stiffening Δ_{stiff} [1]

Setup of the measuring set configuration:
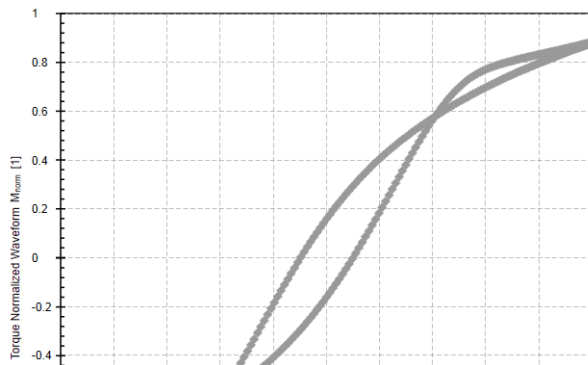
Technical Details:

The MCR has Multi-purpose analogue connectors, AN1...AN4 (M1, M2), with an analog output of ±10 V (with 16 bit resolution).

The time interval of the data output is 100 ms.

All **Device variables** are based on **SI units** [Nm, rad, …]. For other units, the factor should be changed accordingly.

Normal force:

    Offset = 32768

Factor = -3.0524e-4

Encoder signal A and B:

1.0

The output voltage is calculated as:

UBNC = Offset + Factor * DSP Size value * (10 V / 10,000)

5.3 Action Analysis

The **Analysis** action is used to define the an automated analysis based on the <**Next test**>. The analysis is executed as part of the test definition.

Placeholders such as <**Next test**> and placeholders for various results of the test definition such as:

- <**All results**>

- <**All measuring results**>

- <**All analysis results**>

- <**Last measuring results**>

- <**Last analysis result**>

- <**All results of an analysis action**>

allow a flexible programming of the input data for automated analysis even in looped measurements. As default the **Last measuring result** of the **Next test** is chosen.

Design of the analysis	
Input data	Click link to define the input data or drag and drop to input
Result data	Click link to define the result data
Step	Steps are used in analysis definitions to combine multiple analysis methods. Each step could have temporary or permanent result. The temporary results are typically taken over as input data for any of the following steps. Drag and drop the output of any step to the input of the other step to create a connecting line for defining the input data.
Method	A **Method** is a **Basic analysis method**.
Macro	A **Macro** is a ready to use **Analysis macro** consisting of one or multiple analysis methods. For more information on Macros, have a look at the section in this chapter.

5.4   Action Camera

Use the action **Camera** to start recording a **Video** or **Pictures** during a measurement.

In practice two actions are needed: The first **Camera** action prior to the **Measurement** to **Start recording** and a second **Camera** action after the **Measurement** action to **Stop recording**.:
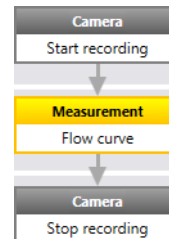
Fig. 5 - 21   Action Camera

Special settings in the details pane:

1. In <**Name, Info**> the **Name of the action** and the Info shown when the mouse cursor is over the action should be defined.

2. In <**Camera action**> the mode is defined. Modes:

  • **Start recording video**
      - Limit video by **Duration** or **Size** (MB)

  • **Stop recording video**

  • **Start recording pictures**
      - Take picture **When a measuring point is created**
      - Take picture **In time intervals of x seconds**

  • **Stop recording pictures**
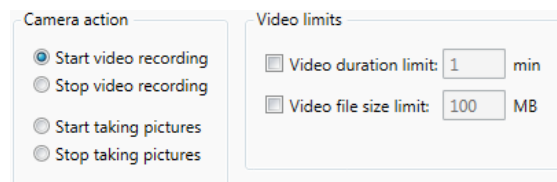
Fig. 5 - 22   Video options
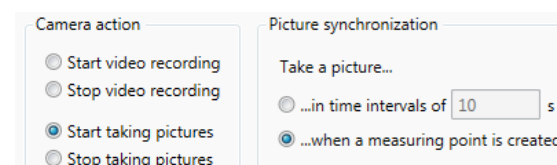
Fig. 5 - 23   Picture options

3. In <**Settings**> the settings of the **Video input device are defined**.
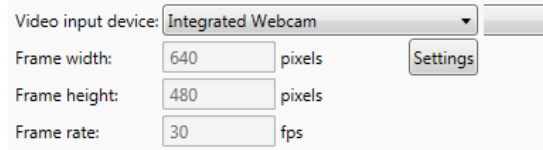
Fig. 5 - 24   Device settings

5.5   Action Device

Special settings in the details pane:

1. In <**Name, Info**> the **Name of the action** and the **Info** shown when the mouse cursor is over the action should be defined.

2. In <**Picture, title, buttons**> the following items can be defined:

    1. **Picture** to be shown in the bubble of the action

    2. **Title text** of the action

    3. **Buttons**
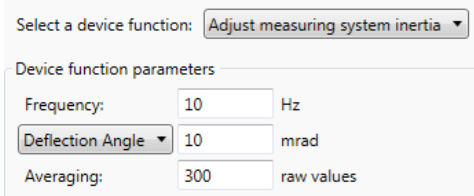
        a. **Abort test**: Show this button to allow any user to abort a test

        b. **Skip**: Show this button to allow any user to skip the Current action and proceed with the next action

        c. **Continue**: Show this button to prompt any user to press the button continue in order to execute the defined function. Use case: Wait for Continue until moving to the measuring position.

3. In <**Device functions**> a function of the device can be defined. Some functions are dependent on the device type or configuration and the firmware of the device.

Adjust drive inertia	Use this function to adjust the **Drive inertia** of the device. The drive inertia is adjusted without any measuring system connected to the quick connect coupling. It is highly recommended to adjust the inertia using the default parameter settings: The drive inertia is stored in the device and not in the software.

Adjust measuring-system inertia	Use this function to adjust the **Measuring system inertia**. It is recommended to use the default parameter settings for adjusting the inertia except for the magnetic coupling of the pressure cell. The **Measuring system inertia** is stored in the software. Special case: Use 1Hz and 100mrad for adjusting the inertia of the magnetic coupling (pressure cell).
Adjust motor	Use this function to adjust the motor of the rheometer. It is recommended to execute this action as part of the predefined project template found in the **New template, Verification and adjustment** category of the **App manager**.
Detect zero-gap	Use this function to detect the zero-gap of a parallel plate or cone & plate measuring system. Make sure the measuring system and the measuring cell have reached the equilibrium temperature before starting the zero-gap routine.
Initialize device	A device is **initialized** once after switching it on. This is typically done in the **Control panel**. Use this option to automatically initialize a device as part of a test definition. It is recommend to define a separate test definition for preparing the device for a series of measurements.
Move to loading position	Use this function to **Lift the head** of the measuring drive and **Move to the loading position**. The loading position is typically used to load a new sample or for cleaning the measuring system. *IMPORTANT NOTE:* It is strongly recommended to **Open** the **Quick connect coupling** before moving to the loading position. **CTD temperature control system**: Make sure to open the cell or the quick connect coupling of the measuring system before lifting the head of the drive.
Move to measuring position	Use this function to **Move to the measuring position**. The trim position is overruled by this option.

Move to trim or measuring position	Use this function to **Move to the trim or measuring position**. The trim position is used depending on the measuring system type and the settings in the measuring system: **Setup, Measuring systems, <Positioning>, Trim position mode**. In **Trim position** the user is prompted to trim the sample and to press **Continue** to move to the final **Measuring position**:
Move to waiting position	Use the function **Move to waiting position** to move to any position suitable for the application. Typically use case: After loading polymer pellets the measuring cell is closed and the measuring positioned above the sample, e.g. at 5 mm waiting position. After a certain equilibration time the sample is molten and the final measuring position can be set using the function **Move to measuring position**.

Reset normal force	Use this function to reset the normal force of the normal force sensor located in the rheometer drive. Make sure a measuring system is connected to the quick connect coupling.
	The normal force is already reset to zero during the zero gap routine (PP, CP) or while reading the Toolmaster data (SRF). Therefore this function is seldom needed to reset the normal force.
	Because of surface tension effects it is sometimes advisable to reset the normal force in measuring position – after the sample has been loaded. But please keep in mind that the contact angle changes during rotation and edge effects may worsen the situation.
	Additional information about measurements of the 1st normal stress difference: N1 measurements can be quite challenging. The main issue with N1 measurements is the fact that edge effects become dominant while N1 increases. This makes it almost impossible to determine rheologically correct values for most paste like samples.
	Surface tension and contact angle: Filling is crucial. It has a major impact on the initial normal force at rest.
	Do the following experiment to figure out the influence of filling and surface tension: Slightly underfill the measuring gap with water. As a result the normal force becomes negative (-0.05 N) whereas if correctly filled the normal force is 0 N. Overfilling has a positive impact on the normal force – the normal force becomes positive (+0.05 N).
	If N1 is negative from the beginning the value stays negative on a sample developing low N1 values. It may even happen that the filling situation changes due to centrifugal forces during rotation. This may have an impact on the contact angle and as a consequence may create a negative offset of the normal force. **Best case studies:** We recommend to use polymer solutions such as PIB to proof the capability of the MCR to measure N1.
Set PT100 input offset and span	Use this function to define the **Offset** and **Span** of any PT100 sensor connected to the **PT100 port** of the **MCR**. Offset and Span are stored in the memory of the MCR and not in the software. **Important note:** The Offset and Span is used for any PT100 connected to the PT100 port once defined. Make sure to check if the parameter comply with the PT100 currently being used.
Set thermo-couple input offset and span	Use this function to define the **Offset** and **Span** of any **Thermocouple** sensor connected to the **TE port** of the **MCR**. Offset and Span are stored in the memory of the MCR and not in the software. **Important note:** The Offset and Span is used for any thermocouple connected to the TE port once defined. Make sure to check if the parameter comply with the thermocouple currently being used.

Set start angle	Use this function for **Defining a start angle** to define the position of the quick connect coupling at test start. The function can be used to make sure the mark on the coupling is facing the front of any other position. This is handy in the case of using a UXF fixture or any other measuring system requiring a predefined position. While this function is used to **Define the user angle** another **Device action** should follow to **Move to the angle**. This is done by the **Move to measuring position** command.
Set value	Use this function to **Set any value** and optionally **Wait until the value is reached**. **Wait until value is reached** is used to define a tolerance for the set value (here 25°C +/- 0.2°C). The value must stay within the tolerance for the defined **Surveillance time** (e.g. 60 s) until the action jumps to the next action. If the **Timeout** is reached (e.g. 1000 s) the action is **Terminated** by the **Timeout**. Select a device function: Set value Temperature (P-PTD200) ▼ Run on device: 1 - MCR 302 ▼ Device function parameters Variable to be set: T Temperature ▼ Default ▼ Tolerance ±: 0.2 °C Set value: 25 °C ▼ Surveillance time: 180 s ☑ Wait until value is reached Timeout: 1000 s
Switch off accessory	Use this function to **Switch off any accessory** connected to the MCR. **Use case**: A test has been started in the late afternoon and to make sure all temperature control devices are off once the test is finished this function is used.
Set degauss accessory	Use this function to **Start the degauss** for any **Magneto Cell MRD** connected to the MCR. Variable to be set must be **Current I**.
Reset axial compliance	Use this function to set the value for the **Axial compliance** of the rheometer.

5.6   Action Export

Use the action **Export** to export **Tests**, a **Report** or a **Table** content. Several export format are available such as **xps**, **pdf**, **csv**, **xml** depending on the element to be exported.
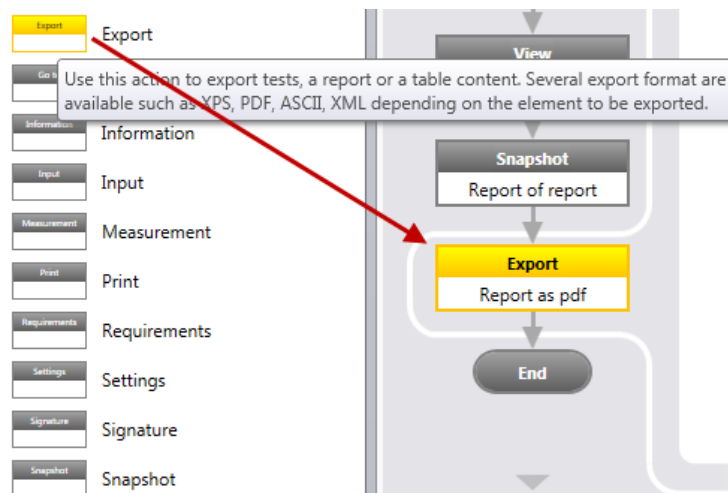
*Fig. 5 - 25 Action **Export** as part of the test definition*

Special settings in the details pane:

In **<Name, Info>** the **Name of the action** and the **Info** shown when the mouse cursor is over the action should be defined.

In **<Export>**, the origin of data (type of window) as well as the export parameter and formats are defined.

Export of any table in the project	 • Select the table no. • Select the path • Define a name or placeholders for the name • Check or uncheck the "overwrite" option
Export of any report in the project	 • Select the format of the report (pdf or Microsoft xps) • Select the report no. • Select the path • Define a name or placeholders for the name
Export of any test in the project	 • Select format of the test to be exported (*.xml) • Select the test name (e.g. placeholder <Next test>) • Select the result of the test • Select the path • Define a name or placeholders for the name

List of place-holders		
	{DATE}	Current date
	{DATEANDTIME}	Current date and time
	{TIME}	Current time
	{PROJECT}	Project name
	{TESTNAME}	Test name
	{LOGIN}	User name
	{BATCHNO}	Batch no.
	{DESCRIPTION}	Description
	{CUSTOMER}	Customer
	{CUSTOMERNO}	Customer no.
	{DELIVERYDATE}	Delivery date
	{DEPARTMENT}	Department
	{EXPIRATIONDATE}	Expiration date
	{INSPECTIONLOT}	Inspection lot
	{LABJOURNAL}	Lab journal
	{MANUFACTURINGDATE}	Manufacturing date
	{MANUFACTURER}	Manufacturer
	{OPERATOR}	Operator
	{ORDERNO}	Order no.
	{PROJECTNO}	Project no.
	{REFERENCENO}	Reference no.
	{REFERENCESAMPLE}	Reference sample
	{RETAINEDSAMPLE}	Retained sample
	{SAMPLE}	Sample
	{SAMPLEID}	Sample ID
	{SAPNO}	SAP no.
	{SHORTNAME}	Short name
	{SUPPLIER}	Supplier

5.7 Action Go To

The **Go to** action is used to repeat a measurement depending on the **Condition** defined in the **Go to** action.

Special settings in the details pane:

- In <**Name, Info**> the **Name of the action** and a **Info** which is shown when the mouse cursor is over the action should be defined.

- In <**Going to**> the target is defined.

- In <**Condition**> the condition is defined. There are four conditions:
  The default **Condition** is **End of value list or end of value is reached**. The **Boolean result**… conditions are used for specific loops based on analysis actions mainly in combination with the asphalt grading.

  1. Jump **Always**: Use this option to define an endless loop. Select this option if you would like to stop the test manually.

  2. Jump **For a fixed number of times**: Use this option to repeat the test for a certain number of times.

  3. Jump if **A condition is fulfilled**: Use this option to check if a variable (e.g. temperature below 90° C) is within a certain limit. If the value is outside the defined limit the loop is interrupted.

Fig. 5 - 26   Example

4. Jump **Until a condition is fulfilled**: Use this option to define a value list (e.g. a temperature list). In each loop the next value is set (next temperature of the defined list). An option is to **Wait until** the set value is reached and **Inside the predefined tolerance**. Make sure the **Abort after...** value which acts as a **Safety criteria** is set to a value suitable for your application. There are five options for defining the values to be set:

- i. **Set value using initial value, final value and increment** whereas if the final value is lower than the initial value the increment must be negative.

Fig. 5 - 27   Example

- **ii. Set value using initial value, increment and direction** based on a Boolean result from a specific analysis action. This option is mainly used for **Asphalt grading** and part of a special **Project template**.
- **iii. Set value using value list**: Click Edit to define the value list.
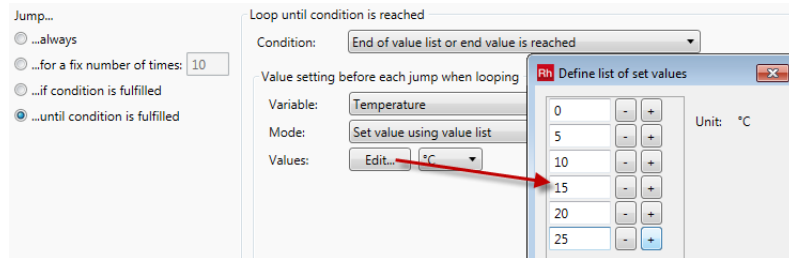
Fig. 5 - 28   Example

- **iv. Set value using increment**. Use this option only in combination with a **Stop criterion (Abort after…)**.
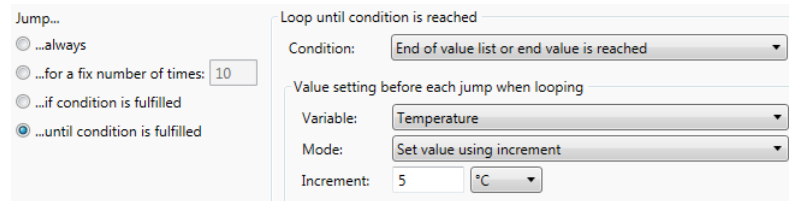
Fig. 5 - 29   Example

- **v. Set value using increment and direction** based on a Boolean result from a specific analysis action. This option is mainly used for **Asphalt grading** and part of a special **Project template**.

Wait until in tolerance is used to define a tolerance for the set value (here 20 °C +/-0.2 °C). The value must stay within the tolerance for the defined **Surveillance time** (e.g. 180 s) until the action jumps to the other action. If the **Timeout** is reached (e.g. 1000 s) the action is **Terminated** by the **Timeout**.
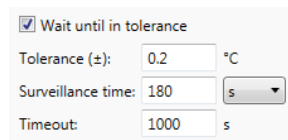
Fig. 5 - 30   Example

5.8   Action Information

The **Information** action is used to show instruction texts or media in form of a video, picture or spoken text to the operator of the device.

Special settings in the details pane:

- In <**Name, Info>** the **Name of the action** and an **Info** which is shown when the mouse cursor is over the action should be defined.

- In <**Picture, title, buttons**> the following items can be defined:

1. Media to be shown in the bubble of the action. The following media types are available:

- **Video** (*.wmv)
- **Picture** (*.bmp, *.jpg, *.jpeg, *.gif)
- Audio/**Sound** (*.wav)

Any media selected from the Windows file system is presented automatically during runtime. Picture and sound could be checked simultaneously.

2. Title text of the action

3. Buttons

- **Abort test**: Show this button to allow any user to abort a test
- **Skip**: Show this button to allow any user to skip the **Current action** and proceed with the next action
- **Continue**: Show this button to prompt any user to press the button continue in order to execute the defined function. Use case: Wait for Continue until moving to the measuring position.

- In <**Instruction**> an instruction is defined to be displayed in the bubble during runtime.

5.9   Action Input

The **Start** action is used to enter **Information** about the test and to start the test using the **Start test** icon.

Special settings in the details pane:

1. In <**Name, Info**> the **Name of the action** and the **Info** shown when the mouse cursor is over the action should be defined.

2. In <**Picture, title, buttons**> the following items can be defined:

- •   **Picture** to be shown in the bubble of the action
- •   **Title text** of the action
- •   **Buttons**
    - -   a. **Abort test**: Show this button to allow any user to abort a test
    - -   b. **Skip**: Show this button to allow any user to skip the **Current action** and proceed with the next action
    - -   c. **Continue**: Show this button to prompt any user to press the button continue in order to execute the defined function. Use case: Wait for Continue until moving to the measuring position.

3. In <**Instruction**> an instruction is defined to be displayed in the bubble during runtime.

4. In <**Additional inputs**> any additional input parameter can be defined to be show in the bubble of the start action.

Parameter settings of the additional inputs:

Checkmark	Meaning
	Input field is shown at runtime
	User can change input at runtime
	Input is required; field must not be empty

5.10 Action Print

In <**Name, Info**> the **Name of the action** and the **Info** shown when the mouse cursor is over the action should be defined.

In <**Document**> select any report contained in the project to be printed. To add a new report to the project, click the **View icon**

Double click the new view to change its name.

Click ribbon **Window, New report** and select any report template.

5.11 Action Requirements

Use the action **Requirements** to define the requirements for the specific test definition such as type of measuring system being used for this specific test.
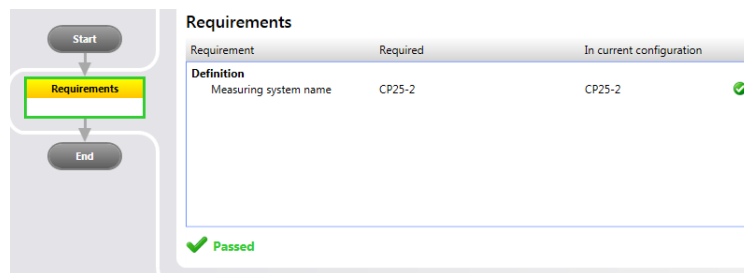
Fig. 5 - 31   Example of a requirement

Special settings in the details pane:

1. In <**Name, Info**> the **Name of the action** and a **Info** which is shown when the mouse cursor is over the action should be defined.

2. In <**Requirements**> the required device components can be defined. Device components are:

- **Accessory** name or Accessory name and SN (=serial number) or Accessory type
- **Device component** name or Device component name and SN or Device component type
- **Measuring system** name or Measuring system name and SN or Measuring system type

- **No measuring system** (used for the **Device** action **Initialize device**)

<None> ▼
Accessory name
Accessory name and SN
Accessory type
Device component name
Device component name and SN
Device component type
Measuring system name
Measuring system name and SN
Measuring system type
No measuring system
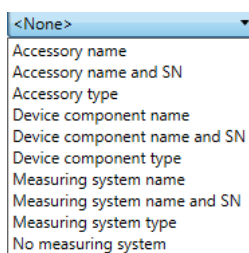
5.12 Action Settings

Use the action **Settings** to define non standard settings of the measuring device. If no **Setting** is defined the most recent settings are chosen by default which gives good measuring results in 99% of all cases.

Special settings in the details pane:

In <**Name, Info**> the **Name of the action** and the **Info** shown when the mouse cursor is over the action should be defined.

In <**Device settings**> the application specific settings are defined.

Name of setting	Function
Moving profile	Use this setting to select a **Moving profile** for the test and actions of type **Measurement** and **Move to...**. In the moving profile all parameter are defined for the gap setting such as velocity and normal force limits for the vertical movement. There are predefined moving profiles for specific applications or device components such as measuring systems. To generate a user defined editable moving profile from any existing Anton Paar moving profile click <**Setup**>, **Moving profiles, New**.
Normal force dynamic	Use this controller to fine tune the **Normal force dynamics**. Without activating the controller action the best possible setting is chosen by the device (recommended). Typical use case: Tack tests with more aggressive normal force and gap setting control (see also 'Moving profile' for tack).

Name of setting	Function

Override torsional compliance	By using the setting 'Override set torsional compliance' in manual mode, all compliance components defined in the software and rheometer will be ignored for this particular test definition and the user-defined value will be used instead.
	To disable any compliance correction, set the value to 0 mrad / mNm.
	
	TwinDrive: The 'Override set torsional compliance' function is divided into two parts. Each part is calculated based on the original compliance of the measuring system being used.
	
	   • Use Case 1: Set the total compliance to zero (do not use any correction)
	   • Use Case 2: Set the total compliance to a user-defined value
	
	The total amount of the torsional compliance is calculated based on several components:
	   - measuring system (upper)
	   - measuring system (lower)
	   - measuring cell
	   - motor (upper)= 0.00160 rad/Nm (MCRxx1, MCRxx2)
	   - motor (lower)= 0.00160 rad/Nm (MCRxx1, MCRxx2).
	
	Measuring system and measuring cell compliance are defined in the software, whereas the motor compliance(s) is/are defined in the rheometer.
	
	The torsional compliance of the measuring system is also used for the motor controller. Therefore it is advisable not to set the value of the measuring system to zero, but to use the 'Override set torsional compliance' instead.

Piezo compensation	Use this option to disable the Piezo if required.
Shear stress controller (rotation)	Use this controller to fine tune the shear stress dynamics. Without activating the controller action the best possible setting is chosen by the device (recommended). Typical use case: Dynamic control of the sample shear stress for creep testing or flow curves in shear stress control mode. Recommended for low viscosity liquids (water or similar) only.
Torque booster	Use this parameter to enable or disable the Torque Booster. Typical use case: Step tests of ultra stiff materials in rotational mode. With the Torque Booster 'off' the maximum torque in rotation is limited to avoid permanent torques above 150 mNm (curing reactions, etc.).
TruGap™	Use this parameter to enable or disable the TruGap function. Typical use case: Disabled for disposable measuring systems (cap plates, etc.)
TruHarmonics (oscillation)	Use the **Measurement** action to **Define the higher harmonics**. With the option **TruHarmonics On** the higher harmonics are **Actively controlled**. Minimum required firmware is 4.20.
TruRate™ (rotation, rate control)	Use this controller to fine tune the shear rate controller in rotational tests. Without activating the controller action the best possible setting is chosen by the device (recommended). Typical use case: MCR10x.

Name of setting	Function
TruRate™ (rotation, strain control)	Use this controller to fine tune the strain controller in rotational tests. Without activating the controller action the best possible setting is chosen by the device (recommended). Typical use case: MCR10x.
TruStrain™ (oscillation)	Use this parameter to enable or disable the TruStrain function. Without activating the controller action the best possible setting is chosen by the device (recommended). Typical use case: Disabled TruStrain for oscillatory measurements below frequencies of 10e-4Hz.
TwinDrive	Use this parameter to activate a special **TwinDrive mode**. Without activating the controller action the separate motor and transducer is activated (recommended). Other use cases: Counter-movement mode.

5.13 Action View

The **View** action is used to show any view of the project during test execution.

Special settings in the details pane:

In <**Name, Info**> the **Name of the action** and the **Info** shown when the mouse cursor is over the action should be defined.

In <**View**> any view of the Project is selected. The view is then shown during test execution. A **View action** change can be used multiple times. e.g. to show the **Diagram** while measuring and the **Report** after the test has been finished.

5.14 Action Wait

Use the action **Wait** to define a waiting time based on any condition.

Special settings in the details pane:

1. In <**Name, Info**> the **Name of the action** and the **Info** shown when the mouse cursor is over the action should be defined.

2. In <**Picture, title, buttons**> the following items can be defined:

•   **Picture** to be shown in the bubble of the action

•   **Title text** of the action

•   **Buttons**

-   **Abort test**: Show this button to allow any user to abort a test
-   **Skip**: Show this button to allow any user to skip the **Current action** and proceed with the next action

- **Continue**: Show this button to prompt any user to press the button continue in order to execute the defined function. Use case: Wait for Continue until moving to the measuring position.

3. In <**Instruction**> an instruction is defined to be displayed in the bubble during runtime.

4. In <**Wait Condition**> the condition is defined. There are five conditions:
Define a waiting time until:

I.   **A time delay is reached**.

II. The button **Continue** is pressed.

III. A **Time of day or date is reached**.

IV. **A value condition is fulfilled**: Use this option to define a waiting time until a value condition is fulfilled. Select one of the following conditions:

   • Most reasonable conditions:

Fig. 5 - 32   Value within tolerance

   • List box with possible conditions:

Fig. 5 - 33   All conditions

   • Typical variables for conditions:
   - Temperature
   - Normal force
   - Humidity

V.   **T-Ready™ is reached**. In combination with a TruGap™ measuring system this option can be used to start a test automatically whenever the sample temperature is reached. The T-Ready™ status indicates that the sample temperature equals the set temperature.

6 Test Definition

The test definition is a sequence of steps always beginning with the action "Start" (see also *"Ch 5.1, Action Start"*) and ending with the "End". All other steps, i.e. the actions, are inserted in a suitable order into this frame. If you have chosen one of the predefined project templates delivered with the RheoCompass™, your project will already contain a view with a basic test definition including a measurement action with parameters that match the selected project type.

6.1   Creating and Editing a Test Definition

To generate a new test definition, follow all the steps described below. If you want to edit an existing one, skip directly to step 2.

1. In a project, click the button. This will generate an new empty view as the last tab.

2. Make sure that the ribbon **"Window"** is selected and click the button **"New test definition"**. You will now see a test definition containing the **"Start"** and **"End"** actions.

3. Click the toolbox button to display the available actions.

4. Drag the required actions to a suitable position between the start and end actions. The position of the actions may be changed at a later time by dragging them up or down within the test definition. To scroll through the actions, use the mouse wheel or point to the arrow up / down symbols in the test definition.

5. Each action contains an info-pane with several tabs specific to the action type. The tab "Name, Info" is available in all actions as it is used to enter information that describes the function of the action or give instructions to the user. Please see the following chapter, *"Ch 6.1.1, Entering Additional Information About the Action (Tabs "Name, Info" and "Remark")"* for details.

6.1.1 Entering Additional Information About the Action (Tabs "Name, Info" and "Remark")

The entries in the tab **"Name, Info"** are shown in the text field of the action (field under the action type) and in the quick info that is shown once you point the mouse onto the action. Use the action name field (the small field to the left) for a short and concise name for the action. This text is permanently visible, and it should be short enough to fit entirely into the width of the action. The mouse-over text can be used to give the operator more details about what the action is doing. This text will only be visible, if you point the mouse onto the action.

The text entered in the tab **"Remarks"** is visible, if you point the mouse to the relevant analysis step in the bubble. This can be used for additional details about the analysis or as a "note-to-self" for the person responsible for the templates.

7 Analysis Methods, Macros and Steps

There are two ways of analyzing test results:

1. Automated, by adding an Analysis action to the Test definition

- Use this option for QC tasks whenever the same analysis is required directly after the measurement

2. Interactive, by selecting a curve or a part of the curve and clicking the Calculator icon in the ribbon

- Use this option for flexible analysis of curve data now and then

Details 1

This is the general model of an analysis action that is part of an automated test definition.

Design	
	Example: Analysis action with a **Method** used for **Rearranging (Merging)** the incoming data in a first step. The merged data is then used as input data in the second step, which contains a more **Application**-based **Macro** for the **Yield-stress** analysis
Input data	Click link to define the input data, or drag and drop to input
Result data	Click link to define the result data
Step	**Step** number of the **Analysis action**. An Analysis action contains one or multiple steps
Method	Basic analysis method
Macro	A ready to use Analysis macro consisting of one or more analysis methods. The Macro is more Application-oriented, whereas the Method is the Basic mathematical model and is used in all Macros with application-specific presets.

Details 2

See Joe Flow for more details and examples.

7.1 Working with Methods and Macros in Practice

Interactive curve analysis within the diagram

Analysis macros are started by selecting a curve in the diagram (Fig. 7 - 1). With a double-click all measuring points are selected. A part of the curve is selected by single-clicking and dragging or by using the Shift key.
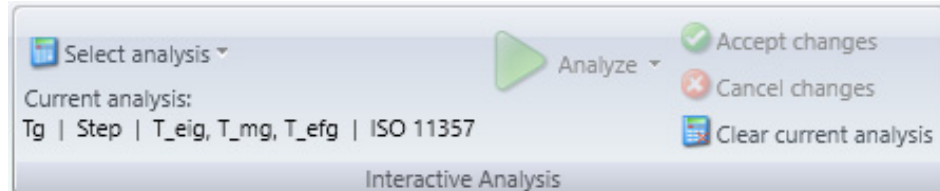
Fig. 7 - 1   Interactive analysis ribbon

The calculator icon in the curve ribbon is used to select the appropriate analysis macro or an analysis step from a test definition of the project. Click the Start button to start the analysis of a single curve of click the start batch mode to analyze multiple curves simultaneously. The regressed curve is presented immediately together with the parameters in the diagram legend (*Fig. 7 - 2* with example of Tg step analysis in Edit mode).

Edit mode:

For certain analyses, such as the **Tg analysis**, the diagram is initially in edit mode. In edit mode, the selected curve area can be adjusted by dragging the circular markers.

A further click on **Accept changes** completes the analysis and takes over the evaluation data. **Cancel** changes allows you to leave editing mode without saving the analysis data.

Ancillary elements:

Ancillary elements are displayed for certain analysis together with an analysis result text. They serve as ancillary constructs of the calculated points.).
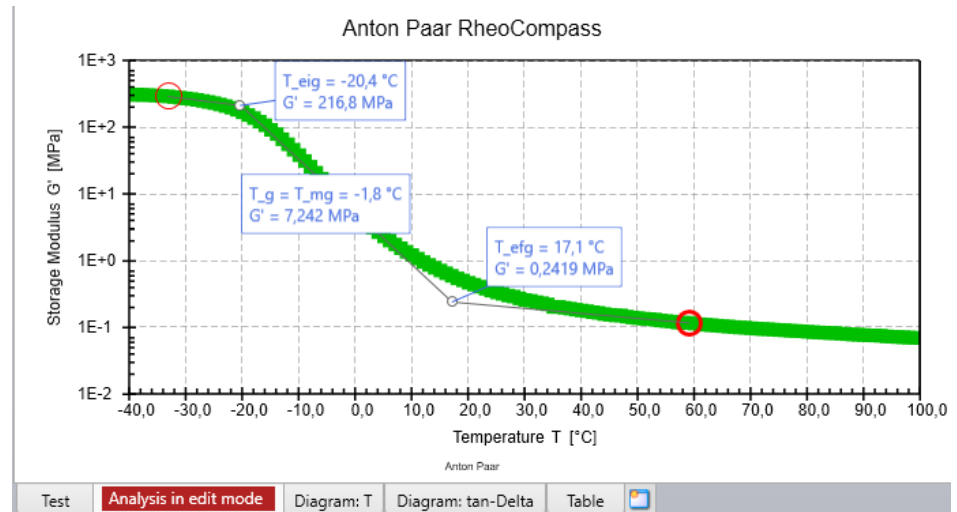
Fig. 7 - 2   Diagram with legend and analysis

For further information, the analysis result is selected in the data tree of the navigation pane. The **Details pane** is then showing the corresponding regression long result in the **Result details** (*Fig. 7 - 3*). Alternatively, the analysis result is presented in the report window (*Fig. 7 - 7*).

Fig. 7 - 3   Analysis long result

Automated analysis as part of the test definition

The same settings are often used for a series of measurements. In such cases, it is advisable to define an automated run using the test-designer toolbox 🛠 in the navigation pane or to add a new action from the ribbon.
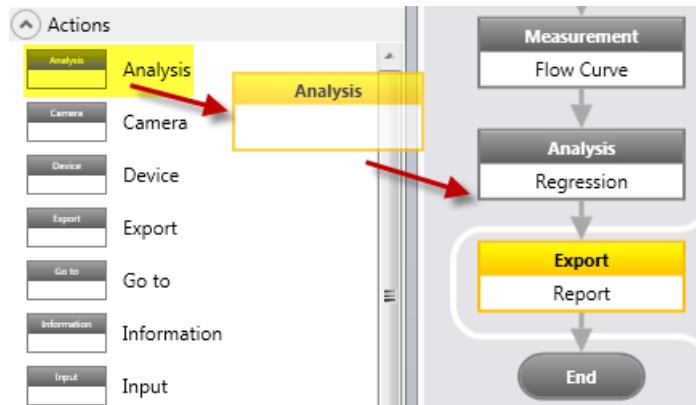
Fig. 7 - 4   Adding an analysis action to the test definition

Simply drag and drop the analysis action to the test definition. Then add the required analysis steps or macros to the analysis action and define the input data using the placeholder <next test>. The measurement and analysis are executed fully automatically once the 'next test' has been started.

If the analysis fails for any reason, use the interactive analysis by selecting a curve in the diagram (*Fig. 7 - 1*) to re-start a single analysis action contained in the test definition. Instead of the macros, select the analysis contained in test definition which is now listed after expanding the lower part of the list box (*Fig. 7 - 5*).
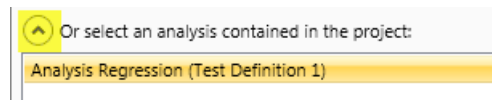
Fig. 7 - 5   Interactive analysis using the analysis actions of a test definition.

This routine is also used to develop and optimize a new analysis action before starting the test.

Presentation of Analysis Results in the Report

The analysis result of an automated test as well as any other information is easily presented in a report window. Use the 'Data' icon to add an analysis result to a report window.
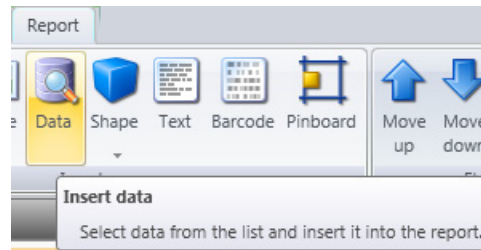
Fig. 7 - 6   Add data element to report

Choose the parameters presented in *Fig. 7 - 7* to show the analysis short result text. By using the placeholder <Next test>, the report is up to date with the results of the latest measurement.
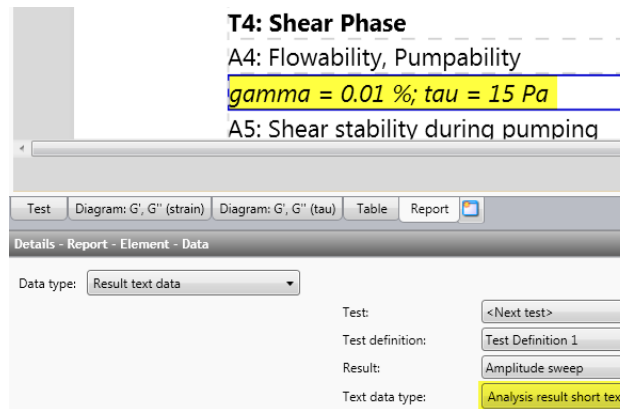
Fig. 7 - 7   Parameters of the data element showing the analysis short result

How RheoCompass Experts Define Analysis Macros

As a RheoCompass expert you may wish to define your own analysis macro. This is easily done within the 'Macro Designer' of RheoCompass, as the following example shows:

Let's assume you are in the main category 'Project' of RheoCompass and a measuring curve in the diagram is selected for analysis of the interpolated viscosity at the shear rate 25 s^{-1} (see *Fig. 7 - 1*). There are predefined macros listed in each project, filtered by the test type of the project, but the one you are looking for is missing.

For creating your own macro, open the main category <RheoFinder>, expand <More> and select the item **Macros (for analysis)**.

Next click **New** in the ribbon **Home** to create a **New macro**. Insert an existing Anton Paar macro from the ribbon **Analysis** (click the expander to see the list of predefined analysis macros). Check 'incompatible' to disable filtering if the macro you are looking for is not part of the list. Now click **Convert to steps** to see the single analysis steps of the Anton Paar macro. Some macros only contain one step.

In this example, the original macro consists of two steps. Step one is the interpolation itself, while step two formats the resulting data and defines the variables for the final result. Change the parameters of the macro, e.g. from shear rate 10 s^{-1} to 25 s^{-1} (*Fig. 7 - 8*).
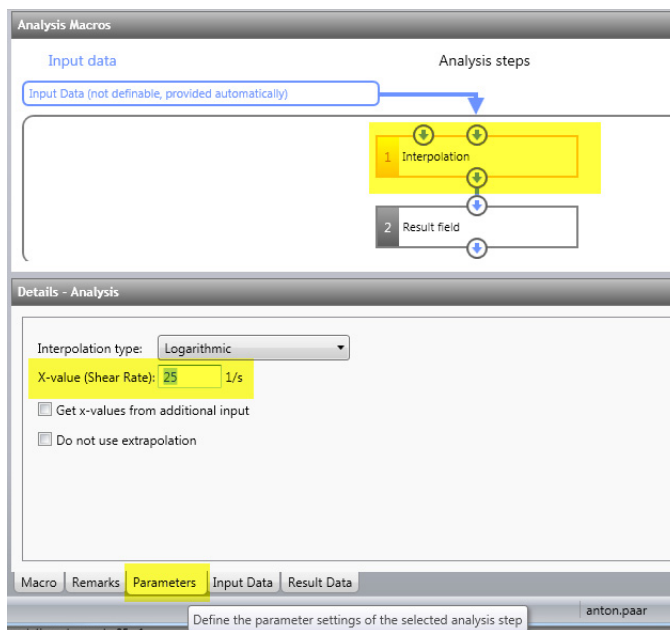
Fig. 7 - 8   Editing parameters for the analysis steps.

Now enter the macro name, e.g. 'Interpolation, shear rate 25 s^{-1}' in the 'Macro' tab. The name can be changed at any time in RheoFinder (*Fig. 7 - 9*), where you also have the option to assign a test type to the macro for further filtering, which is used in most projects.

Fig. 7 - 9   Save new analysis macro as your own macro.

The macro is then available for interactive analysis in the project, as presented in *Fig. 7 - 9*.

7.2   Analysis Methods

A **Method** is the **Basic analysis model**. The more application-oriented **Macros** are often used instead of a **Method**. A **Macro** contains one or more **Methods**.

Compared to a **Method**, which offers many parameters for tweaking, a **Macro** is ready to use and has only a few parameter settings, or even none at all.

Special settings in the details pane:

1. In <**Name, Info**> the **Name** and a **Description**, which is shown when the cursor is over the action, should be defined.

2. Use the tab <**Remarks**> to define the information text for each step.

3. In <**Parameters**>, all parameters for the mathematical model are defined. The **Parameters** tab may contain further tabs with special settings on the right-hand side of the window. Check all parameters before use.

4. Use **Input data** to define the input data of the **Method** or drag and drop input.

5. Use **Result data** to define a result name or to define a result as temporary data to be used as input data for other steps. Insert placeholders to predefine an automated name that reflects the test input and information.

6. <**Text results**>

- Check the option to **Show parameter settings** in case the parameter settings need to be documented with the analysis result or printed as a report.

Examples of basic analysis **Methods**:

Curve derivatives	Calculates the derivatives of a curve. The 1st derivative is saved in variable X, the second in variable Y.
Curve inflection points	Calculates the inflection points of a curve.
Curve maximum	Calculates the curve maximum.
Curve minimum	Calculates the curve minimum.
Curve slope	Calculates the curve slope between the first and the last input data point after sorting the input data ascending by the x-value.
Envelope	Calculates the tolerance envelope for a device.
Equation editor	Used for defining equations and calculating the result values of these equations for each input data point.

A **Method** in the analysis action:
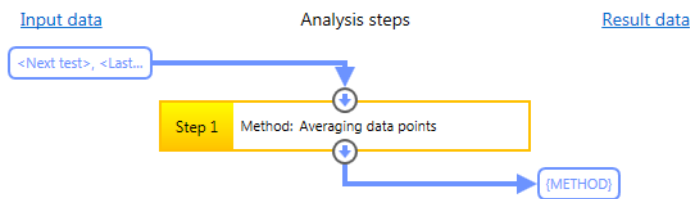
An example of Macro-specific **Parameters** (yellow):
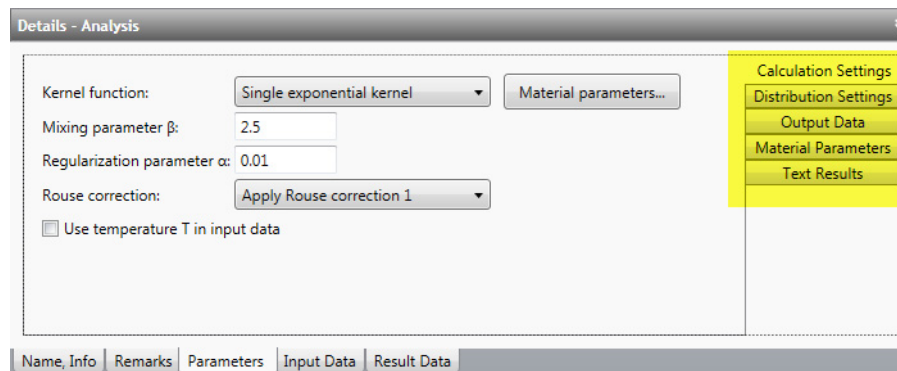
7.2.1   Overview of the Analysis Methods

7.2.1.1   Three-Interval Thixotropy Test (3ITT)

This method is used to analyze structure recovery of a sample after a sudden shear load.

<Intervals>

Select the interval test type. The **rest interval 1** and **recovery interval 3** simulate the sample at rest, and therefore a low shear rate or oscillatory shear is applied. The **load interval 2** is the application interval, in which the application process is simulated by putting the sample under high shear conditions, or by applying an oscillatory shear with larger strain and frequency than in the LVE region. The following are example sequences of 3ITT tests

- I1: Rotation -> I2: Rotation -> I3: Rotation

- I1: Oscillation -> Rotation or Oscillation -> Oscillation

If the intervals are not 1, 2 and 3, then enter the correct intervals accordingly.

\<Steady-state check\>

Optional steady-state check in the rest interval to detect unsteady sample behavior such as:

- Recovery due to gap setting
- Recovery due to previous shear
- Skin formation due to evaporation of liquid/solvent phase

\<Calculation\>

Select one of the following calculation modes for analyzing sample properties:

Calculation mode for recovery interval:	Calculate recovery ratio after a given time
	Calculate recovery ratio after a given time
	Calculate y-difference
	Calculate time for a given recovery ratio
	Calculate time until G'=G"
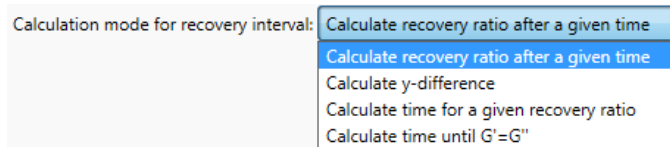
1. Calculate recovery after a given time

   - The recovery ratio in [%] is calculated for a predefined time.
   - **Recovery ratio = Actual value of recovery interval / steady-state value in the rest interval**

2. Calculate y-difference

   - The actual value of the recovery interval is compared to the first value in the recovery interval
   - Variable in oscillatory shear: G'
   - Variable in steady shear: Eta

3. Calculate time for a given recovery ratio

   - The time is calculated until the **recovery ratio** reaches a certain [%] value.
   - **Recovery ratio = actual value of recovery interval / steady state value in the rest interval**
   - This method does not work if the ratio is not achieved
   - Variable in oscillatory shear: G'
   - Variable in steady shear: Eta

4. Calculate time until G'=G"

   - The time is calculated until G'=G"
   - This method does not work if no cross-over is found

7.2.1.2 Asphalt Fail Temperature

This method is used to calculate the fail temperature during a grading test

<Calculation>

- Select the AASHTO test type:

  - AASHTO T315 Original binder
  - AASHTO T315 RTFO
  - AASHTO T315 PAV

- Limit:

  - Definition of the limiting value for the verification criterion.

- Number of first input result (in descending order = e.g. for a value 5 it is the 5th counted from the last result)

- Number of the second input result (in descending order = e.g. for a value of 1 is the last result)

7.2.1.3 Asphalt Linearity

This method is used to determine:

- the critical strain at the end of the linear viscoelastic region (LVE-range)
- the critical strain is found at the end of the G' plateau

The method is similar to a determination of LVE range.

<Calculation>

Define the number of data points to be used for determining the LVE range. If there are more data points in the measuring profile than defined, then the last input data points are used for the calculation.

<Temperature>

- **Temperature Offset**

  - Enter the value for a temperature offset; Default value is 0°C

- **Target Temperature**

  - **Auto**: A list with typical asphalt measuring temperature in [K] is selected
    - Default values in [K]:
    - 274.15; 277.15; 280.15; 283.15; 286.15; 289.15; 292.15; 295.15; 298.15; 301.15; 304.15; 307.15; 310.15; 313.15; 316.15; 319.15; 322.15; 325.15; 331.15; 334.15; 337.15; 343.15; 349.15; 355.15; 361.15
  - **Manual**: Enter any user-defined temperature value.

7.2.1.4   Asphalt MSCR

This method is used to determine the rutting resistance and damage tolerance of asphalt binders according to **AASHTO T350-14** or **FGSV 723**

<Calculation>

Set the default parameter for the standard **AASHTO T350-14** or **FGSV 723**. If used with the correct project templates, all parameters will be predefined in compliance with the measurement action.

- Load levels:

  - Depending on the selected standard the Load levels are defined

- Number of intervals to skip

  - Value of number of intervals to be skipped used for preconditioning and not used in the calculation

- Number of conditioning cycles

  - Value of number of conditioning intervals not used for the calculation

- Number of cycles per load level

  - Value for number of load intervals used for the calculation

- Creep phase duration

  - Value for duration of the creep phase

- Recovery phase duration

  - Value for duration of the recovery phase

7.2.1.5   Asphalt Original Binder

This method is used to verify the originality of an asphalt binder in accordance with AASHTO T315-12

<Calculation>

- **Number of data points**:

  - Define the **Number of data points** to be used for detection of the LVE range. If there are more data points in the measuring profile than defined, then the last input data points will be used for the calculation.

- **Passed criterion**:

  - Select the passed criterion for the verification of the sample.
  - The criterion is predefined in the project template and should not be changed.

- **Limit**:

    - Definition of the limiting value for the verification criterion.

<Temperature>

- **Temperature offset**

    - Enter the value for a temperature offset; Default value is 0 °C

- **Target temperature**

    - **Auto**: A list with typical asphalt measuring temperature in [K] is selected
    - **Manual**: Enter any user defined temperature value.

7.2.1.6   Asphalt PAV

This method is used to verify that PAV aged asphalt binder is in accordance with AASHTO T315-12

<Calculation>

- **Number of data points**:

    - Define the **Number of data points** to be used for the detection of the LVE range. If there are more data points in the measuring profile than defined, then the last input data points will be used for the calculation.

- **Passed criterion**:

    - Select the passed criterion for the verification of the sample.
    - The criterion is predefined in the project template and should not be changed.

- **Limit**:

    - Definition of the limiting value for the verification criterion.

<Temperature>

- **Temperature offset**

    - Enter the value for a temperature offset; the default is 0°C

- **Target temperature**

    - **Auto**: A list with typical asphalt measuring temperature in [K] is selected
    - **Manual**: Enter any user defined temperature value.

7.2.1.7   Asphalt RTFO

This method is used to verify that RTFO aged asphalt binder is in accordance with AASHTO T315-12

<Calculation>

- **Number of data points**:

  - Define the **Number of data points** to be used for the detection of the LVE range. If there are more data points in the measuring profile than defined, then the last input data points will be used for the calculation.

- **Passed criterion**:

  - Select the passed criterion for the verification of the sample.
  - The criterion is predefined in the project template and should not be changed.

- **Limit**:

  - Definition of the limiting value for the verification criterion.

<Temperature>

- **Temperature offset**

  - Enter the value for a temperature offset; the default is 0°C

- **Target temperature**

  - **Auto**: A list with typical asphalt measuring temperature in [K] is selected
  - **Manual**: Enter any user defined temperature value.

7.2.1.8   Averaging Data Points

This method is used to calculate the average among all **Input data** points of a single test **Result**

Note: The average is built from all motor variables such as torque and deflection angle. The average of the motor variables is then used to calculate **All application variables**. Thus, the value of the viscosity is not equal to the average of all viscosity values. To calculate the average of a rheological variable, use the particular **Macro** (e.g. **Averaging viscosity, over data points**)

<Calculation>

Mode:

- **Averaging over all data points** within an interval **(Default)**

The average is calculated by averaging all data points within an interval

This is done for each interval separately

- **Averaging over *n* data points**

The average is calculated by averaging over the first *n* data points, then over the next *n* points, etc.

- **Averaging over the *n*th data point** of each interval

The averaging is calculated by averaging the 1st data point of all intervals, the 2nd data point of all intervals, etc.

Average Type:

•   **Arithmetic mean (Default)**

  -   Use arithmetic mean when numbers just add up

•   **Geometric mean**

  -   Use geometric mean when numbers multiply together

•   **Quadratic mean**

  -   Use quadratic mean when the squares of the numbers add up

•   **Standard deviation**

  -   Use standard deviation to calculate the square root of the variance

Other:

•   **Save all averages into one single interval**

  -   Use this option for **Results** with multiple intervals ensure all results are saved in just one interval instead of the number of original intervals of the **Input** data.

More Information

Drag and drop test to the multi-input symbol:
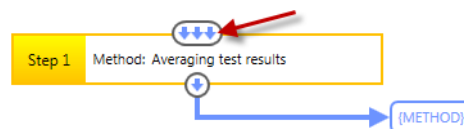
7.2.1.9   Averaging Test Results

Use this method to calculate the average among all data points from multiple test results

Note: The average is built from all motor variables such as torque and deflection angle. The average of the motor variables is then used to calculate **All application variables**. Thus, the value of the viscosity is not equal to the average of all viscosity values. To calculate the average of a rheological variable, use the particular **Macro** (e.g. **Averaging viscosity, over data points**)

<Calculation>

Average Type:

•   **Arithmetic mean (Default)**

  -   Use arithmetic mean when numbers just add up

- **Geometric mean**

  - Use geometric mean when numbers multiply together

- **Quadratic mean**

  - Use quadratic mean when the squares of the numbers add up

- **Standard deviation**

  - Use standard deviation to calculate the square root of the variance
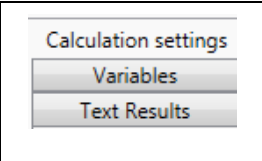
Example:

Average 1 = (Data point 1 of Result 1 + Data point 1 of Result 2 + Data point 1 of result 3 + .../ number of results)

Average 2 = (Data point 2 of Result 1 + Data point 2 of Result 2 + Data point 2 of result 3 + .../ number of results)

7.2.1.10   Basic Operations

Use this method to modify a variable or the values of a variable

Method specific tabs at the right hand side of the Details pane: - For more Details see bullet points below	Calculation settings Variables Text Results

<Calculation>
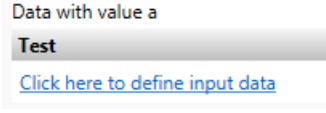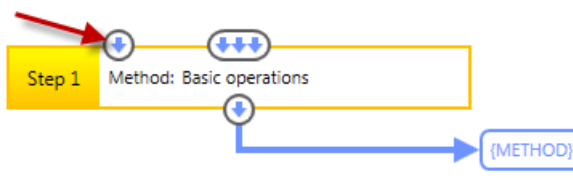
Mode:

1. Use a **Fixed operant**

- Example: Add a fixed value to the viscosity variable; eta = eta + 2.5 with a = 2.5)

- **Calculation**:

  - Addition: x + a
  - Subtraction: x - a
  - Multiplication: x * a
  - Division: x / a
  - Absolute value |x|
  - Natural logarithm: ln(x)
  - Exponential: e^x
  - Common logarithm: log(x)
  - Exponential: 10^x
  - Square root: x^0.5
  - Power function: x^a
  - Normalizing to 1st point: x / x1
  - Normalizing to maximum of all points: x / x_max

- **Origin of value a** (depending on the selection of **Calculation** operant, **a** is visible):

  - **Value a is given as fixed parameter**
    - **Enter** the value **a** as a **Fixed parameter** in the **Calculation settings**
  - Take value **a** from data on additional input
    - **Define** a **Side input** containing a single data point

Use the <Input> tab	Data with value a **Test** Click here to define input data
or use drag and drop	Step 1 Method: Basic operations {METHOD}

  - **Variable selection**
    - Value of **variable** is **Identical** to parameter **Input variable**

      ✂ This is the standard case with e.g. a = eta and x = eta

  - **Variable** of value a is freely **Selectable**

      ✂ Use this case for special operations, e.g. a = ratio and x = tan(delta)

2) **Apply calculation** between **Two Results** defined as **Input** data

- Example: Subtract viscosity of measurement 2 from viscosity of measurement 1; eta(result 2) - eta(result 1)

- Calculation:

  - Addition: x1 + x2
  - Subtraction: x1 - x2
  - Multiplication: x1 * x2
  - Division: x1 / x2

<Variables>
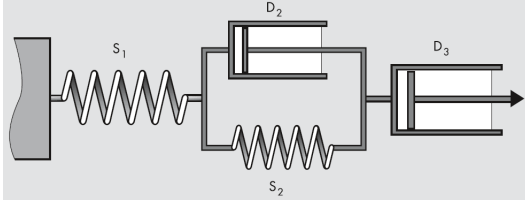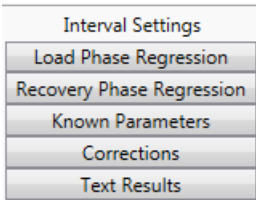
- **Variables mode**:

  - **Apply the calculation to all input variables**
    - This option is only available for the calculation using a fixed operant
  - **Apply the calculation to only the selected input variable**
    - Use this option to apply the calculation to a predefined single variable, here called **Input variable**
    - Optionally, the variable can be saved as a new variable

      ✂ Example: Apply calculation to tau, where tau = tau * a but save it as G'

    - Another option is to **Save all other variables from Input data** that are not defined for the calculation in the **Result data**

7.2.1.11 Creep

Use this method to calculate a regressed curve for the creep and recovery interval based on a Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance.

Creep regression is mainly used to analyze polymer melts and polymer solutions.

Burgers model	
Method-specific tabs on the right-hand side of the Details pane: - For more details, see bullet points below	

<Intervals>

• Select the **Interval** number of the **Load** phase and the **Recovery** phase.

• Make sure the load interval 1 starts at t = 0 s and the deflection angle is reset at interval start in the interval settings of the measurement action.

• If the creep phase is over several intervals then the intervals must be separated by semicolons, e.g. 1;2;3 for the creep phase and 4;5;6 for the recovery phase.

<Load phase>

The creep phase can be divided into three sections, as shown in the parameter dialog box. Check the regions you would like to be calculated. If no creep interval has been defined above, all regions need to be unchecked.

General:

Most creep curves show the following curve regions:

• Instantaneous compliance

  • jump-like, purely elastic deformation occurring immediately after the start of the test
  • elastic response
  • the spring S1 in the Burgers model

- Viscoelastic compliance

  - delayed viscoelastic deformation
  - viscoelastic response
  - the spring S2 together with the dashpot D2

- Newtonian compliance

  - a purely viscous deformation
  - viscous response
  - the dashpot D3

Settings of the load phase:
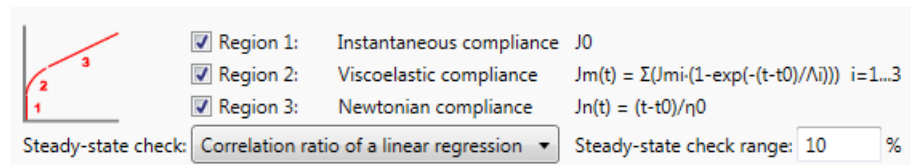
	☑ Region 1:	Instantaneous compliance	$J0$
	☑ Region 2:	Viscoelastic compliance	$Jm(t) = \Sigma(Jmi \cdot (1-\exp(-(t-t0)/\Lambda i)))$ $i=1...3$
	☑ Region 3:	Newtonian compliance	$Jn(t) = (t-t0)/\eta0$

Steady-state check: Correlation ratio of a linear regression ▾ Steady-state check range: 10 %

User-specific settings:

- Uncheck region if it is not represented by the measured curve
- Set the range for the steady-state check in the last part of the creep curve (default = 10 %)
- Define the steady-state check condition

Steady-state check:

This analysis method checks whether a steady state has been reached at the end of the creep phase. It is also possible to disregard this check by choosing the option 'No Steady-State Check'.

Methods for determining steady state:

- Correlation ratio of a linear regression gamma(t) = f(t)

This method calculates a linear regression on the last data points of the creep phase (strain vs time curve). The number of data points is defined in the text box 'Region Size'. The region size gives the number of points as a percent of the total number of points during the creep phase. 10 % is recommended as a default value. The criterion for the steady state is that the correlation ratio of the regressed data approaches 1. The boundary value is 0.997.

- Slope of a linear regression log(J(t)) = f(log(t))

With this method, a linear regression is done on a logarithmic curve of the compliance as a function of time. As with the previous method, the data points at the end of the creep curve are used. The value for 'Region Size' gives the number of points for the calculation as a percent of the total number of points during the creep phase. 10 % is recommended as a default value. The criterion for the steady state is that the correlation ratio of the regressed data approaches 1. The boundary values are 0.95 and 1.05.

- Slope changing between adjacent time windows

For this method, the creep curve is divided into the given number of sections (time windows) and a linear-regression curve is calculated for each section. The change of slope from each section to the next is compared. Steady state has been reached if the change of slope approaches zero. The boundary value is 0.1.

<Recovery phase>

Check the regions you would like to be calculated for the recovery phase. If no recovery phase has been defined above, all recovery regions will need to be unchecked.

General:

Most creep curves show the curve regions:

- Instantaneous compliance

  - jump-like, purely elastic deformation occurring immediately after the start of the test
  - elastic response
  - the spring S1 in the Burgers model

- Viscoelastic compliance

  - delayed viscoelastic deformation
  - viscoelastic response
  - the spring S2 together with the dashpot D2

Settings of the load phase:
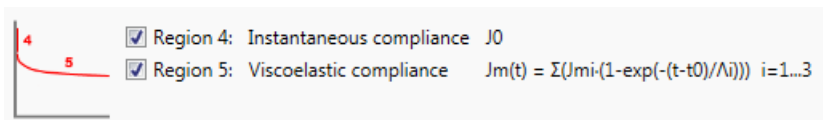
User-specific settings:

- Uncheck region if it is not represented by the measured curve.
- Set the range for the steady-state check in the last part of the creep curve (default = 10%)
- Define the steady-state check condition

Steady-state check:

This analysis methods checks whether a steady state has been reached at the end of the creep phase. It is also possible to disregard this check by choosing the option 'No Steady State Check'.

Methods for determining steady state:

- Correlation ratio of a linear regression gamma(t) = f(t)

This method calculates a linear regression on the last data points of the creep phase (strain vs time curve). The number of data points is defined in the text box 'Region Size'. The region size gives the number of points as a percent of the total

number of points during the creep phase. 10 % is recommended as a default value. The criterion for the steady state is that the correlation ratio of the regressed data approaches 1. The boundary value is 0.997.

- Slope of a linear regression $\log(J(t)) = f(\log(t))$

With this method, a linear regression is done on a logarithmic curve of the compliance as a function of time. As with the previous method, the data points at the end of the creep curve are used. The value for 'Region Size' gives the number of points for the calculation as a percent of the total number of points during the creep phase. 10 % is recommended as a default value. The criterion for the steady state is that the correlation ratio of the regressed data approaches 1. The boundary values are 0.95 and 1.05.

- Slope changing between adjacent time windows

For this method, the creep curve is divided into the given number of sections (time windows) and a linear-regression curve is calculated for each section. The change of slope from each section to the next is compared. Steady state has been reached if the change of slope approaches zero. The boundary value is 0.1.

\<Known parameters\>

In case any of the variable values given in this section are known, the parameter can be checked, and the value entered.

Define fixed sample parameter:

☐ J0:	☐ Jm1:	☐ Λ1:
☐ Jmax:	☐ Jm2:	☐ Λ2:
☐ η0:	☐ Jm3:	☐ Λ3:
☐ t0 load:	☐ t0 recovery:	

\<Corrections\>

Set parameters for corrections of the creep and recovery intervals:

- **Set shear stress to 0 in recovery interval (default = checked)**

  The initial part of the recovery interval may show a few outliers. Check this option to correct these points and set all stress values to zero in the recovery phase.

- **Set creep compliance to 0 in recovery phase**

  If this box is checked, all $J(t)$ values in recovery phase are set to 0. This has an advantage in a log-log diagram with t_int on the X- and $J(t)$ and $Jr(t)$ on the Y-axis. In such a diagram, $J(t)$ is only shown for the creep phase and $Jr(t)$ is only shown for the recovery phase.

- **Apply the drift correction (Default = checked)**

In case of rotational drift in the recovery interval, check the option **Apply the drift correction**. If the option is activated, the analysis method compensates for a drift in the recovery phase.

The measuring-system drift becomes negligible for samples with high viscosity.

- **Apply strain and J$_{max}$ correction**

  The strain correction is used to correct the time shift. The time shift arises because

- the time stamp of the variable 'time' is identical with the creation time of the measuring point

- but the mechanical and rheological variables are calculated based on the time stamp of averaging.

  Thus, for longer measuring-point durations, with **Averaging** set to **Automatic**, the time stamp of the variable 'time' is not identical with the time stamp of the variable 'Strain'. This difference between the two time stamps is referred to as the time shift.

  Example: The measuring point duration is 10 s. Therefore, the variable 'time' = 10 s. With **Automatic averaging**, the 'average time' is calculated over the last 50 % of the measuring-point duration, in this example, over the last 5 s. The time stamp of the variable 'strain', which is equal to the 'average time', is therefore at 7.5 s. The time shift is 2.5 s.

  ```
  time-----------------------------------------------------------x

  average time----------------------------------x---------------

  strain---------------------------------------x---------------
  ```

  By using **Manual averaging** with the option **Raw values (rotation) over exactly 1**, the last raw data point is taken. As one raw data point lasts for only 1 ms (MCRxx2 series), the time stamp of the variable 'strain' will be at 9.999 s and therefore almost identical to the time stamp of the variable 'time'.

  ```
  time-----------------------------------------------------------x

  average time-------------------------------------------------x

  strain-------------------------------------------------------x
  ```

Additionally, a J_{max} correction is done for the same reason.

For measurements performed with one of the project templates defined in RheoCompass, the three variables time, average time and strain are almost identical (shift <1 ms). This is due to the fact that the averaging of the measuring point is defined over one raw value.

> ☑ Set shear stress τ to 0 in recovery interval   ☑ Apply drift correction
> ☐ Set creep compliance J(t) to 0 in recovery interval
> ☑ Apply strain and Jmax correction
> Time variable used for calculation from measuring data:
> [Average time t_avr (recommended if contained in measuring data)   ▼]
> Measurement settings for 'Averaging' in 'Data Generation': [Setting was 'Over...' ▼]
> Time used for raw value sampling: [0.001   ] s

- **Settings for the time variable**

  - Average time, t_{avr}: The average time, t_{avr}, is taken as the time, and therefore no strain correction is needed. However, a J_{max} correction is still applied. This setting gives the best results, but requires t_{avr} to be contained in the measuring data.
  - Time t: Time t is taken as the time, and both strain and J_{max} corrections are applied. This setting can also be used if t_{avr} is not contained in the measuring data.
  - Averaging in data generation: This setting should comply with the settings in the measurement action of the creep test if the option 'Apply strain and J_{max} correction' is checked. This information is essential for correcting the time stamp.
  - Raw-value sampling: The time over which raw-data sampling is done (only if option 'Setting <Over...>' is selected)

<Test results>

Check the option **Show** additional parameter settings in the case the parameter settings need to be documented with the analysis result or printed as a report.

> ☐ Show parameter settings
> ☑ Show result table for load phase
> ☑ Show result table for recovery phase

Typical Calculations Within the Creep Method:

1. Calculation of mean tau value, tau_0, in the creep phase

2. Calculation of J(t,tau_0) for any point in the creep phase:

- J(t,tau_0) = gamma(t)/tau_0

3. Calculation of J(t) for any point in the creep phase:

- J(t) = gamma(t)/tau_0

4. Calculation of Jr(t) for any point in the creep phase:

- Jr(t) = 0

5. Calculation of J(t,tau_0) for any point in recovery phase:

- J(t,tau_0) = gamma(t)/tau_0

6. Calculation of max. J(t,tau_0) value Jmax of creep phase:

- Jmax = max(J(t,tau_0))

7. Calculation of Jr(t) for any point in recovery phase:

- Jr(t) = Jmax – J(t,tau_0)

8. Creep phase:

- J(t) = J0 + Jm(t) + Jn(t), tau0 = const. > 0

9. Recovery phase:

- J(t) = Jmax – J0 – Jm(t) + Jdrift(t), tau0 = const = 0
- with Jm(t) = SUM(Jm_i·(1-exp(-(t-t0)/Lambda_i)) i=1...3
- Jn(t) = (t-t0)/eta0
- Jdrift(t) = ((t-t0)/tau0)·d(gamma_drift)/dt

The resulting values J0, Jm_i, Lambda_i, eta0 and d(gamma_drift)/dt are calculated separately for the creep and recovery phases from the measured data, according to the equations above. The unknown values can then be determined from these regression parameters:

- Creep phase:

  - gamma0 = J0 · tau0
  - Dn = tau0 / eta0

- Recovery phase:

  - Je0 = J0 + SUM(Jm_i) i=1...3
  - Je = J0 + SUM(Jm_i) i=1...3
  - Jv = Jmax – Je
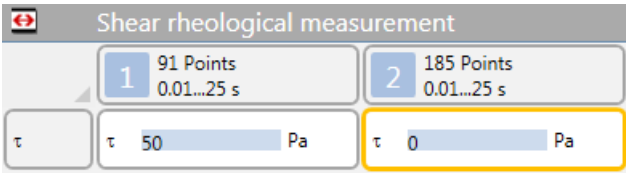
Examples:

Example 1 (recommended) for a creep and recovery measurement with analysis for polymer melts and manual short-term averaging over 1 ms (no effective correction needed, as variable time equals average time):

Measuring profile	
	Shear rheological measurement
	1 91 Points 0.01...25 s **2** 185 Points 0.01...25 s
	τ τ 50 Pa τ 0 Pa

Data generation	
Averaging/Corrections	

Example 2 (not recommended) for a creep and recovery measurement with analysis for polymer melts and auto averaging over 50 % of the measuring-point duration:

Measuring profile	
Data generation	
Averaging/Corrections	

7.2.1.12 Curve Crossover

This method is used to calculate the cross-over between the functions G'(gamma) and G"(gamma).

Method specific tabs at the right hand side of the Details pane - For more details see bullet points below	Modes and X-Variable Y-Variables Text Results

\<Calculation\>

Crossover mode:

- **Crossover of 2 Y-variables** within one data range

    - Example: Select this option to calculate the curve-crossover of G' and G".

- **Crossover of 2 data ranges** (test results) for one Y-variable

    - Example: Select this option to calculate the curve-crossover of G' from two different measurements.

Crossover points:

- Calculate **All** crossover points
- Calculate only the **First** crossover point (default)
- Calculate only the **Last** crossover point

Interpolation:

- Select the interpolation type. The interpolation is use to determine a cross-over not represented by the measuring point before and after the crossover. The default is **Automatic detection**. The detection type depends on the slope and the order of the curve (linear or logarithmic).

\<Variables\>

Define the X-variable:

- Example: Omega, gamma, temperature, time.

Define the Y1-variable and the Y2-variable:

- Example: G' and G"
- There is no need to define the variables by using the interactive analysis.
    - Using the **Calculator** icon in the ribbon with manual selection of data points, the data and the variables are automatically adopted.

Example:

Amplitude sweep with determination of the curve cross-over G'(gamma) = G"(gamma)	
Frequency sweep with determination of the curve cross-over G'(omega) = G"(omega)	
Temperature ramp in oscillation with determination of the curve-cross over G'(T) = G"(T). The meaning of the point depends on the application. In this example of a gelation process, it is equivalent to the gel-point.	
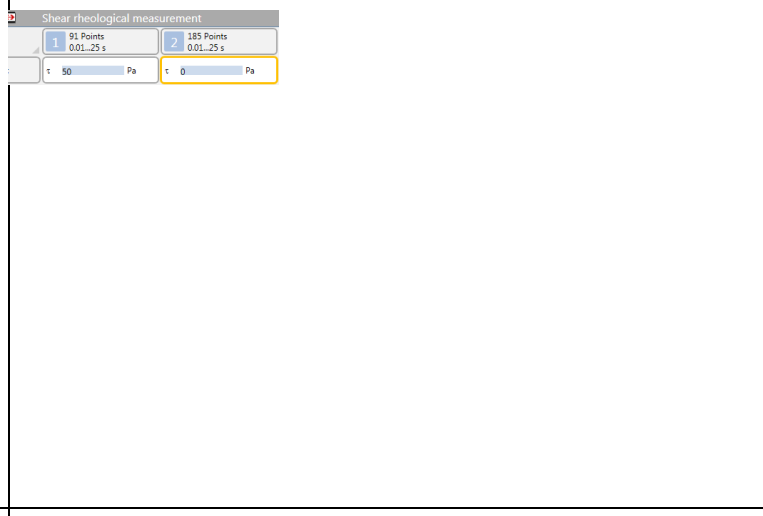
7.2.1.13 Curve Derivatives

This method is used to calculate the **Curve derivatives**.

Method specific tabs at the right hand side of the Details pane - For more details see bullet points below	Modes and X-Variable Y-Variables Text Results

\<Calculation\>

Y-Scaling:

- linear
- logarithmic

Smoothing:

- smoothing with specification of absolute smoothing range

    - not recommended for most rheological measurements

- smoothing with specification of relative smoothing range

    - recommended for fine tweaking the maxima or minima to a known value

- **auto-smoothing with smoothing criterion**

    - **default, recommended setting**
    - smoothing criterion with number of
        - local maxima
        - local minima
        - **inflection points (use this setting with exactly 1 as default; the recommended maximum value is 3)**

Save smoothed curve in result data

- check this option to save the smoothed curve together with the derivative. Saving the curve might help to improve and understand the effect of the smoothing parameter.

\<Variables\>

Define the X-variable and up to three Y-variables:

- Example: T and G'
- There is no need to define the variables by using the interactive analysis.
    - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.

Analysis Results:

The resulting variables are stored as physical variables; X = 1st derivative, Y = 2nd derivative. To see the derivatives in a diagram or table, select the variable group \<all variables\> and scroll to the end of the list. Now insert the X or Y variable and select the Analysis to be displayed in the window.

Example: Presentation of the analysis of the curve derivative.

1st derivative as X variable	
2nd derivative as Y variable	
Curve minimum of 2nd derivative -equivalent to curve onset of G' or Tg	

7.2.1.14   Curve Inflection

This method is used to calculate the **Curve inflection point(s)**.

Method specific tabs at the right hand side of the Details pane - For more details see bullet points below	Modes and X-Variable Y-Variables Text Results

<Calculation>

Y-Scaling:

- linear
- logarithmic

Smoothing:

- smoothing with specification of absolute smoothing range

  - not recommended for most rheological measurements

- smoothing with specification of relative smoothing range

  - recommended for fine tweaking the maxima or minima to a known value

- **auto-smoothing with smoothing criterion**

  - **default, recommended setting**
  - smoothing criterion with number of
    - local maxima
    - local minima
    - **inflection points (use this setting with exactly 1 as default; the recommended maximum value is 3)**

<Variables>

Define the X-variable and the Y-variable:

- There is no need to define the variables by using the interactive analysis.
  - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.

Example: a curve inflection point found with **Logarithmic Y-scaling** and **Auto-smoothing criterion with one inflection point**.

Selection of a narrow range	
Result	
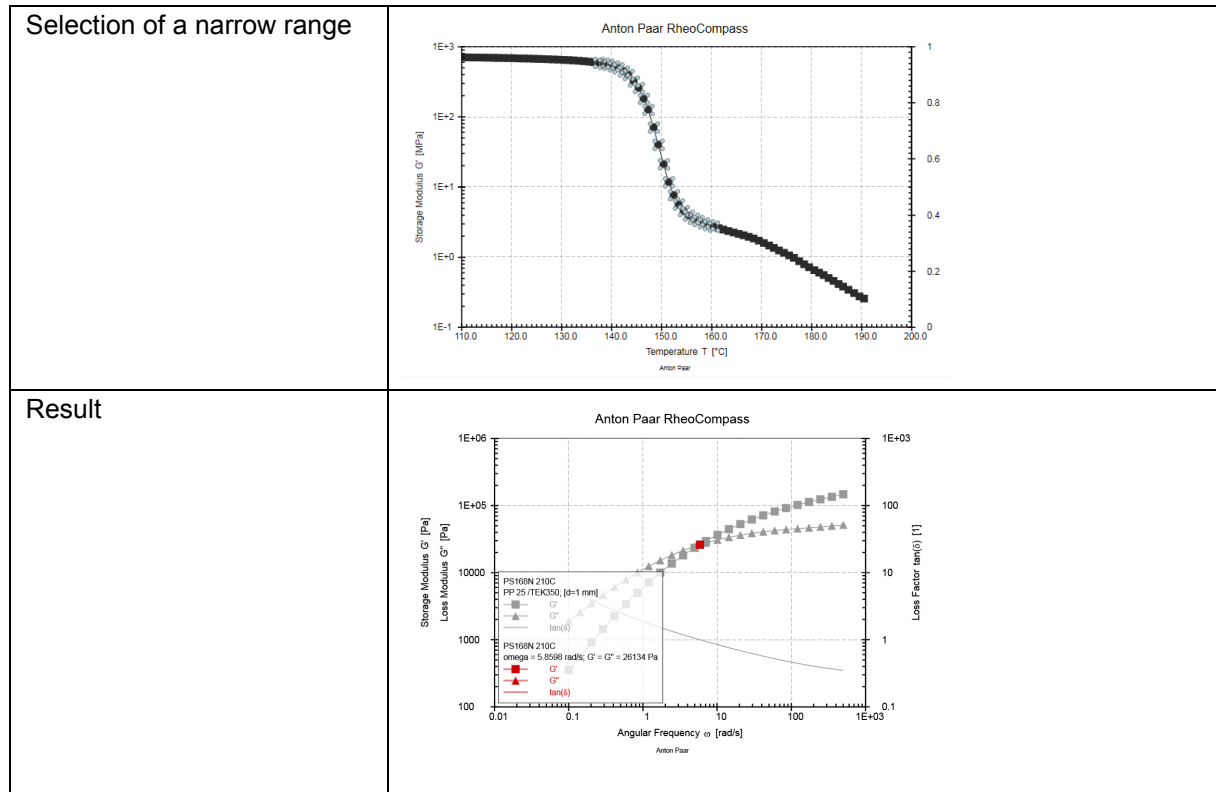
7.2.1.15   Curve Maximum

This method is used to calculate the **Curve maximum**.

Method specific tabs at the right hand side of the Details pane - For more details see bullet points below	Calculation Settings Variables Text Results

<Calculation>

Y-Scaling:

- linear
- logarithmic

Smoothing:

- **no smoothing**

    - **default, recommended setting**

- smoothing with specification of absolute smoothing range

    - not recommended for most rheological measurements

- smoothing with specification of relative smoothing range

    - recommended for fine tweaking the maxima or minima to a known value

- auto-smoothing with smoothing criterion

    - smoothing criterion with number of
      - local maxima
      - local minima
      - inflection points

<Variables>

Define the X-variable and the Y-variable:

- There is no need to define the variables by using the interactive analysis.
    - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.

Example: analysis of the maximum in tan(delta).
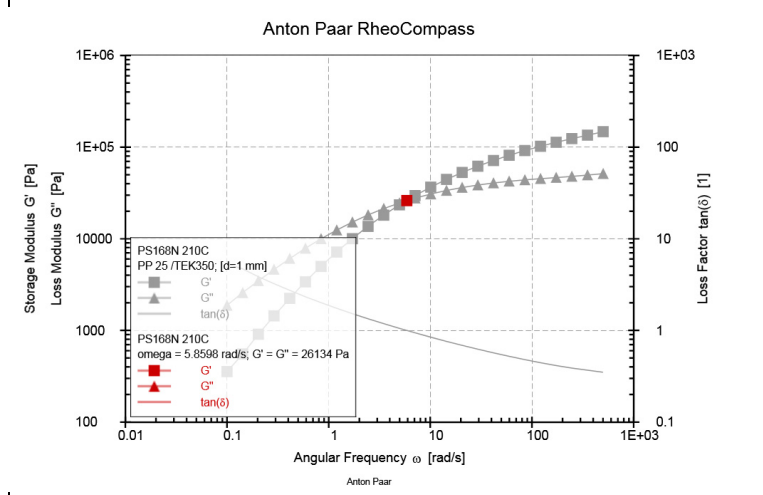
Maximum of tan(delta)	
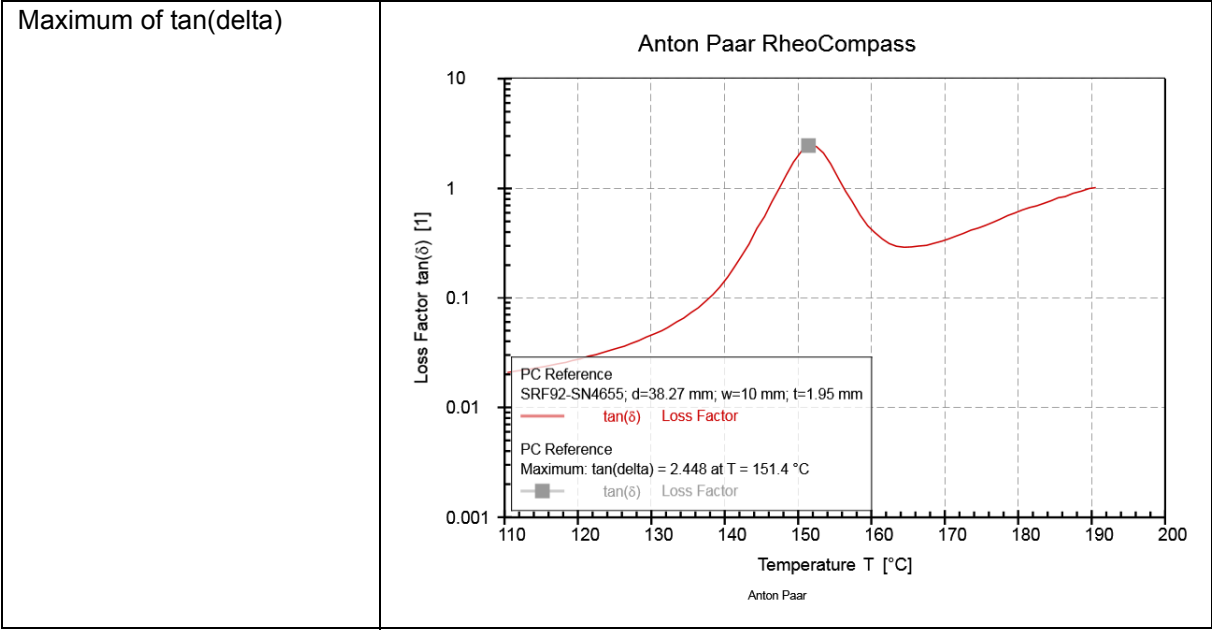
7.2.1.16 Curve Minimum

This method is used to calculate the **Curve minimum**.

Method specific tabs at the right hand side of the Details pane - For more details see bullet points below	Calculation Settings Variables Text Results

\<Calculation\>

Y-Scaling:

• linear
• logarithmic

Smoothing:

• **no smoothing**

  - **default, recommended setting**

• smoothing with specification of absolute smoothing range

  - not recommended for most rheological measurements

• smoothing with specification of relative smoothing range

  - recommended for fine tweaking the maxima or minima to a known value

• auto-smoothing with smoothing criterion

  - smoothing criterion with number of
    • local maxima
    • local minima
    • inflection points

\<Variables\>

Define the X-variable and the Y-variable:

• There is no need to define the variables by using the interactive analysis.
  - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.
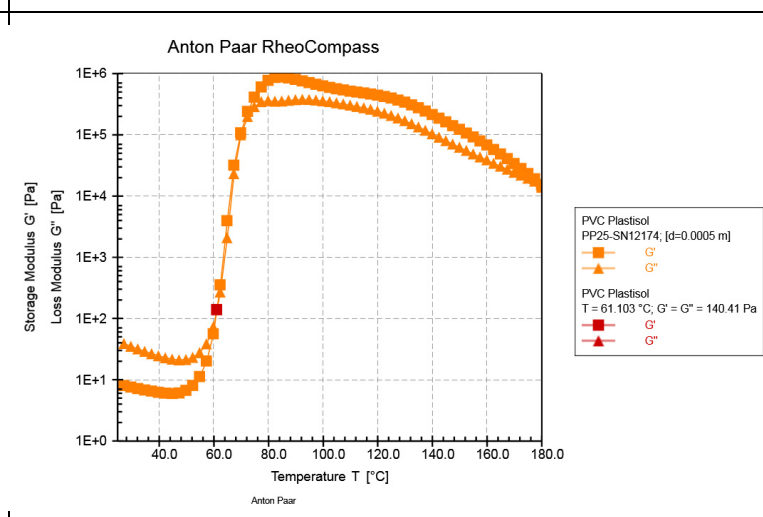
Example: analysis of the minimum in viscosity during a curing reaction—also known as the softening point.

Viscosity minimum	
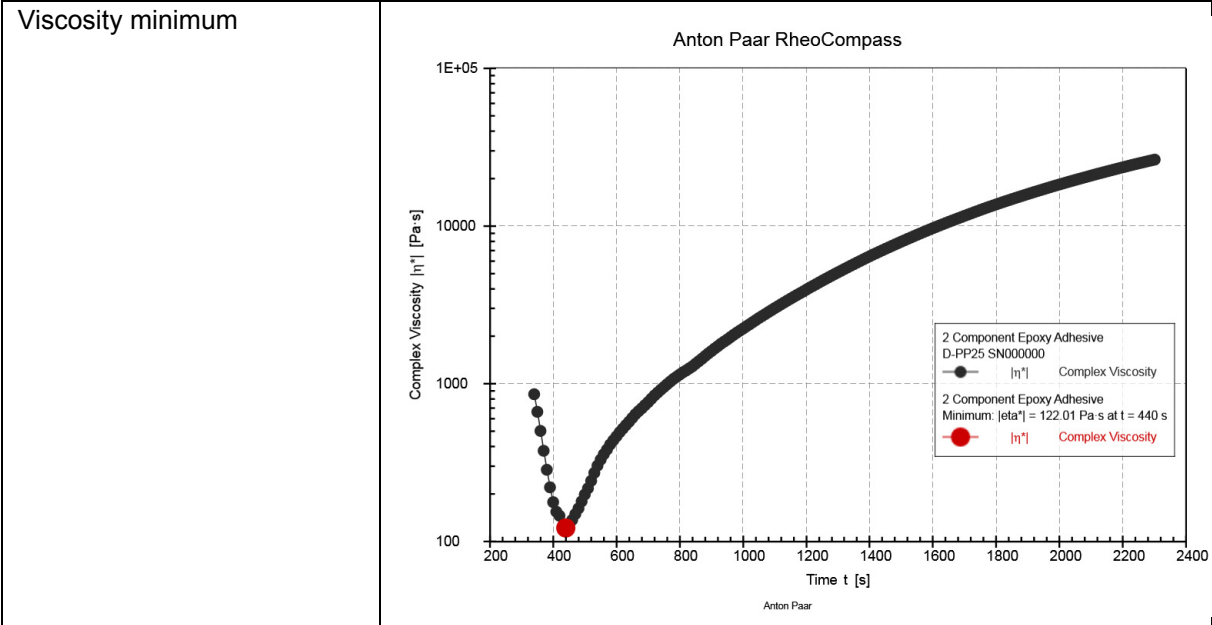
7.2.1.17 Curve Slope

This method is used to calculate the **Curve slope**.

Method specific tabs at the right hand side of the Details pane - For more details see bullet points below	Calculation Settings Variables Text Results

<Calculation>

Select the scaling according to the diagram axes settings. Take care not to mix up linear and logarithmic scaling for the X and Y axes.

X-Scaling:

• linear
• logarithmic

Y-Scaling:

• linear
• logarithmic

<Variables>

Define the X-variable and the Y-variable:
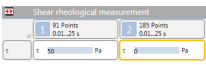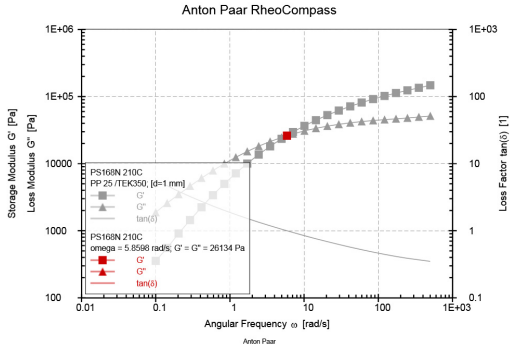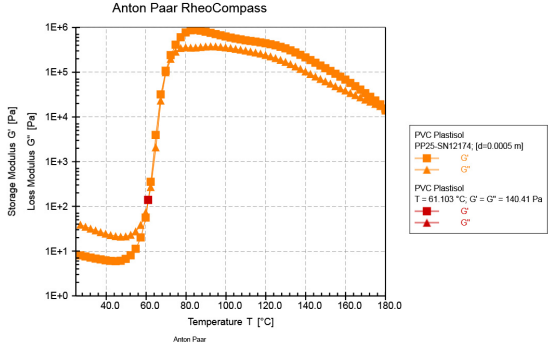
• There is no need to define the variables by using the interactive analysis.
  - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.

Example: calculation of the curve slope based on G' in a log-scaled diagram.

slope in a log-scaled diagram	
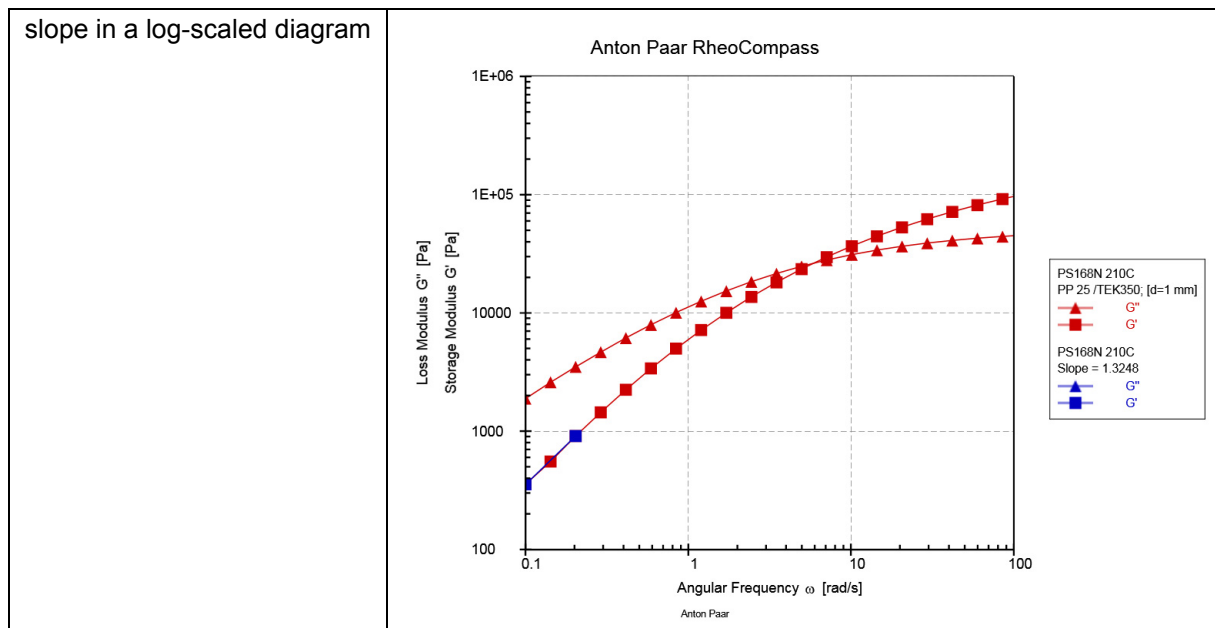
7.2.1.18 Envelope

This method is used to calculate the upper and lower error boundaries in air or calibration oil for a selected measuring system and device

Method specific tabs at the right hand side of the Details pane - For more details see bullet points below	

\<Calculation\>

Calculation mode:

- Calculate device envelope for oil measurement

    - Points per decade:
        - Points generated by the method to be displayed in the diagram or table.
    - Viscosity
        - Enter the viscosity of the calibration oil at the desired measuring temperature

- Calculate device envelope for air measurement

The resulting data is calculated for the selected sample and specific viscosity.

\<Measuring system\>

Before starting the analysis, be sure to select a measuring system and click **Use selected measuring system**.
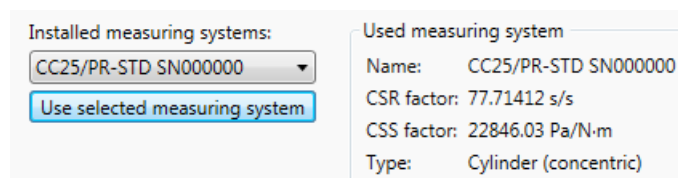
The resulting data is calculated for the selected measuring system.

\<Device\>
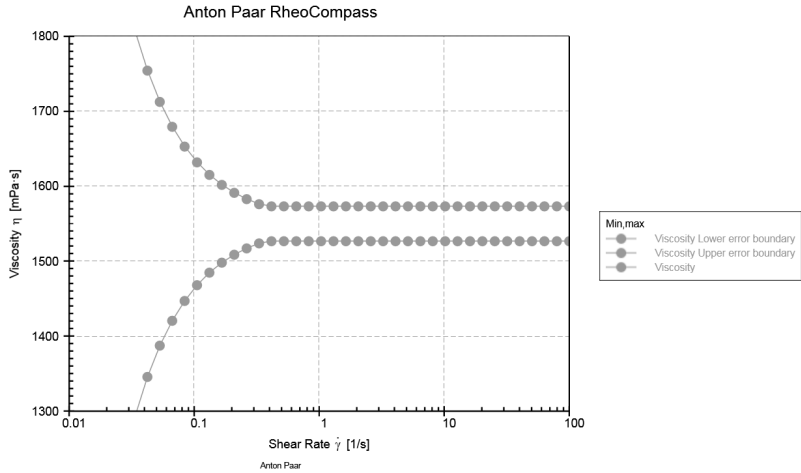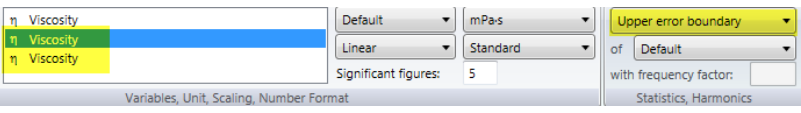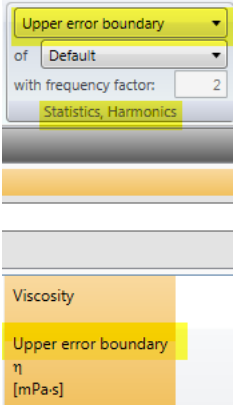
Select the device being used for the measurement. The practically relevant error boundaries are set automatically. The resulting data is calculated for the selected device.

Example:

TIP: Use one of the predefined service templates:
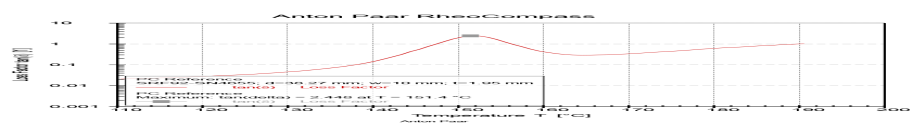
In user-defined diagrams, be sure to add the viscosity or torque three times to the Y-axis.

Diagram with eta selected three times on the Y axis	
Select the meaning **Upper error boundary, Lower error boundary** and **Default** for the variable viscosity	
The same applies for the table. Select the meaning to see the values of the boundaries	

7.2.1.19 Equation Editor

This method is used for defining and calculating **Equations** for each data point

Only the variables defined in the **Equation editor** are part of the result data.

<Formula>

To get any variable through the **Equation editor** without modification, define it as follows. Example for **Temperature** and **Time**:

T = T

t = t

Using this function, the equation editor is a smart tool for **Reducing the number of recorded application, mechanical or transducer/sensor variables** needed for further analysis to a minimum

The **Variables** supported by the equation editor have **Specific names**, while the **Functions** have **Specific symbols**. Use the Insert buttons to insert any unknown **Variable** or **Function**.

The button **Check equations** is used to check if all **Variables** and **Functions** have been identified correctly.

Tool for defining Variables and Functions	

The equations are used for all input data points. The existing variable is on the right-hand side and the variable on the left-hand side of the equality sign. Add a new line to define an equation for any additional variable.

Examples:

Multiply viscosity by factor 0.98 and save as new viscosity	eta = eta*0.98
Multiply viscosity by factor 0.98 and save as new variable Y	Y = eta*0.98
Get through variables	T = T
Definition of a ratio	Delta = G_complex/G'

7.2.1.20 Equidistant Distribution

Use this method to calculate a data point with an **Equidistant distribution** for filling a gap or for generating points at predefined X values

<Calculation>

Distribution of data points to be interpolated between initial and final point number:

• **Linear**

• **Logarithmic**

More parameters:

• **Number of interpolated values** between initial and final point number.

• **Initial point number**

• **Final point number**

Settings		
	Distribution:	Linear ▼
	Number of interpolated values:	100
	Interval no.:	1
	Initial point no.:	1
	Final point no.:	100

7.2.1.21 ERF Analysis

ERF analysis is used to calculate several **electro-rheological variables** not contained in the measuring data, when set variable voltage U is included in the measuring data.

<Calculation>

Define the parameter used for calculating the electrical field strength [V/m] and the electrical flux density [A·s/m²].

• Relative permittivity

   - Relative permittivity of the sample; Default=1

• Correction factor

   - Used for calibration of the values of electric field strength E
   - By default this parameter is set to 1

• Measuring gap

   - Default value based on a standard concentric cylinder CC27 is 1.13 mm

<Voltage Profile>

Set the values according to the measuring profile being used in this test with the correct scaling type. For a constant voltage, set **Initial value** to the same as the **Final value** and use **Linear** scaling.

7.2.1.22   Hysteresis Area

This method is used to calculate the **Hysteresis area** between the **Upward** and **Downward** curves of a **Flow curve** test, or the **Hysteresis area** as an **Integral value** normalized by the sample volume (to be entered as a parameter).

<Intervals>

Define the intervals of the **Up** and the **Down** curves. If an up curve is over two or three intervals, these intervals must be separated by semicolons ";".

| Settings of the interval	Interval no. of up curve: 1 Interval no. of down curve: 3	Intervals must be separated by semicolons (e. g. 1;2;3)

<Variables>

Define the X-variable and the Y-variable:

• There is no need to define the variables by using the interactive analysis.
  - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.
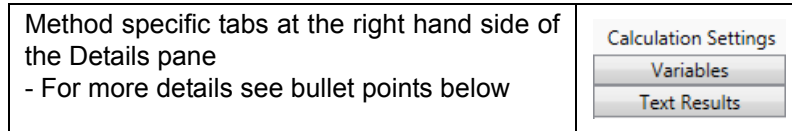
Sample Volume

Use this parameter to define the sample volume of the measuring system being used. The sample volume can be found in the category **Setup, Measuring systems** by selecting the specific measuring system in the list view.

The parameter is used to calculate a hysteresis area normalized by the sample volume.

7.2.1.23   Interfacial Viscosity

This method is used to calculate the **Interfacial viscosity shear variables** based on an interfacial measurement using the bi-cone.

Requirements

The **Interfacial Analysis Package** is an optional feature of RheoCompass™. To check whether the license feature is enabled, click on **About RheoCompass** and check whether the feature **Analysis package** is **Enabled**. To request a trial license, including the feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

If the complex viscosity of the upper or lower liquid is unknown, it should be measured using a standard measuring system such as a DG27 or CP60-1.

<Dimensions>

Use **Automatic** detection of the **Dimensions** or enter all dimensions manually.

- Height of lower fluid H1

    - Enter the height of the lower fluid in [mm] or use Automatic if using a Toolmaster measuring system. Default = 22.5 mm
    - Ensure the glass ring is mounted in the right direction. If the lower height is not 22.5 mm, then fix the glass ring in the other direction.

- Total height of both fluids H1 + H2

    - Enter the height of both fluids (even if upper phase is "air")
    - Default = 47mm

- Dimensions of the measuring system

    - Refer to the measuring-system container of the measuring-system data sheet for details, or use Automatic if using a Toolmaster measuring system.

<Upper fluid>

Enter the density and complex viscosity of the upper fluid in [Pas]. The upper fluid should be a Newtonian liquid or air.

Use the value 1.8E-05 Pas for air.

Upper fluid	
	Density ρ2: 0.0012 g/cm³ (Air: 0.0012 g/cm³) ☑ Complex viscosity η2 = η2' - i·η2" is constant Re(viscosity) η2': 1.8E-05 Pa·s (Air: 0.000018 Pa·s) Im(viscosity) η2": 0 Pa·s (Air: 0 Pa·s)

<Lower fluid>

Enter the density and complex viscosity of the lower fluid in [Pas]. If the option is checked, the lower fluid should be a Newtonian liquid.
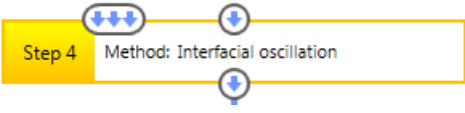
Before starting a new test, be sure to check the parameters of the analysis method.

Lower fluid	
	Density ρ1: 1 g/cm³ (Water: 1 g/cm³) ☑ Complex viscosity η1 = η1' - i·η1" is constant Re(viscosity) η1': 0.001 Pa·s (Water: 0.001 Pa·s) Im(viscosity) η1": 0 Pa·s (Water: 0 Pa·s)

By **Unchecking** the option for the **Upper fluid** or **Lower fluid**, an **Additional input** should be defined to load a **Frequency sweep** of any **non-Newtonian liquid**.

The viscosity of the upper or lower fluid is taken from additional input:

Select this option to use the data from the **Additional input**. At least two data points are required, and there are two options to define the **Additional input**:

Drag and drop to define additional input (green symbol)	

Click <Input Data>

Two separate viscosity curve measurements of lower and upper fluid measured with any measuring system (each with at least 2 data points)

Test	Result	Intervals/Points	From	To
Click here to define input data				

Name, Info | Remarks | Parameters | Input Data | Result Data

7.2.1.24   Interfacial Oscillation

This method is used to calculate the **Interfacial shear oscillatory variables** based on an interfacial measurement using the bi-cone.

Requirements

The **Interfacial Analysis Package** is an optional feature of RheoCompass™. To check whether the license feature is enabled, click on **About RheoCompass** and check whether the feature **Analysis package** is **Enabled**. To request a trial license, including the feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

If the viscosity of the upper or lower liquid is unknown, it should be measured using a standard measuring system such as a DG27, CC27, CP60-1 or CP50-1.

<Dimensions>

Use **Automatic** detection of the **Dimensions** or enter all dimensions manually.

• Height of lower fluid H1

   - Enter the height of the lower fluid in [mm] or use Automatic if using a Toolmaster measuring system. Default = 22.5 mm
   - Ensure the glass ring is mounted in the right direction. If the lower height is not 22.5 mm, then fix the glass ring in the other direction.

• Total height of both fluids H1 + H2

   - Enter the height of both fluids (even if upper phase is "air")
   - Default = 47 mm

- Dimensions of the measuring system

  - Refer to the measuring-system container of the measuring-system data sheet for details, or use Automatic if using a Toolmaster measuring system.

<Upper fluid>

Enter the viscosity of the upper fluid in [Pas]. The upper fluid should be a Newtonian liquid or air. Use the value 1.8E-05 Pas for air.

<Lower fluid>

Enter the viscosity of the lower fluid in [Pas]. If the option is checked, the lower fluid should be a Newtonian liquid.

Before starting a new test, be sure to check the parameters of the analysis method.

By **Unchecking** the option for the **Upper fluid** or **Lower fluid**, an **Additional input** should be defined to load a **Flow curve** of any **non-Newtonian liquid**.

The viscosity of the upper or lower fluid is taken from additional input:

Select this option to use the data from the **Additional input**. At least two data points are required, and there are two options to define the **Additional input**.

Drag and drop to define additional input (green symbol)	
Click <Input Data>	

Two separate viscosity curve measurements of lower and upper fluid measured with any measuring system (each with at least 2 data points)

Test	Result	Intervals/Points	From	To
Click here to define input data				

Name, Info | Remarks | Parameters | Input Data | Result Data |

7.2.1.25   Integration

This method is used to calculate the **Integral value** of the function Y(X).

<Calculation>

There are two **Calculation modes** for the **Integration**.

1. Total integration (Default)

• Calculates the **Integral value** between the first and last measuring points defined in limitations or based on the input data.

2. Accumulated single integration values

• Calculates the **Integral value** between each data point and the next. The sum of all single integration values should be equal to the **Total integration value**.

<Variables>

Define the X-variable and the Y-variable:

• There is no need to define the variables by using the interactive analysis.
  - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.

<Limiting>

Limitation of values in x-direction:

Use these limiters to define **Fixed limits** for the **X values** independent of the defined input data range.

7.2.1.26   Interpolation

This method is used to calculate **Interpolation values** of the function Y(X).

<Calculation>

Interpolation type:

• Linear

• **Logarithmic** (Recommended for most measurements)

• Cubic Spline
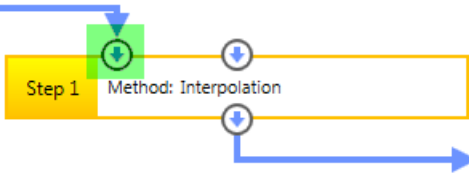
X-value:

Value to be interpolated.

Do not use extrapolation: Check this option to avoid extrapolated values not within the measuring range of the test.

Get x-values from additional input:

Select this option to use the data from the **Additional input**. At least two data points are required, and there are two options to define the **Additional input**.

Drag and drop to define additional input (green symbol)	
Click <**Input Data**>, **dynamic x-values**	

<Variables>

Define the X-variable and the Y-variable:

- There is no need to define the variables by using the interactive analysis.
  - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.

7.2.1.27 Interpolation (FAQ): Calculation of the Viscosity at Multiple Shear Rates

Define an **Analysis action** with multiple **Interpolation methods** as in the attached template (see example with 3 steps). The analysis can then be used for **Interactive analysis** or as part of a **Test definition**. The **Rearrange method** is used to provide the **Input data** for all **Interpolation steps**.

Copy & paste an **Interpolation step** to define additional shear rates to be interpolated (**Ctrl C**, **Ctrl V**).

Interactive analysis with an example project:	
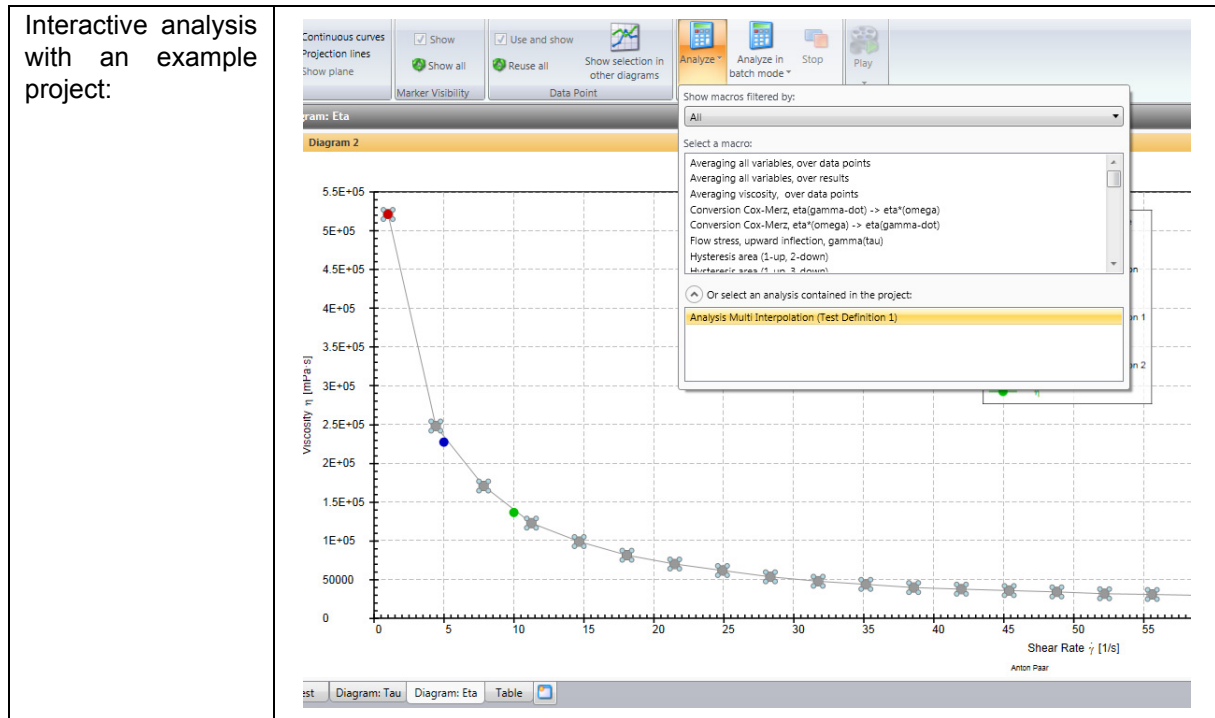
7.2.1.28 Limitations

This method is used to limit the incoming data points and cut off any value below the defined minimum, as well as to cut off any value above the defined maximum

\<Variable\>

Define the X-variable to be limited.

\<Limiting\>

Use minimum:

- Check this option to use a lower limit

- **Minimum**: Enter the value for the lower limit

- Check the option **Remove data points with value < minimum**
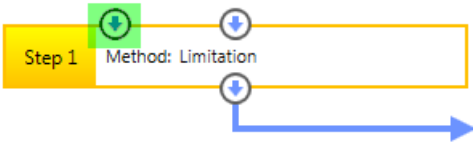
Use maximum:

- Check this option to use an upper limit

- **Maximum**: Enter the value for the upper limit

- Check the option **Remove data points with value > maximum**

Minimum is taken from additional input:

Select this option to use the data from the **Additional input** for interpolation. AtOnly one data point is allowed as input data. There are two options to define the **Additional input**.

Drag and drop to define additional input (green symbol)	
Click <**Input Data**>, **dynamic x-values**	

Example:

Before limitation	 Anton Paar RheoCompass
After limitation: T_min=100°C T_max=175°C	 Anton Paar RheoCompass

7.2.1.29   LVE Range

This method is used to calculate the **LVE range** of an amplitude sweep.

It is also used to detect

- an **Upward Deflection**

- a **Downward Deflection** or

- the point at which a curve is **Leaving a tolerance band**

of any other test type or function.

<Calculation>

Select the Calculation mode for the LVE detection type:

- **Leaving a tolerance band** (Default for amplitude sweeps)

  - The default parameter for the Tolerance is 3 %. Use a higher value if the data is very noisy.
  - Use curve smoothing to ensure outliers at the very low end of the curve are removed and to avoid any error in detecting the first point leaving the tolerance band. The default smoothing range is 5 %. Use a higher value if the data is not very reliable. Better: Change the measuring system for one with a larger diameter and smaller gap with respect to the cone angle (low-viscosity samples) or smaller diameter and larger gap (highly viscous samples containing particles).

- **Detection of an upward bend**

  - Detects an **Upward bend** in the measured curve. This method is an **Alternative** to the tolerance band and makes sense as alternative for the function tan(delta) over gamma or a curve of any other test type.

- **Detection of a downward bend**

  - Detects a **Downward bend** in the measured curve. This method is an alternative to the tolerance band and makes sense as alternative for the function **G' over gamma** or any other curve or test type.

<Variables>

Define the X-variable and the Y-variable:

- There is no need to define the variables by using the interactive analysis.
  - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.

<Output>

Output data:

- **Proposal**

  - Calculates the proposal for any oscillatory measurement to ensure measuring results lie within the linear viscoelastic region (non-destructive measurements). The proposal is slightly higher than limit of the LVE and therefore on the safe side. Furthermore, it is rounded and easy to remember.

- **Limit of the LVE**

  - Calculates the **Limit of the linear viscoelastic region** based on the **Calculation settings**.

- **Limit of the LVE + proposal**

  - Combines both options described above.

- **Smoothed input data**

     - Use this option to calculate the smoothed curve used for the criterion or to evaluate the effect of smoothing on any unsteady curve. This option is mainly used for developing a new method.

Check the parameter **Calculate interpolated values for the following variable** to add any other variable to the result.

Example:

Amplitude sweep with boundary	
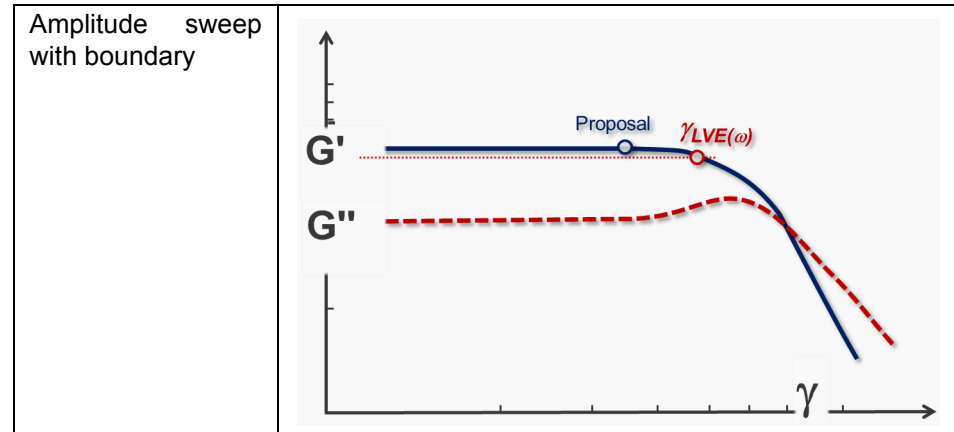
7.2.1.30 Master Curve (TTS)

The Master curve (TTS) is used

• to measure frequency sweeps at various temperatures

• to shift the curves to a reference temperature

• to extend the frequency range.

The **Time Temperature Superposition** is used to extend the **Frequency range** of a **Frequency sweep**. Furthermore the **Flow activation energy** is calculated from the shift factors using the **Arrhenius regression**.

Requirements

The **Polymer Analysis Package** is an optional feature of RheoCompass™. To check whether the license feature is enabled, click on **About RheoCompass** and check whether the feature **Analysis package** is **Enabled**. To request a trial license, including the feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

Samples:

• Use this method for linear polymers (polymer melts)

• The method is designed for Maxwell-like samples

• It does not work on branched polymers, polymers with cross-links, emulsions or samples containing solid particles

- It may work (with limitations) on samples undergoing a phase transition, such as crystallization processes. For such cases, we recommend using a specific template based on a continuous-frequency sweep superimposed by a temperature ramp:

⌃ Temperature & frequency dependency (TTS) | Thermoplastic, thermosetting
Measurement of the master curve of a solid bar (SRF):
- Continuous frequency sweep with analysis of a master curve
- This test ensures a good overlapping in the glass transition region
- Measurement from the solid state to the rubber elastic region

\<Modes\>

TTS mode:

There are two TTS modes; Standard TTS and Generalized TTS. The standard mode is used for shifting moduli of a frequency sweep:

- **Standard TTS** (variation of temperature)

  - Use this mode for shifting-frequency sweeps measured at different temperatures

- Generalized TTS (variation of any variable)

  - Use this mode for Master curves based on shear rate, pressure or temperature

Calculation mode:

- **Recalculate Values for a Different Target Value**

  - Use this mode to calculate:
    - A frequency-sweep-based master curve at any temperature (interpolated) which is not necessarily the measured temperature.
    - Note: aT, and bT shift factors are not included in the resulting variables

  - Typically, the target values are calculated in two steps:
    In step one, the so-called master curve based on reduced rheological variables G'/bT(omega*aT) and G"/bT(omega*aT) is calculated. Because these variables cannot be presented together with standard frequency

sweeps, in the second step, G'/bT is converted to G' and G''/bT to G''. The target temperature of this second step could be any temperature converted by the frequency sweeps.

Input data → Master curve → Result data at T≠T0	Interval Settings Load Phase Regression Recovery Phase Regression Known Parameters Corrections Text Results
Master Curve	
Result data	
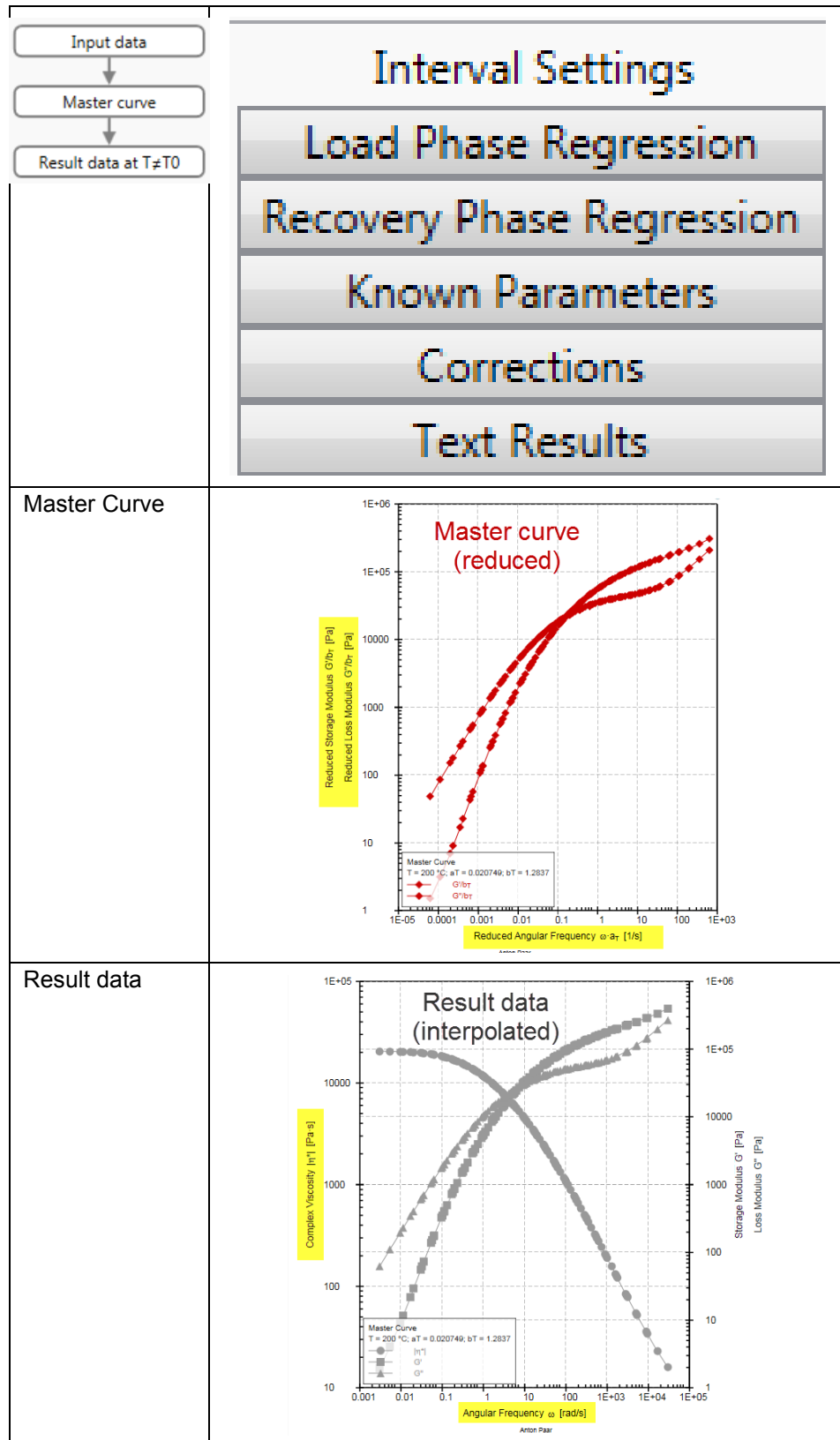
- Calculate a master curve

  - Use this mode to calculate:
    - Reduced variables
    - Shift factors aT and bT used for the Arrhenius or WLF regression
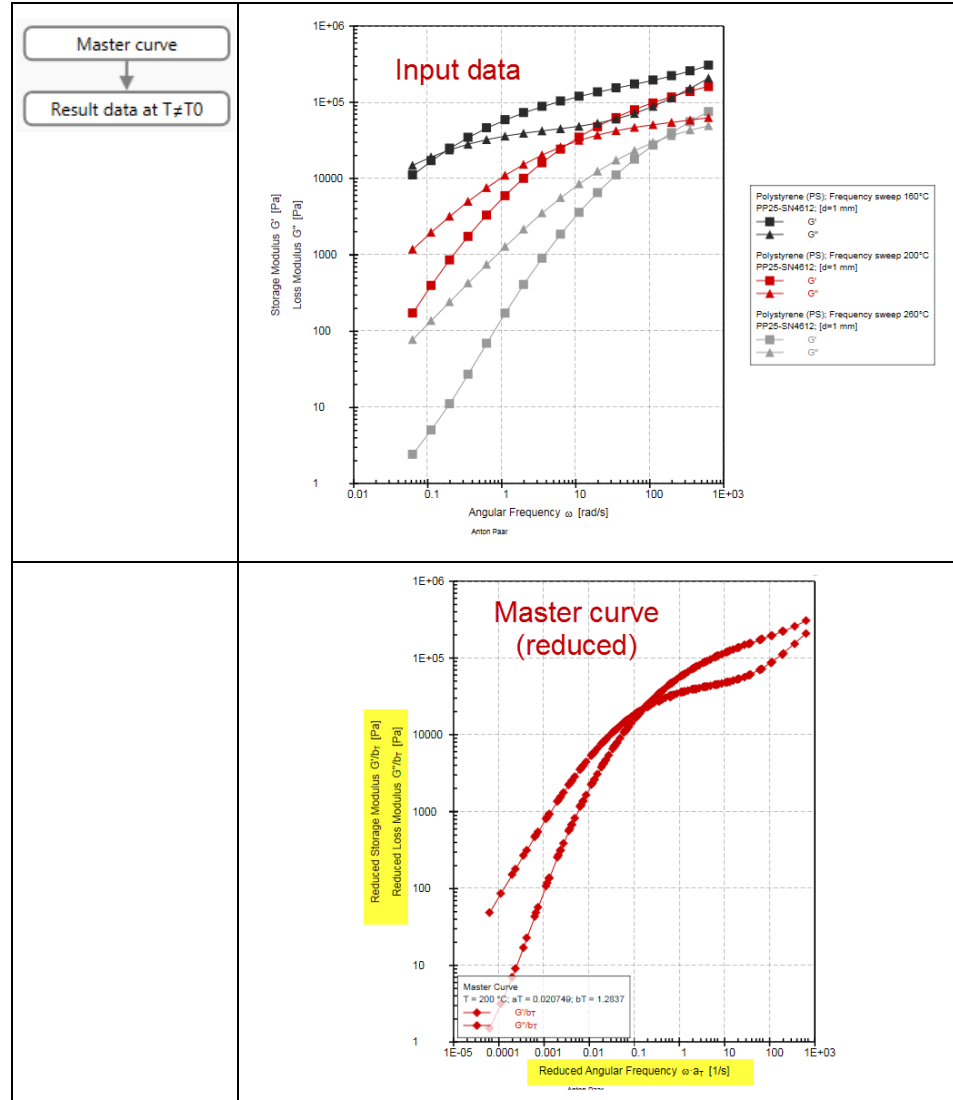
- Calculate values from a master curve

Use this method to convert reduced variables into frequency sweep variables

	Master curve ↓ Result data at T≠T0	Data generation Max. adjusting duration: Automatic Averaging over: Automatic Timeout: Automatic

Result data (interpolated)

<Variables>
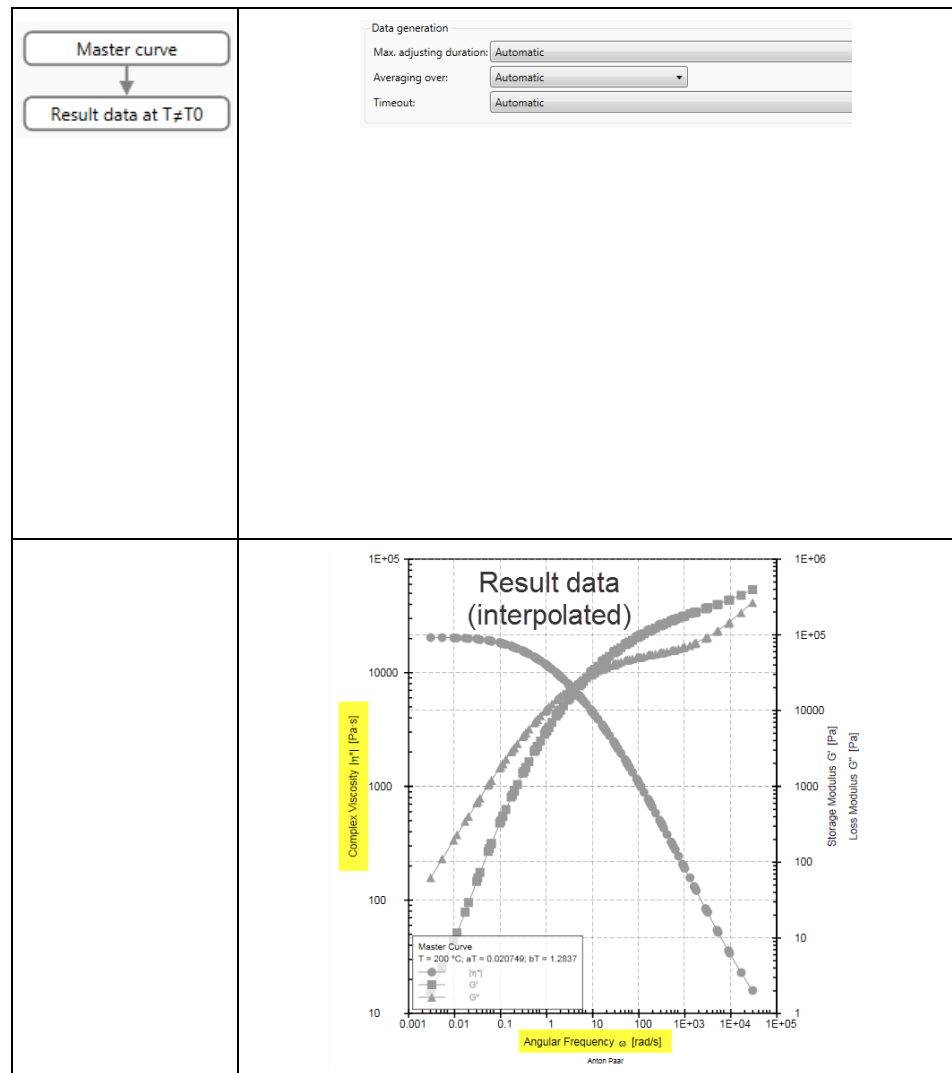
Variable mode:
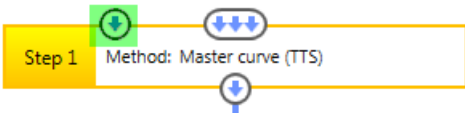
- Two variable as a function of frequency

  - This is the default option for shifting-frequency sweeps

- One variable as a function of frequency

  - In the case of unsteady curves with various outlines, we suggest shifting one curve at a time, e.g. G'

- One variable as a function of time

  - Select this option to shift the Relaxation modulus G(t)

<Calculation>

The definition of the **Reference temperature** or **Target temperature** depends on the Calculation mode.

Settings for calculation mode:

- One variable as a function of frequency

    - **Target value**: Define the target temperature of the Master curve. If the target value is equal to the minimum or maximum temperature and a warning is displayed, then try with a slightly higher temperature, e.g. 190.1 °C instead of 190 °C or 259.9 °C instead of 260 °C.

- **Calculating a master curve**

    - **Take reference value from additional input**:
      Get x-values from additional input:
      Select this option to use the value from the **Additional input** for interpolation. Only one data point is allowed as input.
      There are two options for defining the **Additional input**:

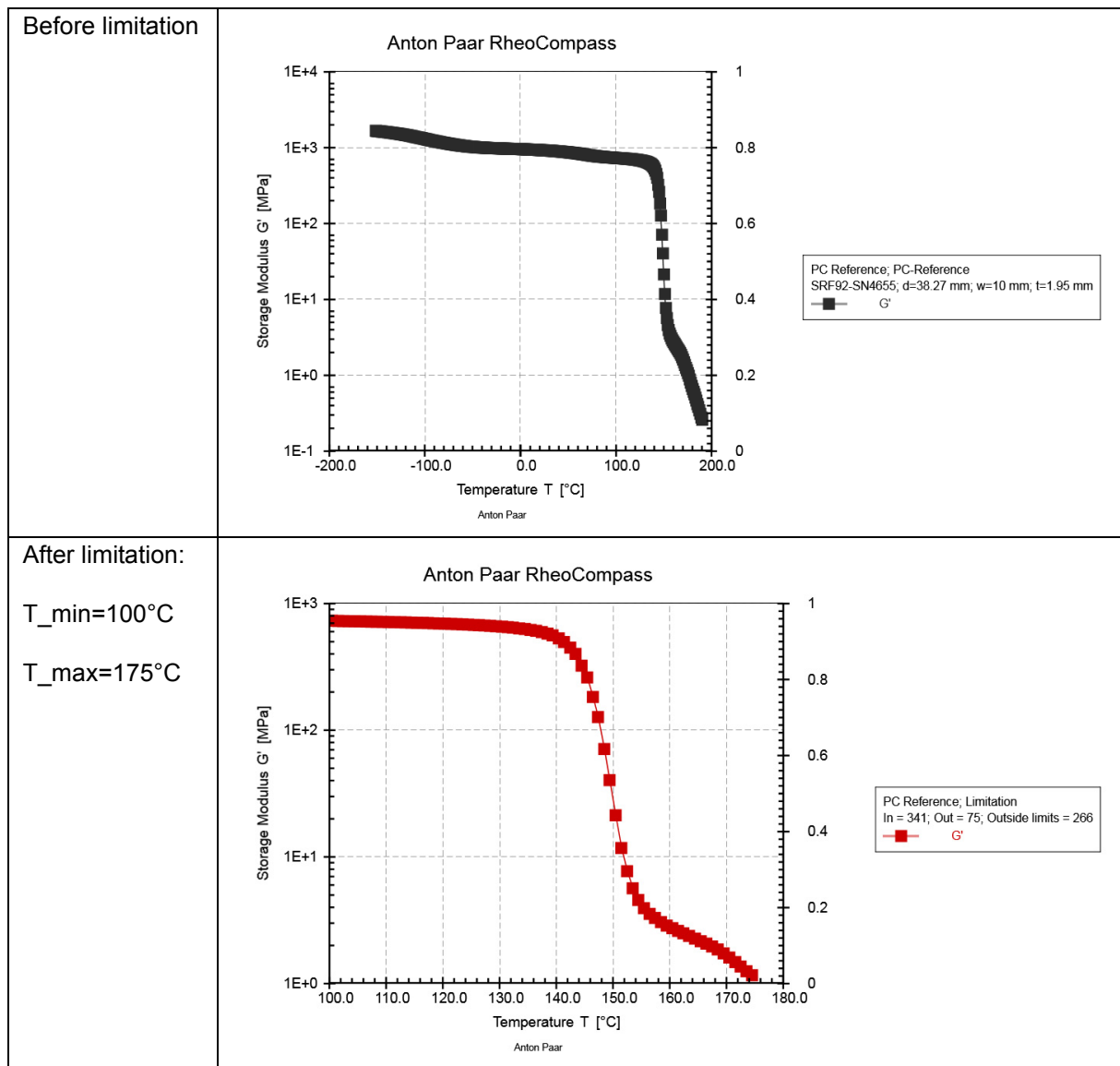| Drag and drop to define additional input (green symbol)	
Click <**Input Data**>, **dynamic x-values**	

    - **Reference value is given manually**:
      Use any frequency-sweep temperature. If the temperature does not comply with the temperature of the frequency sweep a warning will be displayed.

- **Settings**

    - Use **Automatic** settings by default. If the default does not work try with **Manual** settings.

- **Shift directions**

    - For most master curves of polymer melts, the **Horizontal** shift provides good results. For partially crystalline structures, or if a sample undergoes a phase transition (TTS of solid bars), it is advisable to use the **Horizontal and vertical** shift. This ensures compensation for the change in density (vertical shift).

- Range

    - This is the allowed maximum deviation of the measuring points from the reference curve. Increase this parameter if a warning is displayed. 100 % is still acceptable for curves with outliers in a log-scaled diagram.

<Limiting>

- **Use input data only from a given range of x-values**:

  - Define a range of frequencies for the input data. Use this option if all points outside a certain frequency limit are found to be invalid. Select the action **Analysis** and the step **Master curve (TSS)**. Select the tab **<Parameters>** and the tab on the right-hand side **<Input limiting data>** to define the values for Use input data only from the given range of x-values.

- **Do not use the following input data for calculation of shift factors but do not switch**:

  - Define the relative range of the curve that should not be used for calculation but should be shifted and taken up into the resulting curve. This is a kind of data weighting. Typically, the priority range of the shifted curve is in the mid area, whereas at the lower and higher ends, the data is not so reliable. Select the action **Analysis** and the step **Master curve (TSS)**. Select the tab **<Parameters>** and the tab at the right side **<Input limiting data>** to define the relative range that should not be used for calculation.

7.2.1.31   Master Curve (TTS) (FAQ)

Q: I have measured several frequency sweeps at various temperatures but can not shift the data. Each attempt is terminated with a warning. What can I do to get it to work? What are the limitations of the method?

For trouble shooting, please read this information carefully and change the settings accordingly.

The **Time-Temperature Superposition** is a method used for extending the **Frequency range** of a **Frequency sweep**. Furthermore, the **Flow activation energy** is calculated from the shift factors using the **Arrhenius regression**.

Project Templates:

Use one of the templates provided by RheoCompass to analyze your sample. The following project template can be found in the App Manager, **<New Project>**.

Templates:	**Template name**
	DMTA-torsion, temperature ramp with master curve - TTS
	DMTA-torsion, temperature ramp with master curve - TTS (example)
	Frequency sweep, melt with master curve - TTS
	Frequency sweep, melt with master curve - TTS (example)

Type of Polymer Melt:

For some materials it may not be advisable to run the TTS method.

- The method has been developed to shift rheologically simple thermoplastics that obey the **Maxwell Model**.

- In an ideal case, the polymer has a linear structure and is amorphous.

- Some polymer melts, for example PE (LDPE, HDPE), do not provide any significant extension of the frequency range. It is more efficient to run a single frequency sweep over a wider frequency range.

- The method should not be used for filled polymers nor should it be used for polymer melts with the tendency to show degradation (PET, PA, etc.).

- It is very difficult to shift curves of crystalline polymers and of polymers undergoing a phase transition (see remarks below).

LLDPE: 150°C–250°C - not effective -	
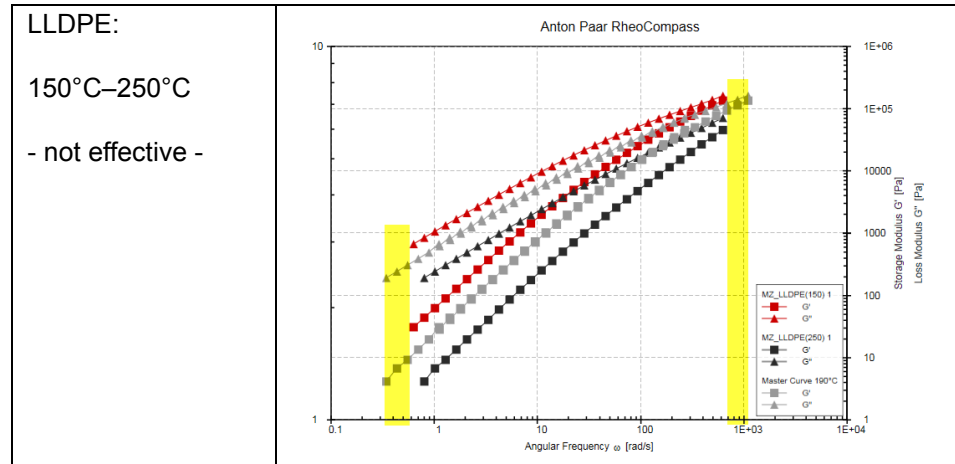
Overlapping of Curves:

Make sure the curves overlap if shifted in horizontal direction. It is helpful to show only one variable on the Y1 axis (here G' versus Omega) for a visual assessment.

Visual assessment	
Example	The -20° C curve does not overlap with the 0 °C curve. Remedy: Remove the -20 °C from the input data or measure at some additional temperatures, e.g. -15 °C, -10 °C, -5 °C to allow the curves to overlap.
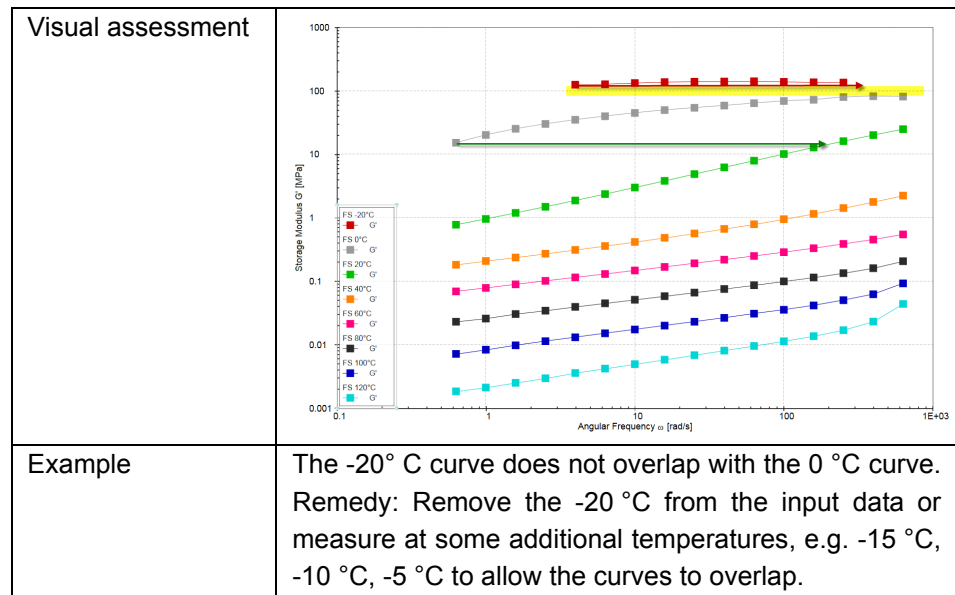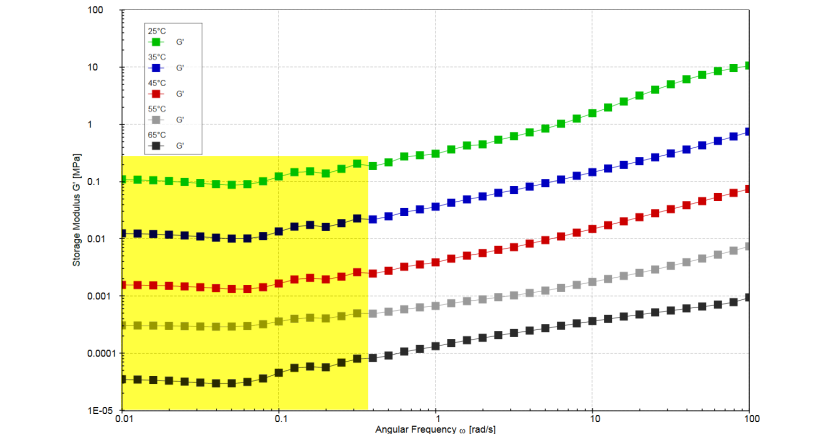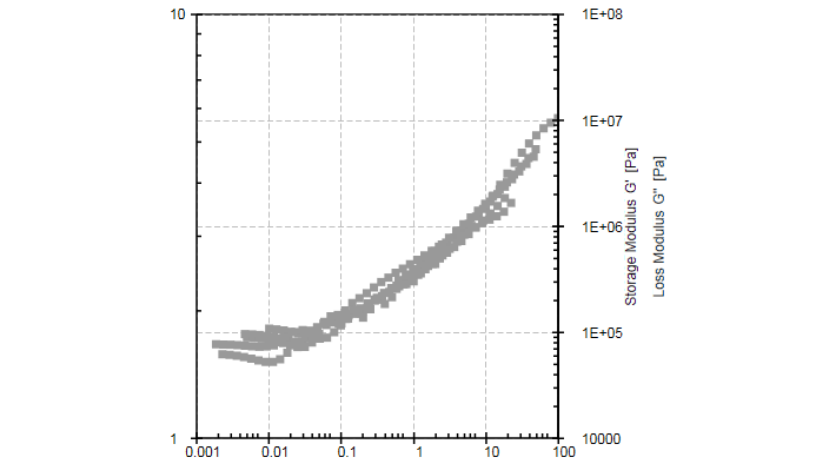
Unsteady Shape of Curve:

For some samples it is quite difficult to find the right parameter settings to obtain good measuring data at lower and higher frequencies. This is even more difficult if the sample is measured at various temperatures.

There are three options to improve the TTS result by removal of outlying data points:

1. **Define a relative range of the curve which should not be used for calculation** but should be shifted and taken up into the resulting curve. Typically, the priority range of the shifted curve is in the mid area, whereas at the lower and higher ends, the data is not so reliable. Select the action **Analysis** and the step **Master curve (TSS)**. Select the tab **<Parameters>** and the tab at the right side **<Input limiting data>** to define the relative range that should not be used for calculation.

Example	
Weighting of data	
Result without data weighting: G' only	

Result with data weighting: G' only (option: one variable as function of frequency)	
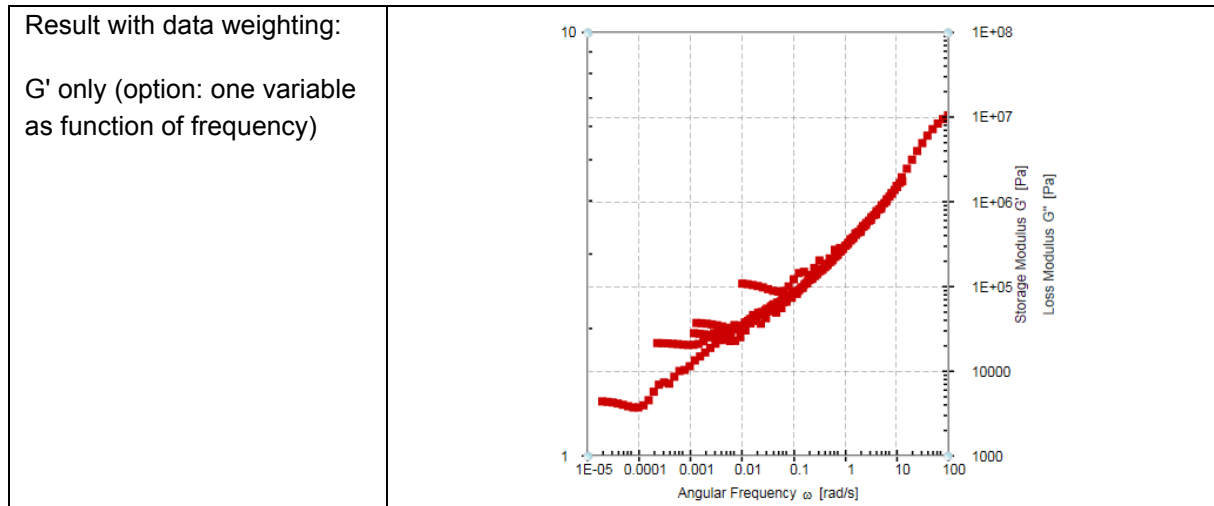
2. Remove single outliers in the diagram (1st click marks complete curve, 2nd click just one point; hold the shift key to mark a range). Now right mouse click and uncheck the option **Use and show selected Datapoint(s)**. The data points are no longer used as input data for the TTS analysis.

3. Define a range of frequencies for the input data. Use this option if all points outside a certain frequency limit are found to be invalid. Select the action **Analysis** and the step **Master curve (TSS)**. Select the tab **<Parameters>** and the tab at the right side **<Input limiting data>** to define the values for **Use input data only** from a given range of x-values.

More Calculation Parameters:

Target value	Define the target temperature of the Master curve. If the target value is equal to the minimum or maximum temperature and a warning is displayed, then try with a slightly higher temperature, e.g. 190.1 °C instead of 190 °C or 259.9 °C instead of 260 °C.
Settings	Use **Automatic** settings by default. If the default does not work, try with **Manual** settings.
Shift directions	For most master curves of polymer melts, the **Horizontal** shift provides good results. In the case of partially crystalline structures, or if a sample undergoes a phase transition (TTS of solid bars) it is advisable to use the **Horizontal and vertical** shift. This ensures compensation for the change in density (vertical shift).
Range	This is the allowed maximum deviation of the measuring points from the reference curve. Increase this parameter if a warning is displayed. 100 % is still acceptable for curves with outliers in a log scaled diagram.

Input Variables:

Variable mode	Default is **Two variable as a function of frequency**. In the case of unsteady curves with various outlines we suggest to shift one curve at a time, e.g. G'. In that case, select the option **One variable as a function of frequency**.

7.2.1.32 Molar Mass Eta(0)

This method is used to calculate **molar mass M_w** from the **zero-shear viscosity eta(0)**.

Samples:

- This method is suitable for linear polymers (polymer melts) only

- The method is based on Maxwell-like samples

- It does not work on branched polymers, polymers with cross-links, emulsions or samples containing solid particles

Alternative Methods:

The **Regression, Carreau-Yasuda** method is a good alternative to the **MMD Bimodal** or **Molar mass Eta(0)** method, providing reliable relative data for the **Mw**, **MMD** and **Relaxation time Lambda**. Compared to the **Molar mass Eta(0)**, the parameter from **Carreau-Yasuda** is directly related to the rheologically measured data.

Requirements

The **Polymer Analysis Package** is an optional feature of RheoCompass™. To check whether the license feature is enabled click on **About RheoCompass** and check whether the feature **Analysis package** is **Enabled**. To request a trial license, including the feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

<Input data>

The method is always used in combination with **Regression** and calculation of the zero-shear viscosity, which is needed as an input parameter.

Select the result from the analysis method **Regression Carreau-Yasuda** as input. This method provides the **zero-shear viscosity** calculated from a **Flow curve** or **Frequency sweep**. Do not forget to select the corresponding **X** and **Y variables** depending on the test type.

Combination of regression and molar mass calculation	

<Parameters>, <Material parameters>
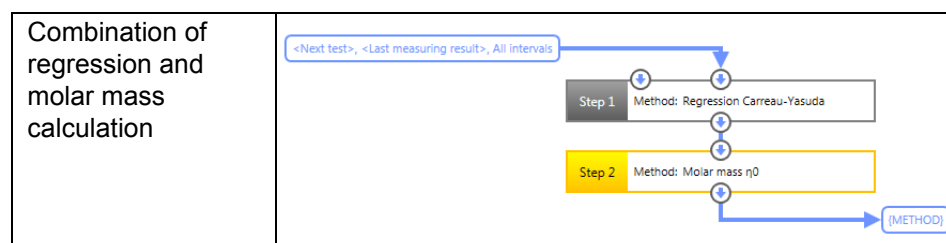
Select the material parameters for the polymer melt. The material parameters are material dependent.

- Relaxation time coefficient k

- Relaxation time coefficient a

Click the button **Material parameters** to get the list of material parameters from the literature for a selection of polymer melts.

| Relaxation time coefficient K: | 5E-15 | Material parameters... |
| Relaxation time coefficient a: | 3.4 | |

The parameters recommended for this method are marked with **Mw=K*eta0^a**. Select the parameter identical with the measuring temperature.

Rh Material Parameters

Material parameters:

LDPE	LDPE	190 °C	(Mw=K·eta0^a)	3.87E-14	3.41
	LDPE	190 °C	(Single-Exp.)	6.91E-20	3.41
	LDPE	190 °C	(Doi)	6.91E-20	3.43
	LDPE	190 °C	(BSW)	6.91E-20	3.55
	LDPE	190 °C	(Thimm)	8.0E-21	3.74
	LDPE	190 °C	(Brabec-Schausberger)	6.91E-20	3.5
LLDPE [linear]	LLDPE	190 °C	(Mw=K·eta0^a)	2.76E-14	3.45
	LLDPE	220 °C	(Mw=K·eta0^a)	9.45E-16	3.67
	LLDPE	190 °C	(Single-Exp.)	6.91E-20	3.45
	LLDPE	220 °C	(Carrot/Guillet)	1.15E-21	3.67
	LLDPE	190 °C	(Doi)	6.91E-20	3.46
	LLDPE	190 °C	(BSW)	6.91E-20	3.7
	LLDPE	190 °C	(Thimm)	8.0E-21	3.78
	LLDPE	190 °C	(Brabec-Schausberger)	6.91E-20	3.56

7.2.1.33   MMD Bimodal H(lambda)

Use the method MMD Bimodal H(lambda) for the calculation of molar mass distribution from a continuous relaxation time spectrum.

Samples:

- The method is suitable for linear polymers (polymer melts) only

- The method has been developed for Maxwell-like samples

- It does not work on branched polymers, polymers with cross-links, emulsions or samples containing solid particles

- For industrial polymers, this is only a rough estimation as the theory has been developed based on ideal linear samples with narrow distributions.

Alternative Methods:

The **Regression, Carreau-Yasuda** method is a good alternative to the **MMD Bimodal** or **Molar mass Eta(0)** method, providing reliable relative data for the **Mw**, **MMD** and **Relaxation time Lambda**. Compared to the **Molar mass Eta(0)**, the parameter from **Carreau-Yasuda** is directly related to the rheologically measured data.

Requirements

The **Polymer Analysis Package** is an optional feature of RheoCompass™. To check whether the license feature is enabled click on **About RheoCompass** and check whether the feature **Analysis package** is **Enabled**. To request a trial license, including the feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

Calculation of the MMD is based on three steps:

1. A **Frequency sweep** is measured, which should provide the **zero shear viscosity region** as well as the **Power law region** with **Curve cross over**. If a frequency sweep does not provide both regions, it is advisable to **Extend the frequency range** or to create a **Master curve** using the appropriate **Project template for TTS**.

Example
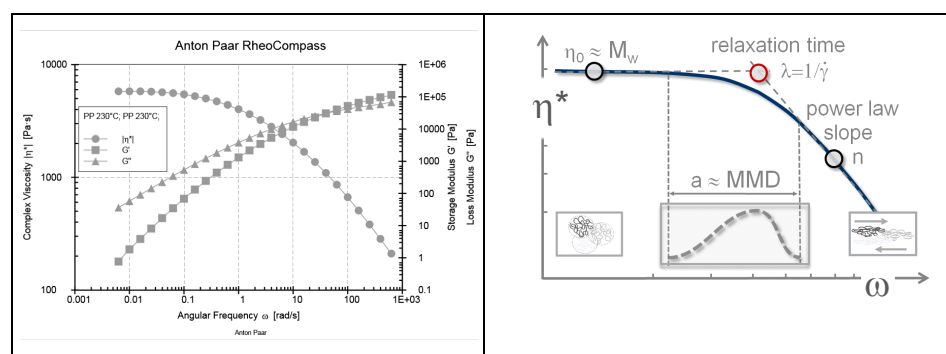
2. **Relaxation time spectrum** (continuous): The **Relaxation time spectrum** is generated from the **Transition region** between the **Zero shear viscosity plateau** and the **Power law region**. The **Relaxation time spectrum** is still based on the measured data and is thus a good indicator for the polymer structure of the investigated polymer melt. No model parameters are needed to calculate the **Relaxation time spectrum**.

I. **Lambda_min = 1 / Omega_max; Lambda_max = 1 / Omega_min**

II. The **Relaxation time Lambda** is proportional to the **Molar mass** of each component

III. The **H(lambda)** is the **Intensity** of each component (molecule)

IV. By multiplying the **Relaxation time** with the **Intensity**, a quasi **Gaussian distribution** is generated equivalent to the **MMD distribution**

V. This is still rheological data and not "diluted results"—in contrast to the MMD, whose accuracy depends on the input of model parameters

Example
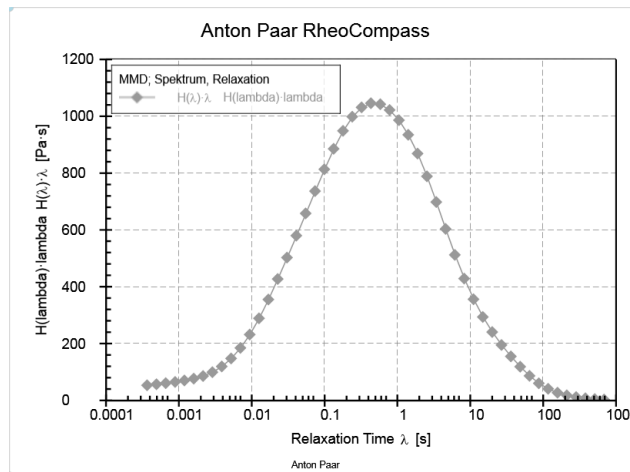
3. MMD: The molar mass distribution is based on the **Relaxation time spectrum** and the **Material parameter** from the literature. For industrial polymers, the resulting values are considered relative.

Example:
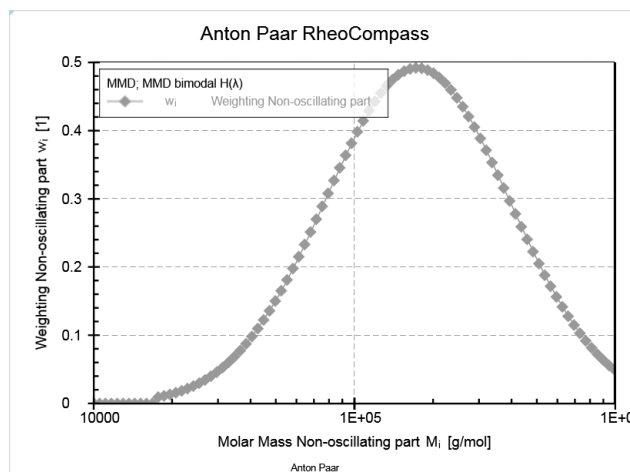
The RheoCompass **<App Manager>** includes a **Project template** as well as a **Project Template with example** for polymer analysis.

Click **New project** and **<Examples>** or **<Melts>** and **<Oscillation, frequency sweep>** to filter the templates. Select:

•   Frequency sweep, melt with spectrum and MMD

•   Frequency sweep, melt with spectrum and MMD (example)

Settings in RheoCompass:

To set the **Material parameter** for the specific polymer to be investigated select the tab **<Analysis>**, action **Analysis** and step **MMD bimodal H(lambda)**. In the **Details** pane click **Material parameters** and make a copy (e.g. copy to MS Excel). The Material parameters have been adopted from various scientific papers published by international scientists. Very often, they refer to model melts

and not to industrial polymers. Thus, the resulting MMD curve as well as the result texts are not guaranteed to be absolutely correct. The material parameters depend on the temperature they were evaluated at.

Anton Paar is not responsible for the parameters. For unknown polymers, it is advisable to select any parameter close to the sample you are going to measure and use the resulting curve for comparison.

Example:

```
Material parameters:

Material Group       Material                                Kernel Function beta  alpha K        a     Me    Rouse
-----------------------------------------------------------------------------------------------------------------------
EP [unlinked resin]  EP       100 °C (Wassermann/Graessley)   Single-Exp.     1.7   0.01  9.35E-20 3.48  1710  Corr. 1
FEP [EP fluorinated] FEP      340 °C (Wu)                     Single-Exp.     1.7   0.01  2.75E-13 2.94  6240  Corr. 1
HDPE                 HDPE     160 °C (Carrot/Guillet)         Single-Exp.     1.7   0.01  6.08E-20 3.42  1900  Corr. 1
                     HDPE     190 °C (Wassermann/Graessley)   Single-Exp.     1.7   0.01  4.28E-21 3.6   1250  Corr. 1
                     HDPE     190 °C (Single-Exp.)            Single-Exp.     2.8   0.01  6.91E-20 3.41  1250  Corr. 1
LDPE                 LDPE     190 °C (Single-Exp.)            Single-Exp.     2.5   0.01  6.91E-20 3.41  1900  Corr. 1
LLDPE [linear]       LLDPE    190 °C (Single-Exp.)            Single-Exp.     3.5   0.01  6.91E-20 3.45  1900  Corr. 1
                     LLDPE    220 °C (Carrot/Guillet)         Single-Exp.     1.7   0.01  1.15E-21 3.67  1900  Corr. 1
LLDPE [metallocene]  LLDPE    190 °C                          Single-Exp.     1.7   0.01  1.96E-21 3.67  1900  Corr. 1
PA                   PA-Nylon 190 °C                          Single-Exp.     1.7   0.01  5.56E-15 3.4   3000  Corr. 1
                     PA-06    270 °C                          Single-Exp.     1.7   0.01  3.64E-19 3.4   1500  Corr. 1
                     PA-12    200 °C (Carrot/Guillet)         Single-Exp.     1.7   0.01  2.46E-18 3.55  1500  Corr. 1
PC                   PC              (Richards/Yoshomura)     Single-Exp.     1.7   0.01  2.38E-21 3.4         Corr. 1
```

Now set the values for the **Output data** and **Material parameters** in the tabs on the left-hand side of the **Details** pane.

Execution of an Analysis Method:

There are two possible methods for defining the data to be analyzed

1. Interactive in the diagram: Mark the G' curve in the **Frequency sweep** diagram, click the **Calculator** icon and **Analyze** in the ribbon **<Curve>, <Operation>**, Expand **Or select an analysis contained in the project** and select the **Analysis Spectrum & MMD** to execute the analysis. The **Analysis result** is then directly linked to the **Test**.

2. Use **Drag and drop** to the **Main input** of the **1st analysis step Spectrum, relaxation** or **Details, Input data** to define the **Frequency sweep** to be analyzed. A separate test is generated with the analysis result.

• **Start** the analysis

• The result is now displayed in the diagram. Click on the result in the data tree to see further **Details** of the analysis.

Example:

```
▷ 📦 PS168N 210C
▲ 📦 MMD
    ▷ ☐ 📊 Spectrum, relaxation
    ▷ ☑ 📊 MMD bimodal H(λ)
```

Analysis result short text

Mo = 1.6909E+05/4.2474E+05 g/mol; Mw = 4.7294E+05 g/mol; PDI = 1974.3

Analysis result text

```
MMD bimodal H(λ)
----------------
Project:                                Template - Frequenz-Sweep (Beispiel, Schmelze)
Input data:                             MMD 1 1, <T1>, Interval 1, From point 1
Result data:                            MMD bimodal H(λ)

ANALYSIS RESULTS:
Number of used input data points:       50
Number of result data points:           90

ATTENTION:  The defined Rouse correction 'Apply Rouse correction 1' could not be applied!
            The calculation was continued without Rouse correction.

Plateau modulus GN0:                    2.1284E+05 Pa
Number-average molar mass Mn:           2.3955E+05 g/mol
Weight-average molar mass Mw:           4.7294E+05 g/mol
Weight-average molar mass Mz:           7.2853E+05 g/mol
Weight-average molar mass Mz1:          9.1693E+05 g/mol
Polydispersity index PDI:               1.9743
Distribution component 1:               Mo = 1.6909E+05 g/mol, q = 0.84984
```

Material parameters

Material Group	Material				Kernel Function	beta	alpha	K	a	Me	Rouse	
EP [unlinked resin]	EP	100	~C	(Wassermann/Graessley)	Single-Exp.	1.7	0.01	9.35E-20	3.48	1710	Corr.	1
FEP [EP fluorinated]	FEP	340	~C	(Wu)	Single-Exp.	1.7	0.01	2.75E-13	2.94	6240	Corr.	1
HDPE	HDPE	160	~C	(Carrot/Guillet)	Single-Exp.	1.7	0.01	6.08E-20	3.42	1900	Corr.	1
	HDPE	190	~C	(Wassermann/Graessley)	Single-Exp.	1.7	0.01	4.28E-21	3.6	1250	Corr.	1
	HDPE	190	~C	(Single-Exp.)	Single-Exp.	2.8	0.01	6.91E-20	3.41	1250	Corr.	1
LDPE	LDPE	190	~C	(Single-Exp.)	Single-Exp.	2.5	0.01	6.91E-20	3.41	1900	Corr.	1
LLDPE [linear]	LLDPE	190	~C	(Single-Exp.)	Single-Exp.	3.5	0.01	6.91E-20	3.45	1900	Corr.	1
	LLDPE	220	~C	(Carrot/Guillet)	Single-Exp.	1.7	0.01	1.15E-21	3.67	1900	Corr.	1
LLDPE [metallocene]	LLDPE	190	~C		Single-Exp.	1.7	0.01	1.96E-21	3.67	1900	Corr.	1
PA	PA-Nylon	190	~C		Single-Exp.	1.7	0.01	5.56E-15	3.4	3000	Corr.	1
	PA-06	270	~C		Single-Exp.	1.7	0.01	3.64E-19	3.4	1500	Corr.	1
	PA-12	200	~C	(Carrot/Guillet)	Single-Exp.	1.7	0.01	2.46E-18	3.55	1500	Corr.	1
PC	PC			(Richards/Yoshomura)	Single-Exp.	1.7	0.01	2.38E-21	3.4		Corr.	1
PETFE	PETFE	280	~C	(Tuminello)	Single-Exp.	1.7	0.01	1.84E-21	3.4		Corr.	1
PIB	PIB MELT	150	~C	(Wassermann/Graessley)	Single-Exp.	1.7	0.01	3.74E-20	3.43	9400	Corr.	1
PMMA	PMMA	220	~C	(Carrot/Guillet)	Single-Exp.	1.7	0.01	1.00E-19	3.4	5000	Corr.	1
PPC	PPC-PAC	125	~C		Single-Exp.	1.7	0.01	5.92E-19	3.4	5500	Corr.	1
PP	PP	185	~C	(Carrot/Guillet)	Single-Exp.	1.7	0.01	8.71E-23	3.77	3500	Corr.	1
	PP	200	~C	(Single-Exp.)	Single-Exp.	2.5	0.01	6.91E-20	3.23	3500	Corr.	1
PP [iso-tactic]	PP	190	~C	(Wassermann/Graessley)	Single-Exp.	1.7	0.01	3.42E-22	3.6	6520	Corr.	1
PP [a-tactic]	PP	190	~C	(Wassermann/Graessley)	Single-Exp.	1.7	0.01	1.82E-22	3.6	6520	Corr.	1
PP [co-polymer]	PP	200	~C	(Sinlge-Exp.)	Single-Exp.	2.5	0.01	6.91E-20	3.23		Corr.	1
PS	PS	150	~C	(Wassermann/Graessley)	Single-Exp.	1.7	0.01	2.38E-17	3.38	17400	Corr.	1
	PS	160	~C	(Carrot/Guillet)	Single-Exp.	1.7	0.01	7.43E-18	3.34	14000	Corr.	1
	PS	160	~C	(McGrory/Tuminello)	Single-Exp.	1.7	0.01	1.26E-17	3.34	17500	Corr.	1
	PS	170	~C		Single-Exp.	1.7	0.01	1.73E-18	3.4	17400	Corr.	1
	PS	200	~C	(Single-Exp.)	Single-Exp.	2.5	0.01	6.91E-20	3.41	17400	Corr.	1
PS [iso-tactic]	PS	200	~C	(Single-Exp.)	Single-Exp.	2.5	0.01	6.91E-20	3.52		Corr.	1
PTFE	PTFE	380	~C	(Tuminello)	Single-Exp.	1.7	0.01	5.37E-20	3.4	4667	Corr.	1
PVDF	PVDF	200	~C	(Carrot/Guillet)	Single-Exp.	1.7	0.01	7.88E-19	3.4	22700	Corr.	1

Distribution Settings:

- **Kernel function**: The Kernel function of first choice is the **Single exponential kernel**

- **Edge-preserving method**: Gives better estimation at ends of spectrum (depending on the polymer to be investigated and the quality of the frequency sweep data).

- **Unimodal, bimodal or auto**:

- Due to the complicated mathematical algorithm it is difficult for an inexperienced user to see whether a second peak is related to measuring artifacts in the input data (**Frequency sweep**) or a true bimodal distribution.

    - The **Unimodal option** is intended for inexperienced users or for known **Unimodal** material.
    - The **Bimodal option** is used for analyzing polymer blends with a second peak or a shoulder in the MMD.
    - The Auto mode is intended to be used for unknown samples.

Calculation Settings for Spectrum, Relaxation:

- **Automatic**: Use these settings by **Default**.

- **Manual**: Use these settings if the **Auto** mode does not provide any result.

    - **Alpha calculation**: Use the value **0.01** (or 0.1) if the **Auto** calculation does not work.

- **Output range**:

    - **Number of alpha values**: Define the number of resulting data points for Lambda
    - **Lambda-Range limits**:
        - Use **Automatic (edge smoothing)** as default
        - Use **Gaussian** if the Automatic provides noisy data
        - Use **Full spectrum** if the left or right end of the spectrum is missing
        - Use **Set range manually** to define your own limits for the **Lambda_min** and **Lambda_max** depending on the Omega range of the frequency sweep (Lambda_min = 1 / Omega_max; Lambda_max = 1 / Omega_min).

7.2.1.34 MMD Inverse

Use this method to calculate the **Continuous relaxation time spectrum** from a Molar mass distribution.

Requirements

The **Polymer Analysis Package** is an optional feature of RheoCompass™. To check whether the license feature is enabled click on **About RheoCompass** and check whether the feature **Analysis package** is **Enabled**. To request a trial license, including the feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

<Output>

Select the **Output data** type:

• Total spectrum

• Entanglement spectrum

• Glass spectrum

Enter the number of data points to be generated and the limitations of the spectrum (default is from 0.001 s to 100 s).

<Material Parameters>

Enter the material parameters of the polymer melt (default settings shown):

Entanglement molar mass Me:	100	g/mol	CW exponent ng:	-1	
Entanglement relaxation time λe:	0.05	s	CW spectrum parameter Hg:	10000	Pa
BSW exponent ne:	100				
Plateau modulus GN0:	1000000	Pa			

7.2.1.35 MRF Analysis

MRF analysis is used if either the set variable **Current I** or the magneto-rheological variables are not included in the measuring data.

<Calculation>

Select the calculation mode:

• Calculate magnetic flux density B from current I

  - Calculate magnetic flux density B from current I using the parameter **Magnetic Flux Density of Cell**

• Measure magnetic flux density B with Teslameter 5180

  - Measure magnetic flux density B with a **Tesla Meter** connected to the MCR and selected as **Accessory** in the **Configuration**

<Relative permeability of sample>

Define the **Relative permeability** of the sample at different **Field strengths**. Values should be separated by semicolons.

Typical values for the MRD are already defined in the project templates for MRF.

<Magnetic flux density of cell>

Only visible in mode **Calculate magnetic flux density B from current I**.

Define the magnetic flux density within the measuring gap without sample at different flux densities. A list of values is provided with the measuring cell based on the standard configuration with the PP20/MRD and without spacer ring.

Typical values for the MRD are already defined in the project templates for MRF.

<Current profile>

Set the values according to the measuring profile being used in this test with the correct scaling type.

In case of a constant voltage, set **Initial value** and **Final value** to the same value and used **Linear** scaling.

7.2.1.36   Quality Control

Use **Quality control** to check whether a measured value is within a certain tolerance.

<Calculation>

Define the allowed tolerance for the x-variable being used.

Tolerance Modes:

- Constant relative tolerance with target value and tolerance

  - Enter Target value and Tolerance [%]:

Target value:	2000	Pa·s
Tolerance ±:	3	%

- Constant absolute tolerance with target value and tolerance

  - Enter Target value and Tolerance [Unit]:

Target value:	2000	Pa·s
Tolerance ±:	60	Pa·s

- Constant relative tolerance with upper and lower boundary

    - Enter Upper boundary and Lower boundary:

| Upper boundary: | 1997 | Pa·s |
| Lower boundary: | 2003 | Pa·s |

\<Variables\>

Define the X variable to be checked.

\<Output\>

In **options**, the criteria for the quality control check are defined.

Define the criteria as **Passed** if

- **all input points are within the tolerance** (recommended)

- maximum n points are outside the tolerance

- maximum n % of all points are outside the tolerance

The result of the quality-control check is defined with the option **Output data**.

Define whether the result is / contains

- The passed/failed result as result text but **No result data points**

- **One result data point with passed/failed result** (recommended)

    - Data point stored in variable **Logical Value b_log**

- All input data points

- All input data points within the tolerance

- All input data points outside the tolerance

- Tolerance boundaries

- All input data points each with relative deviation from the target value

    - Result stored in variable **Relative deviation Delta_rel**

7.2.1.37 Regression
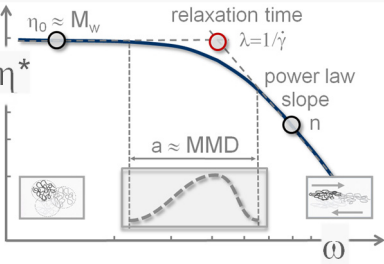
This method is used to apply any regression model to the measured curve, and to extrapolate the regressed curve

<Calculation>

• **Weighting of the fit**:

  - Relative error:
    • Data with small x-values are weighted higher than data with large x-values
    • This provides a better fit of data points at smaller values
  - Absolute error:
    • Even weighting of all data points
    • Mainly used to be compatible with previous software packages

• **Regression parameter**:

  - The regression parameter are calculated by the evaluation algorithm to fit the calculated to the measured values. Each regression model has a certain number of regression parameter. The regression parameter are calculated automatically. Optionally parameter can be defined by the user as given parameter.

• **Regression model**:

  - All regression methods are universal methods which makes it possible to apply the method to a frequency sweep Eta * (omega) as well as a flow curve Eta(shear rate).
  - X = X-variable defined in input data; very often this is Shear rate, Angular frequency, Temperature
  - Y = Y variable defined in input data; very often this is Eta, Eta* or Tau, G*

Regression model	Typical curve function	Application	Formula
Arrhenius	Eta(T), aT(T)	**The Arrhenius regression** describes the change of the viscosity with temperature. The equation is valid for liquid materials. It can also be used to describe the temperature dependency of the zero shear viscosity.	$y = a \cdot e^{b \cdot \left(\frac{1}{x+c} - \frac{1}{x_0+c} \right)}$
Auto-Regression	all	Curve regression with an auto selection of any regression model based on a weighted least-square function.	

Regression model	Typical curve function	Application	Formula
Bingham	Tau (shear rate)	**The Bingham regression** describes the flow curve of a material with a yield stress and a constant viscosity (Newtonian behavior) at stresses above the yield stress. It is frequently used for food or cosmetics. **Related models** are the Casson regression and the Herschel-Bulkley regression which also describe materials with a yield stress. The **parameter** a is calculated as the y-axis value at x=0, the parameter b is calculated as the slope of the curve at x ->∞.	$y = a + b \cdot x$
Blau		**The Blau regression** has been developed to describe the viscosity curve of casting slip. It has a shear thinning region and an end zone with a constant infinite viscosity.	$y = a \cdot \left(\coth \frac{x}{b} \right)^c$
Carreau	Eta (shear rate)	**The Carreau regression** describes the viscosity curve of a material with Newtonian regions at low and at high shear rates and a shear thinning region at medium shear rates. This model is **equivalent** to the Carreau-Gahleitner regression with the parameter b=2.	$y = \frac{y_0 - y_\infty}{[1 + (a \cdot x)^2]^p} + y_\infty$
Carreau-Gahleitner	Eta (shear rate), Eta* (omega)	**The Carreau-Gahleitner regression** describes the viscosity curve of a material with Newtonian regions at low and at high shear rates and a shear thinning region at medium shear rates. If the **parameter** b is equal to 2, this equation is identical with the **Carreau** regression described in the previous chapter.	$y = \frac{y_0 - y_\infty}{[1 + (a \cdot x)^b]^p} + y_\infty$

Regression model	Typical curve function	Application	Formula
Carreau-Yasuda	Eta (shear rate), Eta* (omega)	**The Carreau-Yasuda regression** describes the viscosity curve of a material with Newtonian regions at low and at high shear rates and a shear thinning region at medium shear rates. It is often used to fit a curve of a polymer melt measured with a frequency sweep. Fit parameter for a typical polymer melt: $\eta_0 \approx M_w$ relaxation time $\lambda = 1/\dot{\gamma}$ η^* power law slope n $a \approx MMD$ ω With: η_0 Zero shear viscosity = proportional to molar mass n Power law exponent = qualitative measure for the macro molecules to orient in shear direction und to reduce flow resistance a Width of transition range = proportional to MMD and PDI -> narrow MMD=steep, broad MMD=flat) λ Relaxation time = time dependent recovery of internal stresses De Deborah Number $$De = \frac{Relaxation\ \ Time}{Processing\ \ Time} = \lambda \cdot \dot{\gamma}$$ Rule of thumb for processing Make sure that De value is as low as possible The method is a good alternative to the **MMD Bimodal** or **Molar mass Eta(0)** method. Compared to these methods the data is directly related to the rheologically measured data.	$y = \dfrac{y_0 - y_\infty}{[1+(\lambda \cdot x)^a]^{\frac{1-n}{a}}} + y_\infty$
Casson	Tau (shear rate)	**Casson regression** for Yield stress analysis which is typically used for characterization of food products, chocolate, blood or other yielding samples. The Casson equation describes the flow curve of a material with a yield stress and a non-Newtonian behavior at stresses above the yield stress.	$y^{\frac{1}{p}} = a + b \cdot x^{\frac{1}{p}}$

Regression model	Typical curve function	Application	Formula
Casson-Steiner	Tau (shear rate)	**The Casson-Steiner regression** describes the flow curve of a material with a yield stress and a non-Newtonian behavior at stresses above the yield stress. It often provides a good fit for blood and for food products; it is often used for chocolate. It is **similar** to the **Casson** regression but takes the radius ratio for concentric cylinder systems into account. For concentric cylinder systems according to DIN/ISO this ratio is 1.0847.	$y^{\frac{1}{2}} = a + b \cdot x^{\frac{1}{2}}, \ \tau_0 = a^2$ $\eta_\infty = b^2 \cdot \left(\frac{\delta+1}{2\cdot\delta}\right)^2, \delta = \frac{R_a}{R_i}$
Cross	Eta (shear rate), Eta* (omega)	**The Cross regression** describes the viscosity curve of a material with a zero shear viscosity, a constant viscosity at high shear rate values and a shear thinning region in between. It is similar to the Carreau, Carreau-Yasuda or Carreau-Gahleitner evaluation. The Cross regression often fits well to polymer melts and to biopolymers. The second Newtonian region cannot necessarily be observed for these materials.	$y = \frac{y_0 - y_\infty}{1 + a \cdot x^p} + y_\infty$ $a = c^p$
e-Function	all	**Exponential curve regression** based on an exponential function.	$y = a \cdot e^{b \cdot x}$
Ellis	Tau (shear rate)	**The Ellis regression** is often used to describe the flow behavior of polymers, especially at low shear rates. It describes a material with a zero shear viscosity and a shear thinning region. The high shear rate range is not considered in this model.	$y = a \cdot x + b \cdot x^p$ $p > 1$
Eyring-Prandtl-Ree		**The Eyring-Prandtl-Ree regression** describes the flow behavior of a material whose viscosity is approaching a constant value for -> 0. The model has been developed with the assumption that molecules change their position in the direction of the applied stress.	$y = a \cdot \sinh\frac{x}{b}$
Herschel-Buckley	Tau (shear rate)	**The Herschel-Bulkley regression** describes the flow curve of a material with a yield stress and shear thinning or shear thickening behavior at stresses above the yield stress.	$y = a + b \cdot x^p$

Regression model	Typical curve function	Application	Formula
IOCCC 2000 / Windhab	Tau (shear rate)	Curve **regression** for Yield stress analysis according to the **IOCCC2000/Windhab** method for characterization of Chocolate. This analysis method is generally used for the evaluation of flow curves from chocolate and other cocoa products. It is recommended by the 'International Office of Cocoa, Chocolate and Sugar Confectionery'.	$y = a + b \cdot x + c \cdot \left(1 - e^{-\frac{x}{d}}\right)$
Krieger-Dougherty	Eta(volume concentration)	**The Krieger-Dougherty regression** describes the viscosity curve as a function of the volume concentration of a filler Eta(volume concentration). It is often used to describe the behavior of suspensions.	$y = \frac{y_0 - y_\infty}{1 + a \cdot x} + y_\infty$
Newton	Tau (shear rate)	**The Newton regression** describes the flow curve of a material with a constant i.e. shear rate independent viscosity. The flow curve is a straight line through the origin, the slope of the curve is the viscosity. Select function tau(shear rate) as input data to calculate the Newtonian viscosity.	$y = a \cdot x$
Ostwald/ Power Law	Eta (shear rate), Eta* (omega)	**The Power law (Ostwald) regression** can be used to represent the flow curves of shear-thinning or shear-thickening materials. If the exponent p is equal to one, the equation is identical to the Newton model. For a shear-thinning material, p is smaller than one, and greater than one for shear-thickening materials.	$y = a \cdot x^p$
Phillips-Deutsch	Tau (shear rate)	**The Phillips-Deutsch regression** describes the flow curve of a material that has two Newtonian regions, one at very low shear rates and one at high shear rates. In between, the material is shear thinning. This model is similar to the models Carreau and Carreau-Gahleitner.	$y = a \cdot \frac{1 + b \cdot x^2}{1 + c \cdot x^2} \cdot x$ $c > 0$
Quemada		**The Quemada regression** is commonly used to evaluate measurements on blood and serum.	$y = a \cdot x^p$
Sisko		The Sisko regression describes the behavior of a material with a shear thinning and a Newtonian region at high shear rates.	$y = a \cdot x + b \cdot x^p$ $0 < p < 1$

Regression model	Typical curve function	Application	Formula
Steiger-Ory	Tau (shear rate)	**The Steiger-Ory regression** describes shear thinning materials.	$y = a \cdot x + b \cdot x^3$
Stettin		**The Stettin regression** can be used to describe the viscosity as a function of temperature where the Arrhenius equation does not give a good correlation between measured and calculated values.	$y = a \cdot x^b \cdot e^{\frac{c}{x}}$
Temperature		**This Temperature regression** can be used to describe the temperature dependency of a material where the Arrhenius equation does not give a good correlation between measured and calculated values.	$y = a \cdot b^{x^c}$ $\frac{y}{a} > 1, a > 0$
Tscheuschner	Tau (shear rate)	**The Tscheuschner regression** has been developed to describe the flow behavior of chocolate in a broader range than the Casson equation.	$y = a + b \cdot x + c \cdot x^p$
Vinogradov-Malkin	Eta (shear rate)	**The Vinogradov-Malkin regression** describes the viscosity curve of a material with a zero shear viscosity value and a shear thinning region. The model can be optimized for different parameters (see 'Optimization Target') depending on the sample behavior.	$y = \frac{y_0 - y_\infty}{1 + a \cdot x^p + b \cdot x^{2 \cdot p}} + y_\infty$
WLF	aT(T)	Curve **regression** used for temperature sweeps of non curing samples according to the **WLF** model. The **Williams-Landel-Ferry** equation describes the temperature dependence of the viscoelastic properties of a material. It is used for the time temperature superposition of viscoelastic data. Measurement data, from a frequency sweep for example, taken at one temperature can be shifted horizontally to complement the data taken at a different temperature. Thus, the material properties can be studied over a broader frequency range than it would be possible with just the measurement data at a limited frequency range. The constants a and b are typical values for the material that has been measured, they can be calculated with the 'WLF I' evaluation.	$y = e^{\frac{a \cdot (x - x_0)}{b + (x - x_0)}}$

\<Variables\>

Define the X-variable and the Y-variable:

- There is no need to define the variables by using the interactive analysis.

    - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are adopted automatically.

\<Output\>

Use the output to define the range of the regressed curve.

- X-values from main input data (default)

    - The regression is done for the same x values as measured

- X-values from list

    - Use a list of X-values to define a new range for the regressed curve. Even extrapolation is allowed using the list of predefined X-values.

- Redistribute X-values equidistantly

    - Define the number of X-values within the measured range but distributed equidistantly with a linear or logarithmic distribution

- X-values from additional input data

    - Use the additional input of the analysis step to read X-values from any other result to be used as X-values for the regressed curve.

7.2.1.38   Rearrange

This method is used to rearrange the incoming data points, and to generate a temporary result from the data input, which is then used in several other steps as **Input data**.

Example: Using the method **Rearrange**, a temporary result <T1> is created, which is then used to calculate the **Curve Minimum**, **Maximum** and **Slope**. Benefit: Only one input needs to be defined for three independent methods.

<Calculation>
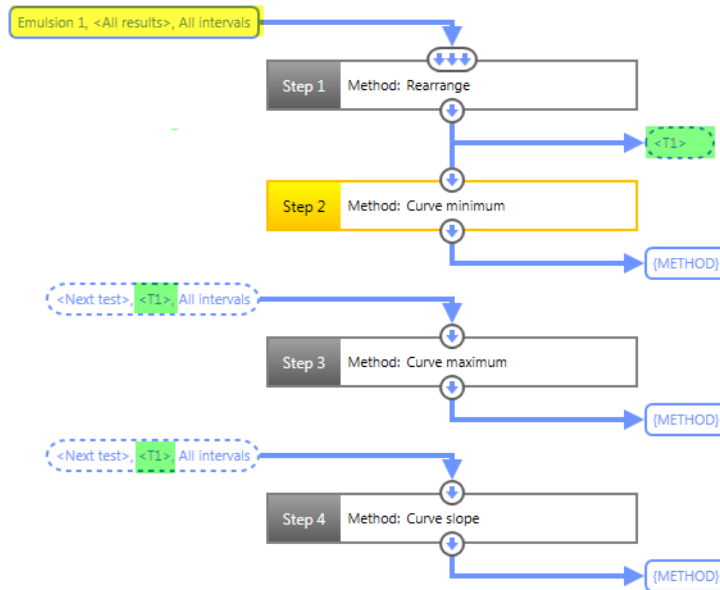
Time Correction:

Select the option to keep all time values unchanged or to set the very first input data point to 0. Example: A measurement contains four intervals but only intervals 2 to 4 are defined as input data. To start the time counter in interval 2 with a time of 0 s, the second option should be selected.

• Keep time values unchanged

• Redefine time values (set start time of first data point in first interval to 0)

Interval Handling:

• Store all data ranges in one single result interval.

- Example: Input data contains intervals 1, 2 and 3. Result data is just one interval containing the data points of all three previous intervals.

• Store input data ranges in separate result intervals.

- Example: Several input data ranges are defined. Each data range is stored in a separate result interval.

Missing Variables:

- Drop variables not contained in every input data range.

    - Example: In input data, two data ranges are defined. The result of data range 2 does not contain variable gap but all other variables also contained in data range 1. After rearranging the two data sets, the gap is removed from the resulting data.

- Keep variables not contained in every input data range, and set value as valid.

    - Example: In input data, two data ranges are defined. The result of data range 2 does not contain variable gap but all other variables also contained in data range 1. After rearranging the two data sets, the gap is added to the 2nd data range with a value of 0.

7.2.1.39 Result Field

The method **Result field** is used to define 1, 2, 3 or 4 variables as **Result text**.

It is advisable to allow only one Input data point in this method. The input data is adopted from any other method, such as **interpolation**, providing many variables to make a selection of the variables needed for a report or to be displayed in the diagram legend.

<General>

Use different number formats for the variables:

- Check this option to set the number format individually for each of the defined variables.

Use different units:

- Check this option to set the units individually for each of the defined variables.

<Variable>

Define the variable, the number format and the units of the variable.

7.2.1.40 Smoothing

Smoothing is used to remove noise from the data.

<Calculation>

Select the **Smoothing algorithm**:

- **Standard smoothing (Default)**

    - Using this method, the same smoothing algorithm is applied to the complete curve range

- Select this option if outliers are distributed over the whole curve
- Smoothing strength with manual settings:
  - Linear: 5 % = low; 10 % = moderate; 20 % = strong
  - Logarithmic: 1 % = low; 3 % = moderate; 6 % = strong

- **FFT smoothing**

  - Using this method, the curve is divided into segments, each with individual curve smoothing.
  - Select this option if there are more outliers in a very limited area of the curve

Select the **Smoothing mode**:

- Select one of the smoothing modes according to the diagram settings

- It is advisable to select **Auto-smoothing** by **Default**.

<Variables>

Define the X- and Y-variable(s)

- There is no need to define the variables by using the interactive analysis.

  - Using the **Calculator** icon in the ribbon with manual selection of data points the data as well as the variables are taken over automatically.

<Interpolation>

Select the distribution method for the resulting x-values:

- Use the x-values of the input data

- **Redistribute x-values equidistantly** (use as **Default**).

7.2.1.41   Sorting

Sorting is used to sort the values of a variable

<Sort by>

Select the variable and the sorting order for this variable:

- Ascending

- Descending

Example:

This method is often used to sort a flow curve of a yield fluid by shear rate (in a stress-controlled test) or shear stress (in a shear-rate-controlled test).

Background: In the transition from rest to flow, the curve becomes unsteady. This method is used to sort the values.

7.2.1.42   Spectrum Inverse, Relaxation

This method is used calculate the **Moduli** G', G" or G(t) from a **Continuous relaxation time spectrum**.

The method is used for checking the accuracy of the **Continuous relaxation time spectrum** with various parameter settings by reversing the calculation. By setting a manual output range, the method can also be used for extrapolating the frequency sweep data:

- G', G" -> **Spectrum, relaxation** -> **Spectrum inverse, relaxation** -> G', G"

It can also be used for converting a function such as:

- G', G" -> **Spectrum, relaxation** -> **Spectrum inverse, relaxation** -> G(t)

- G(t) -> **Spectrum, relaxation** -> **Spectrum inverse, relaxation** -> G', G".

Samples:

- Use this method for linear polymers (polymer melts) only

- The method is based on Maxwell-like samples

- It does not work on branched polymers, polymers with cross-links, emulsions or samples containing solid particles.

<Calculation>

Define the input variables. Typically the input variables are **Dynamic moduli G', G"**.

Check if the temperature is included in input data.

<Output>

Number of Lambda values: Enter the number of Lambda values to be calculated for the spectrum (Default = 90).

Lambda-range limits (wider but noisier range from top to bottom options):

- Automatic (Gaussian smoothing)

  - Provides an output range based on a Gaussian distribution

- Automatic (Edge smoothing)

  - Provides an output range based on smoothened edges)

- Automatic (full spectrum)

  - Provides a full spectrum based on the inverse values of the input data frequency range

- Manual

  - Allows to set the limits for lambda individually
  - Use 1/frequency(maximum) for Lambda(minimum)
  - Use 1/frequency(minimum) for Lambda(maximum)

Example:

This is an example for converting the measured relaxation modulus G(t) from a step-strain test into frequency-sweep data with the modulus G'(omega). There are three steps for create the result data:

1. **Measurement** of the **Relaxation modulus G(t)** using a step strain test

2. **Calculation** of the **Relaxation–time spectrum H(lambda)**

3. **Conversion** of the **Relaxation–time spectrum** into moduli **G'(omega)** and **G"(omega)**

The example can also be found in the RheoCompass **App Manager** called **Step rate, Start up flow, example**.

Measurement of G(t):	
Calculation of Spectrum H(lambda)	

Calculation of frequency sweep data	
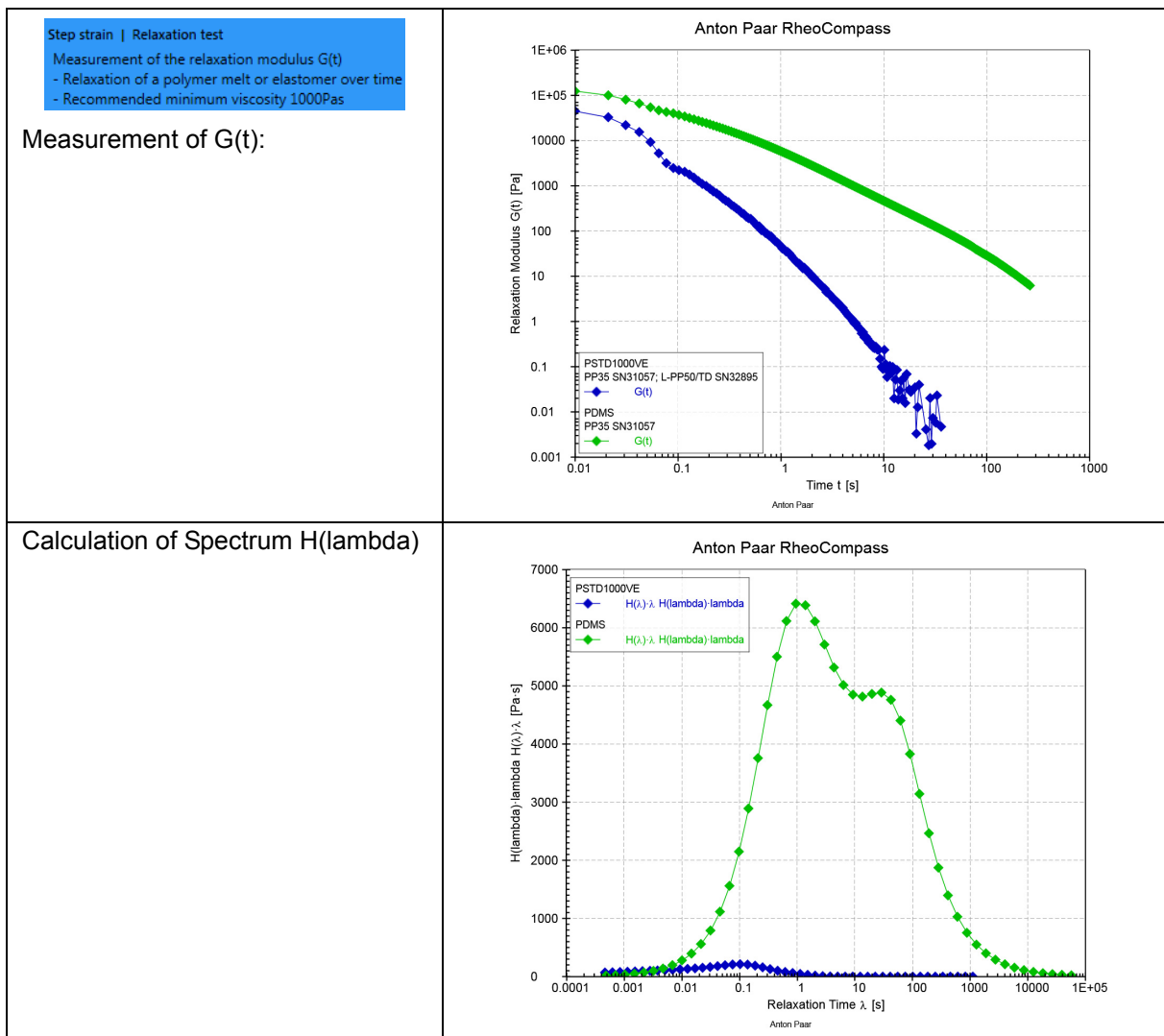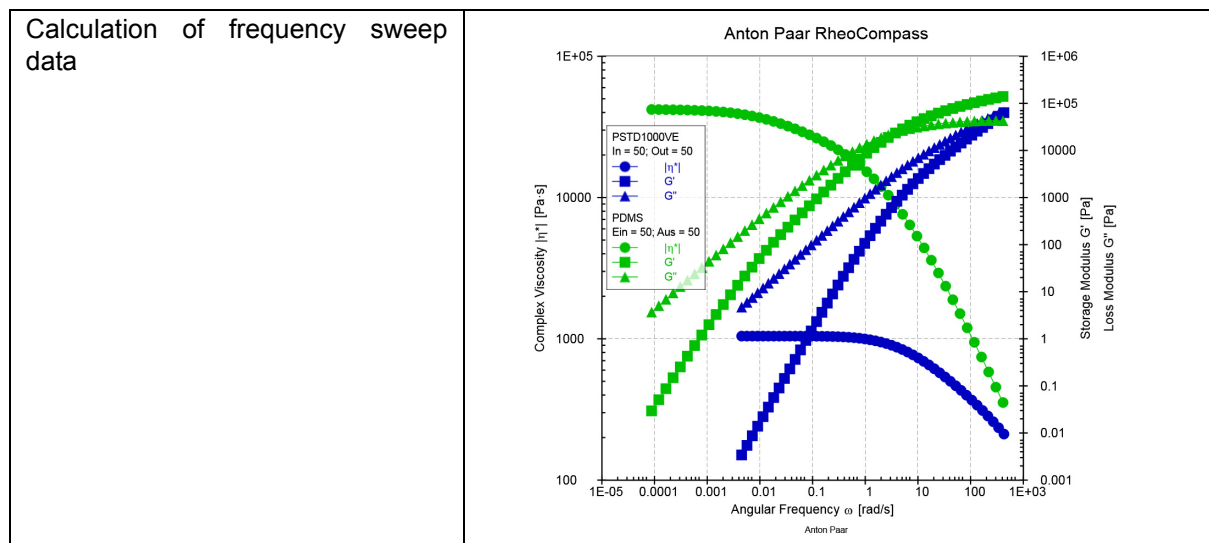
7.2.1.43 Spectrum, Relaxation

This method is used to calculate the **Continuous relaxation time spectrum** from the dynamic moduli.

Samples:

- Use this method for linear polymers (polymer melts) only

- The method is based on Maxwell-like samples

- It does not work on branched polymers, polymers with cross-links, emulsions or samples containing solid particles

<Calculation>

Define the input variables. Typically the input variables are **Dynamic moduli G', G"**.

Check if the temperature is included in input data.

Define the settings of the method:

- Use **Automatic** to let the software select the settings

- Use **Manual** to define settings manually, especially if the automatic mode does not provide good data.

  - **Alpha calculation**:
    - Calculate value automatically
    - Define value manually (use 0.01 as default)
  - **Smoothing**:
    - No smoothing
    - Cubic spline
      - Output: Relaxation time spectrum

- • Output: Smoothened input data (used for checking the effect of the curve smoothing; development of a method with user defined settings)
  - Bandwidth:
    - • Set to default value = 1 %

Edge-preserving regularization (EPR): Based on the regularization method commonly used in rheology, the relaxation-time spectrum is assumed to be smooth. Accordingly, the method is not able to properly resolve spectra containing edges or at least containing large curvatures as proposed in the literature. By selecting the **Edge preserving regularization (EPR)**, peaks are more significant in the terminal relaxation regions.

<Output>

Number of Lambda values: Enter the number of Lambda values to be calculated for the spectrum (default = 90).

Lambda-range limits (wider but noisier range from top to bottom options):

- • Automatic (Gaussian smoothing)

  - Provides an output range based on a Gaussian distribution
  - Extrapolation of data beyond the time scale of the input data

- • Automatic (Edge smoothing)

  - Provides an output range based on smoothed edges)
  - Limited extrapolation of the time scale of the input data

- • Automatic (full spectrum)

  - Provides a full spectrum based on the inverse values of the input data frequency range
  - No limitation applied to the time scale of the input data

- • Manual

  - Allows the limits for lambda to be set individually
  - Use 1/frequency(maximum) for Lambda(minimum)
  - Use 1/frequency(minimum) for Lambda(maximum)

7.2.1.44   Yield Point

Yield point is used to determine the upward inflection of two variables, typically shear strain and shear stress in a logarithmically scaled diagram. The yield point is found at the point where the curve slope changes, assuming that the sample undergoes a change in material properties.

The method is used for calculating

- the flow point TAU_f (sometimes also called the flow stress) based on the upward inflection of the Gamma(tau) function. At the flow point, the gel character changes to a liquid character and the sample starts to flow. Settings: Mathematical & Logarithmic

- the yield point TAU_y (sometimes also called the yield stress) is based on an upward inflection of the Gamma(tau) function. No significant change of the internal structure occurs as long as stresses below the "yield point" are applied. Below the yield point, the material shows reversible viscoelastic behavior. Settings: Linear & Geometric.

Instead of using the described method **Yield point**, we recommend using the ready-to-use **Macros** for **Flow point** and **Yield stress** calculations.

<Calculation>

Define the calculation settings for the Yield point calculation.

• Calculation mode

  - Geometrical determination (default)
    • Select the scaling type of the regression
      • Automatic (default): The software decides whether to select a linear / linear or linear / polynomial regression

        ✂ linear / linear: linear regression for both parts of the curve in a logarithmically scaled diagram

        ✂ linear / polynomial 3rd degree: linear regression for the lower part and polynomial regression of 3rd order for the upper part of the curve. Very often the polynomial regression of 3rd order is the better choice for the upper part of the curve.

    • The geometrical regression is based on a regression line for the range below and above the investigated point. The yield point is found at the intercept of the two regression lines.
    • It is advisable to use logarithmic scaling and calculation
    • The more data points the better and more reliable the result will be.

  - Mathematical determination
    • Select the scaling type of the axes
      • x logarithmic / y logarithmic (default)
      • x linear / y logarithmic
      • x logarithmic / y linear
      • x linear / y linear

        ✂ Linear regression for both parts of the curve in a logarithmically scaled diagram

    • Using the mathematical calculation, the onset is determined in the logarithmically scaled gamma-tau diagram. A regression line is fitted to the measuring data and the point is determined with the maximum distance at both ends of the line. This point is reported to be the yield point.
    • It is advisable to use logarithmic scaling and calculation
    • The more data points, the better and more reliable the result will be.

• **Bending direction**

  - Upward bending (default)
  - Downward bending

- **Bandwidth**

  - 5% is the recommend default value. This value is used to calculate error boundary.

- **Output data**

  - One data point with yield point
    - The calculated intercept is saved as result. This allows the data point to be shown in a diagram, table or report.
  - Curve with criterion
    - Both regression curves are saved in a single result. The result is then used to show the quality of the regressed curve.
  - No output data
    - No result data point is generated but the result is visible in the analysis text result.

<Variables>

Define the X- and Y-variable(s)

- There is no need to define the variables by using interactive analysis.

  - Using the **Calculator** icon in the ribbon with manual selection of data points, the data as well as the variables are automatically adopted.

7.2.1.45 Glass Transition Temperature

The glass transition is a continuous relaxation process from a frozen glassy structure into a more flexible rubber-like material behavior. This process of relaxation allows broad interpretation about where exactly to find the glass transition temperature T_g.

Peak T_g ($\tan(\delta)$max) or End point temperature T_{efg} can be used as lower limits of the use-temperature range of adhesives or elastomer based end products. In an ideal case the moduli of G' and G" are almost constant in the rubber-elastic region which means that the material properties such as the tackiness and shear strength are constant as well. For thermo-melt or thermo-set based end products the extrapolated onset temperature T_{eig} or the Peak T_g (G"max) should be used as upper limits of the use-temperature range which means the material is dimensionally stable until this limit is reached.

This method is used to calculate the glass transition temperature of a sample measured in shear, torsion or extension.

<Calculation>

Calculation method:

Select one of the following calculation modes for calculating the glass transition method:

- Half step height method (ISO 11357-1, ISO 11357-2)

  - Calculation of the extrapolated onset temperature T_{eig}

- Calculation of the extrapolated midpoint temperature according to the half step height T_{mg}
  - Calculation of the extrapolated end temperature T_{efg}

- Flex point method (ISO 11357-1, ISO 11357-2)

  - Calculation of the extrapolated midpoint temperature at the flex point T_{mg}

- 2% method (DIN 65583, DIN 29971)

  - Calculation of the extrapolated onset temperature according to the 2 % method $T_{g2\%}$
  - Calculation of the midpoint temperature T_{mg}

Input variables:

Define the X- and Y-variable T, G' for shear rheological measurements and T, E' for extensional measurements.

Y-Scaling:

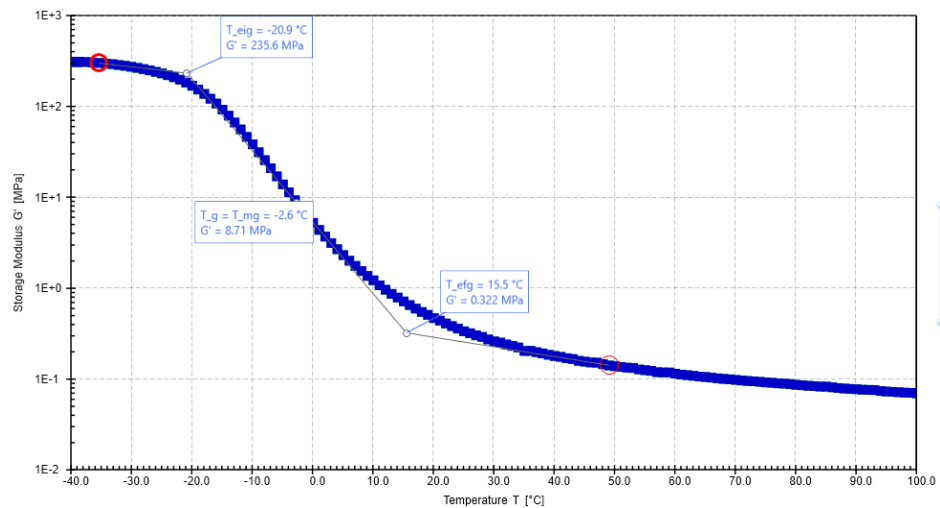- Linear (recommended for the 2 % method)

- logarithmic

Fig. 7 - 10   Example for the half step height method.

7.3   Analysis Macros and the Macro Designer

The **Macro** action combines analysis steps. It is a kind of **Black box** containing one or multiple **Steps** with **Methods**.

The **Macro designer** can be used in the RheoFinder to define a new macro or to edit any existing macro.

In contrast to the **Methods**, the **Macro** is ready-to-use and has no or few parameter settings.
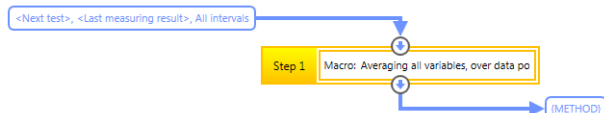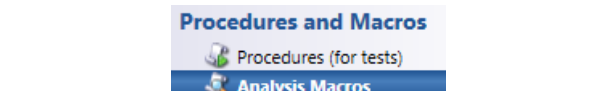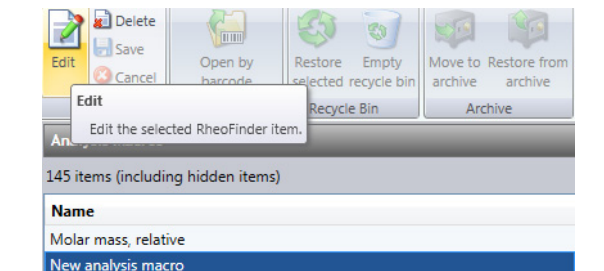
To update a local copy of the macro which is part of a test definition, open the source project and click the ribbon button **Analysis, Analysis Macro, Replace by original**.
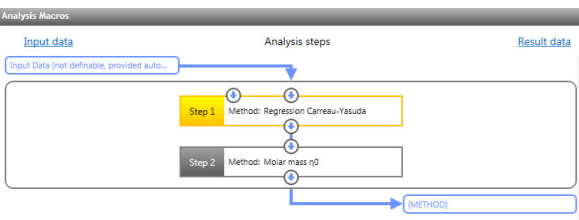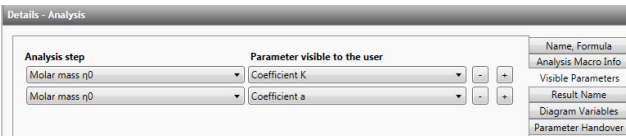
Special Settings in the Details Pane:

1. In <**Name, Info**> the **Name** and a **Description**, which is shown when the mouse cursor is over the action, should be defined.

2. Use the tab <Remarks> to define information text for each step.

3. In <**Parameters**> all details defined for **Visibility** can be set (to be defined in the macro designer).

4. Use **Input data** to define the input data of the macro or drag and drop to input.

5. Use **Result data** to define a result name or to define a result as temporary data to be used as input data for other steps. Insert placeholders to predefine an automated naming dependent on the test input and information.

Examples of ready-to-use analysis macros:

| Target value: | 2000 | Pa·s |
| Tolerance ±: | 3 | % |

Macro in the analysis action	
Macros in the RheoFinder (Macro Designer)	
Open the macro in edit mode or create a new one	

Macro in edit mode of the macro designer	
Example for visibility details	
Save and close	Click ribbon **RheoFinder, Save** to save and close the procedure designer
To adopt changes into the test definition	Open the project and click the ribbon button **Analysis, Analysis Macro, Replace by original**

7.3.1   Overview of the RheoCompass Analysis Macros

A **Macro** is a ready-to-use **Analysis macro** consisting of one or multiple analysis methods. The **Macro** is more **Application oriented** whereas the **Method** is the **Basic mathematical model** used in all Macros with application-specific presets.

This list summarizes the most frequently used analysis Macros.

The documentation and the Macros described therein are subject to change without notice.

Requirements

The **Polymer Analysis Package** is an optional feature of RheoCompass™. To check whether the license feature is enabled, click on **About RheoCompass** and check whether the feature **Analysis Package** is **Enabled**. To request a trial license, including the feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

The **Interfacial Analysis Package** is an optional feature of RheoCompass™. To check whether the license feature is enabled, click on **About RheoCompass** and check whether the feature **Analysis Package** is **Enabled**. To request a trial license, including the feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

Name of Macro	Function
Averaging	
Averaging all variables, over data points	Rheological variables are calculated from the average of motor variables within a single test result.
Averaging all variables, over results	Rheological variables are calculated from the average of motor variables over several test results.
Averaging complex **viscosity**, over data points	Calculation of the average value of complex viscosity within a single test result.

Name of Macro	Function
Averaging viscosity, over data points	Calculation of the average value of viscosity within a single test result.
Cloud point	
Cloud point	Cloud-point calculation based on an Eta(T) upward inflection. This method is used for crude oils as well as for other liquid-like emulsions.
Pour point, midpoint	Pour-point calculation based on an Eta(T) curve inflection. This method is used for crude oils as well as for other liquid-like emulsions.
Pour point, onset	Pour-point calculation based on an Eta(T) downward bending. This method is used for crude oils as well as for other liquid-like emulsions.
Conversions	
Conversion Cox-Merz, Eta(gamma-dot) -> Eta*(omega)	Conversion of the shear viscosity into complex viscosity based on the empirical Cox-Merz rule (only valid for linear unfilled polymers).
Conversion Cox-Merz, eta*(omega) -> eta(gamma-dot)	Conversion of the complex viscosity into shear viscosity based on the empirical Cox-Merz rule (only valid for linear unfilled polymers).
Conversion frequency sweep, G', G" -> G(t)	Conversion of the measured storage G' and loss modulus G" into a relaxation modulus G(t).
Conversion frequency sweep, G', G" -> H(lambda)	Conversion of the measured storage G' and loss modulus G" into a continuous relaxation time spectrum H(lambda).
Conversion mirror relation, Eta(t) -> Eta(gamma-dot)	Conversion of transient viscosity function Eta(t) into a shear viscosity (should be used with the specific project template).
Conversion relaxation modulus with correction, G(t) -> H(lambda))	Conversion of the measured relaxation modulus G(t) into a continuous relaxation time spectrum H(lambda). Correction: The initial part of the Gamma(t) curve is cut off based on a detection of a local maxima.
Conversion relaxation modulus, G(t) -> G', G"	Conversion of the measured relaxation modulus G(t) into storage and loss moduli G' and G".
Conversion relaxation modulus, G(t) -> H(lambda))	Conversion of the measured relaxation modulus G(t) into a continuous relaxation time spectrum H(lambda).
Conversion spectrum, H(lambda) -> G(t)	Conversion of the calculated continuous relaxation time spectrum H(lambda) into a relaxation modulus G(t).
Conversion spectrum, H(lambda) -> G', G"	Conversion of the calculated continuous relaxation time spectrum H(lambda) into storage G' and loss modulus G".
Creep analysis	
Creep (**Burgers** generalized)	Regression of a creep curve based on a generalized Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance.
Creep (**Burgers** model)	Regression of a creep curve based on a standard Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance.
Creep and recovery (**Burgers** generalized)	Regression of a creep and recovery curve based on a generalized Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance.

Name of Macro	Function
Creep and recovery with drift correction (Burgers generalized)	Regression of a creep and recovery curve based on a generalized Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance. A drift correction is applied to correct the values between creep and recovery.
Creep with drift correction (Burgers generalized)	Regression of a creep curve based on a generalized Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance. A drift correction is applied to correct the values between creep and recovery.
Creep with drift correction (Burgers model)	Regression of a creep curve based on a standard Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance. A drift correction is applied to correct the values between creep and recovery.
Rate of curing	
Curing, rate of cross-linkage (X)	Calculation of the rate of cross-linkage from storage modulus versus time G'(t). The variable is stored as physical variable X (choose variable group <all variables> to display).
Curing, t_Rp (X)	Calculation of time t_Rp with the maximum rate of cross-linkage from storage modulus versus time G'(t). The variable is stored as physical variable X (choose variable group <all variables> to display).
Corrections	
Correction of CSR, CSS factor	Use this macro to correct any frequency sweep data measured with the pressure cell (PR-STD or PR400). The measuring profile should comply with the following settings: 31 pt, gamma = 5 %, omega = 0.01 - 10 rad/s (log ramp). The resulting data is acceptable for samples such as PE, PP melts. Please note that this is just a rough estimation and can only be considered as relative data. We suggest to cross-check the results with a standard measuring cell.
Correction of phase angle (PR cell)	Use this macro to correct an incorrect CSR or CSS factor. Please note that this does not replace a real measurement and is only a rough estimation of the true measuring data.
Curve cross over	
Curve cross over G', G" (gamma)	Calculation of the cross-over between the functions G'(gamma) and G"(gamma).
Curve cross over G', G" (omega)	Calculation of the cross-over between the functions G'(omega) and G"(omega).
Curve cross over G', G" (tau)	Calculation of the cross-over between the functions G'(tau) and G"(tau).
Curve cross over G', G" (T)	Calculation of the cross-over between the functions G'(temperature) and G"(temperature).
Curve cross over G', G" (t)	Calculation of the cross-over between the functions G'(t) and G"(t).
Curve difference	
Curve difference gap (d_1 – d_final)	Calculation of the gap difference between the first and last measured points.
Curve derivatives	
Curve derivatives (lin, 3% smoothing)	Calculation of the curve derivatives. Criterion: Linear smoothing with 3 %. The resulting variables are stored as physical variables X = 1st derivative; Y = 2nd derivative (choose variable group <all variables> to display).

Name of Macro	Function
Curve derivatives (lin, auto smoothing)	Calculation of the curve derivatives. Criterion: Linear smoothing with auto factor. The resulting variables are stored as physical variables X = 1st derivative; Y = 2nd derivative (choose variable group <all variables> to display).
Curve derivatives (log, 3% smoothing)	Calculation of the curve derivatives. Criterion: Logarithmic smoothing with 3 %. The resulting variables are stored as physical variables X = 1st derivative; Y = 2nd derivative (choose variable group <all variables> to display).
Curve derivatives (log, auto smoothing)	Calculation of the curve derivatives. Criterion: Logarithmic smoothing with auto factor. The resulting variables are stored as physical variables X = 1st derivative; Y = 2nd derivative (choose variable group <all variables> to display).
Curve inflections	
Curve inflection point	Calculation of the curve inflection point.
Curve inflection point Eta*(T)	Calculation of the Eta*(T) curve inflection point.
Curve inflection point G'(T)	Calculation of the G'(T) curve inflection point.
Curve inflection point G'(T), linear	Calculation of the G'(T) curve inflection point in a linear diagram.
Curve minimum and maximum	
Curve maximum	Calculation of the curve maximum of any variable.
Curve maximum Delta(T)	Calculation of the delta(T) curve maximum.
Curve maximum Eta(t)	Calculation of the eta(t) curve maximum.
Curve maximum G"(gamma)	Calculation of the G"(gamma) curve maximum.
Curve maximum G"(T)	Calculation of the G"(T) curve maximum.
Curve minimum	Calculation of the curve minimum of any variable.
Curve minimum Delta(T)	Calculation of the delta(T) curve minimum.
Curve minimum, FN(d)	Calculation of the FN(d) curve minimum.
Curve rise	
Curve rise Eta 10%	Calculation of a 10 % Eta curve raise based on the initial value.
Curve rise Eta 50%	Calculation of a 50 % Eta curve raise based on the initial value.
Curve rise Eta 90%	Calculation of a 90 % Eta curve raise based on the initial value.
Curve rise G' 10%	Calculation of a 10 % G' curve raise based on the initial value.
Curve rise G' 50%	Calculation of a 50 % G' curve raise based on the initial value.
Curve rise G' 90%	Calculation of a 90 % G' curve raise based on the initial value.
Curve slope	
Curve slope G"(omega)	Calculation of the G"(omega) curve slope.
Curve slope G'(omega)	Calculation of the G'(omega) curve slope.
Curve slope lin-lin	Calculation of the curve slope of any variable in a linear diagram.
Curve slope log-log	Calculation of the curve slope of any variable in a logarithmic (x-axes) and linear (y-axes) diagram.
Dahlquist criterion	

Name of Macro	Function
Dahlquist criterion, lower limit	Calculation of the lower limit for the Dahlquist criterion. The limit is used to evaluate a PSA or hotmelt in the used-temperature range.
Dahlquist criterion, recommended	Calculation of the recommended value for the Dahlquist criterion. The recommended value is used to evaluate a PSA or hotmelt in the used-temperature range.
Dahlquist criterion, upper limit	Calculation of the upper limit for the Dahlquist criterion. The limit is used to evaluate a PSA or hotmelt in the use-temperature range.
Flow stress, Flow transition, Yield stress, Yield point	
Flow stress TAU_f, curve cross over G'=G"	Calculation of the flow stress TAU_f in an amplitude sweep based on the curve cross-over G'=G". At the flow stress the gel character changes to a liquid character. Please check if TAU_f > TAU_y. The result is invalid if the calculated flow stress is lower than the yield stress.
Flow stress TAU_f, upward inflection, gamma(tau)	Calculation of the flow stress TAU_f based on the upward inflection of the Gamma(tau) function. At the flow stress the gel character changes to a liquid character and the sample starts to flow.
Flow transition TAU_f, peak G"	Calculation of the flow transition based on a peak of G" in an amplitude sweep. The peak is indicating a maximum in energy dissipation before the breakdown of the internal structure.
Yield stress TAU_y, onset G' (log)	Calculation of the yield stress or yield point TAU_y based on the onset found in an amplitude sweep using a logarithmic weighting. No significant change of the internal structure occurs as long as stresses below the "yield point" are applied. Below the yield stress, the material shows reversible viscoelastic behavior.
Yield stress TAU_y, upward inflection, Gamma(tau)	Calculation of the yield stress or yield point TAU_y based on an upward inflection of the gamma(tau) function. No significant change of the internal structure occurs as long as stresses below the "yield point" are applied. Below the yield stress the material shows reversible viscoelastic behavior.
Yield stress, TAU_y onset G' (lin)	Calculation of the yield stress or yield point TAU_y based on the onset found in an amplitude sweep using a linear weighting. No significant change of the internal structure occurs as long as stresses below the "yield point" are applied. Below the yield stress, the material shows reversible viscoelastic behavior.
Hysteresis area	
Hysteresis area (1-up, 2-down)	Hysteresis area previously known as thixotropy value. The input data should contain two intervals with an up and a down ramp in shear-rate control.
Hysteresis area (1-up, 3-down)	Hysteresis area previously known as thixotropy value. The input data should contain three intervals with an up (interval 1) and a down ramp (interval 3) in shear-rate control. Interval 2 is a hold interval.
Inertia criteria	
Inertia criteria (Ratio = M / M_el)	The inertia criteria defines whether the measured result is valid at higher frequencies.
- excellent if M / M_el > 2%	

Name of Macro	Function
- acceptable if M / M_el > 0.5%	
- poor if M / M_el < 0.5%	
Integration	
Integration	Calculation of the integral value below a curve.
Integration, FN(d)	Calculation of the FN(d) integral value.
Interpolation	
Interpolation, shear rate 100s-1	Interpolation of all shear rotational variables at the shear rate of 100s-1, whereas shear rate and viscosity are stored in the result field.
Interpolation, shear rate 1s-1	Interpolation of all shear rotational variables at the shear rate of 1s-1, whereas shear rate and viscosity are stored in the result field.
Interpolation, shear rate 50s-1	Interpolation of all shear rotational variables at the shear rate of 50s-1, whereas shear rate and viscosity are stored in the result field.
Interpolation, shear rate 50s-1	Interpolation of all shear rotational variables at the shear rate of 50s-1, whereas shear rate and viscosity are stored in the result field.
Interpolation, user defined	Interpolation of all shear rotational variables at the shear rate <user defined>, whereas shear rate and viscosity are stored in the result field.
Linear-viscoelastic range	
Linear-viscoelastic range LVER, limit (3%)	Calculation of the limit of the linear viscoelastic range based on a boundary definition of 3 %.
Linear-viscoelastic range LVER, limit (3%) and proposal	Calculation of the limit of the linear viscoelastic range based on a boundary definition of 3 %. A proposal is given for other oscillatory tests such as the frequency sweep.
Linear-viscoelastic range LVER, limit (3%) and proposal (extension)	Calculation of the limit of the linear viscoelastic range for extensional test based on a boundary definition of 3 %. A proposal is given for other oscillatory tests such as the frequency sweep.
Linear-viscoelastic range LVER, proposal	Calculation of the proposal for other oscillatory tests such as the frequency sweep based on the detection of the linear viscoelastic range with a boundary definition of 3 %.
Molar mass	
Molar mass, cross-linked elastomer (Mooney-Rivlin)	Input: Density needed as input variable (to be defined in 'Start' as additional input
Output: Mw = Average molar mass between two links; X = Link concentration; Y = Polymerization density	
Molar mass, relative	Calculation of the relative molar mass from a viscosity curve based on the k-value of a polymer.
Plateau modulus	
Plateau modulus, Gn_0	Calculation of the plateau modulus with input data = frequency sweep or master curve. Gn_0 = G' @ $\tan(\delta)_{min}$.
Polydispersity index	
PDI, polydispersity index	Calculation of the polydispersity index (= 100000/G') based on curve cross-over of a frequency sweep with G' = G''.

Name of Macro	Function
PVC Gelation	
PVC, Final Gelation	Calculation of the final gelation point of a curing PVC plastisol sample.
PVC, Initial Fusion	Calculation of the initial fusion point of a curing PVC plastisol sample.
PVC, Initial Gelation	Calculation of the initial gelation point of a curing PVC plastisol sample.
Rearrange	
Rearrange, merging	Rearrange or merge all data defined as input data (Example: Copy all intervals of the incoming data into one). This Macro is also used to create a temporary result taken over as input data in other steps of the analysis.
Curve regression	
Regression, aT, WLF	Curve regression used for temperature sweeps of non-curing samples according to the WLF model.
Regression, auto	Curve regression with auto selection of any regression model.
Regression, e function	Curve regression based on an exponential function.
Regression, Quemada	Curve regression according to the Quemada model.
Regression, Tau, Casson-Steiner	Curve regression for a flow curve according to Casson-Steiner.
Regression, Tau, Ellis	Curve regression for a flow curve according to Ellis.
Regression, Tau, Newtonian viscosity	Select function tau(shear rate) as input data to calculate the Newtonian viscosity.
Regression, Tau, Phillips-Deutsch	Curve regression for a flow curve according to Phillips-Deutsch.
Regression, Tau, Sisko	Curve regression for a flow curve according to Sisko.
Regression, Tau, Steiger-Ory	Curve regression for a flow curve according to Steiger-Ory.
Regression, Tau, Tscheuschner	Curve regression for a flow curve according to Tscheuschner.
Regression, Eta(temperature), Arrhenius	Curve regression for eta(T) according to Arrhenius.
Regression, Eta(temperature), Stettin	Curve regression for eta(T) according to Settin.
Regression, Eta(volume concentration), Krieger-Dougherty	Curve regression for eta(volume concentration) according to Kieger-Dougherty.
Regression, Eta, Carreau	Curve regression for viscosity according to Carreau.
Regression, Eta, Carreau-Gahleitner	Curve regression for viscosity according to Carreau-Gahleitner.
Regression, Eta, Carreau-Yasuda	Curve regression for viscosity according to Carreau-Yasuda. This is a recommended model for polymer analysis. The output data is extrapolated from 0.001s-1 to 1000s-1.
Regression, Eta, ceramic suspensions	Curve regression for viscosity for ceramic slurries.

Name of Macro	Function
Regression, Eta, Cross	Curve regression for viscosity according to Cross. This is a recommended model for polymer analysis. The output data is extrapolated from 0.001s-1 to 1000s-1.
Regression, Eta, power law slope	Curve regression for viscosity according to the power-law model.
Regression, Eta, Vinogradov-Malkin	Curve regression for viscosity according to Vinogradov-Malkin.
Regression, yield stress, Bingham	Curve regression for yield stress analysis according to Bingham. The input range is limited from 10s-1 to 100s-1 to provide a better curve fit. The output range is defined from 0s-1 to 100s-1 to show the Y intercept.
Regression, yield stress, Casson (advanced)	Curve regression for yield stress analysis according to Casson. The input range is limited from 10s-1 to 100s-1 to provide a better curve fit. The output range is defined from 0s-1 to 100s-1 to show the Y intercept.
Regression, yield stress, Casson (standard)	Curve regression for yield stress analysis according to Casson used for characterization of chocolate. The input range is limited from 10s-1 to 100s-1 to provide a better curve fit. The output range is defined from 0s-1 to 100s-1 to show the Y intercept.
Regression, yield stress, Herschel-Bulkley	Curve regression for yield stress analysis according to Herschel-Bulkley. The input range is limited from 10s-1 to 100s-1 to provide a better curve fit. The output range is defined from 0s-1 to 100s-1 to show the Y intercept.
Regression, yield stress, IOCCC2000 / Windhab	Curve regression for yield stress analysis according to the IOCCC2000/Windhab method for characterization of chocolate.
Smoothing	
Smoothing, auto	Smoothing of any variable with auto smoothing settings.
Smoothing, FFT	Smoothing method which is segment based (alternative to the standard smoothing method).
Smoothing, low (lin-lin)	Smoothing of any variable. Settings: Low smoothing in linear scaled diagrams.
Smoothing, low (lin-log)	Smoothing of any variable. Settings: Low smoothing in linear (x-axes) and logarithmic (y-axes) scaled diagrams.
Smoothing, low (log-log)	Smoothing of any variable. Settings: Low smoothing in logarithmically scaled diagrams.
Smoothing, moderate (lin-lin)	Smoothing of any variable. Settings: Moderate smoothing in linear scaled diagrams.
Smoothing, moderate (lin-log)	Smoothing of any variable. Settings: Moderate smoothing in linear (x-axes) and logarithmic (y-axes) scaled diagrams.
Smoothing, moderate (log-log)	Smoothing of any variable. Settings: Moderate smoothing in logarithmically scaled diagrams.
Smoothing, strong (lin-lin)	Smoothing of any variable. Settings: Strong smoothing in linear scaled diagrams.
Sorting	
Sorting of x-axes variable	Sorting of all values of the selected x-axes.
Transition temperatures Tg, Tc, Tm	

Name of Macro	Function
Tc, crystallization temperature	Calculation of the crystallization temperature based on a curve cross-over in G'(T) and G''(T).
Tg | Flex point | T_mg | ISO 11357	Calculation of the extrapolated midpoint temperature at the flex point T_{mg}.
Tg | Step | T_eig, T_mg, T_efg | ISO 11357	Calculation of the extrapolated onset temperature T_{eig}, the extrapolated midpoint temperature according to the half step height T_{mg}, and the extrapolated end temperature T_{efg}.
Tg | 2% offset | T_g2% | DIN 65583, DIN 29971	Calculation of the extrapolated onset temperature according to the 2% method $T_{g2\%}$ and calculation of the midpoint temperature T_{mg}.
Tg, peak Delta(T)	Calculation of the glass-transition temperature Tg_peak based on a maximum in Delta(T).
Tg, peak G''(T)	Calculation of the glass-transition temperature Tg_peak based on a maximum in G''(T).
Tm, melting temperature	Calculation of the melting temperature Tm at the curve cross-over G'=G'' based on a temperature sweep.
Thixotropy	
Thixotropy, all, 3ITT-Rot-Rot-Rot (DIN-SPEC91143-2)	Calculation of the Thixotropy. Test conditions according to DIN-SPEC91143-2 with three rotational intervals.
Thixotropy, recovery after 300s, 3ITT-Osc-Rot-Osc	Calculation of the recovery after 300s. Test with oscillatory load in the 1st and 3rd intervals and shear in the 2nd interval.
Thixotropy, recovery after 30s, 3ITT-Osc-Rot-Osc	Calculation of the recovery after 30s. Test with oscillatory load in the 1st and 3rd intervals and shear in the 2nd interval.
Thixotropy, recovery after 60s, 3ITT-Rot-Rot-Rot (DIN-SPEC91143-2)	Calculation of the recovery after 60s. Test conditions according to DIN-SPEC91143-2 with three rotational intervals.
Thixotropy, recovery until 25%, 3ITT-Osc-Rot-Osc	Calculation of the recovery until 25 % of the initial value. Test with oscillatory load in the 1st and 3rd intervals and shear in the 2nd interval.
Thixotropy, recovery until 25%, 3ITT-Rot-Rot-Rot (DIN-SPEC91143-2)	Calculation of the recovery until 25 % of the initial viscosity value. Test conditions according to DIN-SPEC91143-2 with three rotational intervals.
Thixotropy, recovery until 50%, 3ITT-Osc-Rot-Osc	Calculation of the recovery until 50 % of the initial value. Test with oscillatory load in the 1st and 3rd interval and shear in the 2nd interval.
Thixotropy, recovery until 50%, 3ITT-Rot-Rot-Rot (DIN-SPEC91143-2)	Calculation of the recovery until 50 % of the initial viscosity value. Test conditions according to DIN-SPEC91143-2 with three rotational intervals.
Thixotropy, recovery until 90%, 3ITT-Osc-Rot-Osc	Calculation of the recovery until 90 % of the initial value. Test with oscillatory load in the 1st and 3rd interval and shear in the 2nd interval.
Thixotropy, recovery until G'=G'', 3ITT-Osc-Rot-Osc	Calculation of the recovery until G'=G''. Test with oscillatory load in the 1st and 3rd intervals and shear in the 2nd interval.

7.4   Analysis Action

A short instruction for the Analysis action can be found in Chapter 5, *"Ch 5.3, Action Analysis"*.

8   Windows

8.1   Diagram Window

RheoCompass™ offers you unprecedented presentation options:

- Zoom function
- Recorded pictures can be assigned to measuring points
- Direct analysis of presented data by selection in diagram
- Automatic scaling during measurement
- Any number of curves and axes available
- Free placement and in-place editing of all elements (text, picture, logo)
- Data optionally presented as coordinates

The diagram window is used to present one or more results selected in the **Project data tree**. To display any result or any measurement interval, check the box in front of the item. Use the **Expander** icon in the header of the Project data tree to **Expand all tests currently displayed in the diagram**. Other options are **Collapse all tests** or **Expand all tests**.

To edit the

- **Diagram plane** and all related items, use the **Ribbon Diagram**. Move the mouse point over the ribbon item to see additional information about the ribbon function.

- **Axis settings** or to add or remove an axis from the diagram, use the **Ribbon Axis**. Move the mouse point over the ribbon item to get additional information about the ribbon function.

  - With the Quick Curve function, you can generate comprehensive and attractive diagrams at the touch of a button.

- **Curve settings**, such as the curve scheme and other items, use the **Ribbon Curve**.

  - Edit scheme: Use this menu item to edit the active scheme in the scheme dialog or to **save** a scheme **as a user-defined scheme**. Scheme templates that have already been saved can be found in the **Scheme templates** category in the **RheoFinder**.
  - Replace with scheme: Use this menu item to replace all marker with the default markers of the currently selected scheme. Move the mouse point over the ribbon item to see additional information about the other ribbon functions.

- **Legend content,** click on the legend and open the **Details pane**. Add or remove items for the lists using **(+)** or **(-)** to customize the legend

Interactive Curve Analysis Within the Diagram

Analysis macros are started by selecting data points in the diagram.
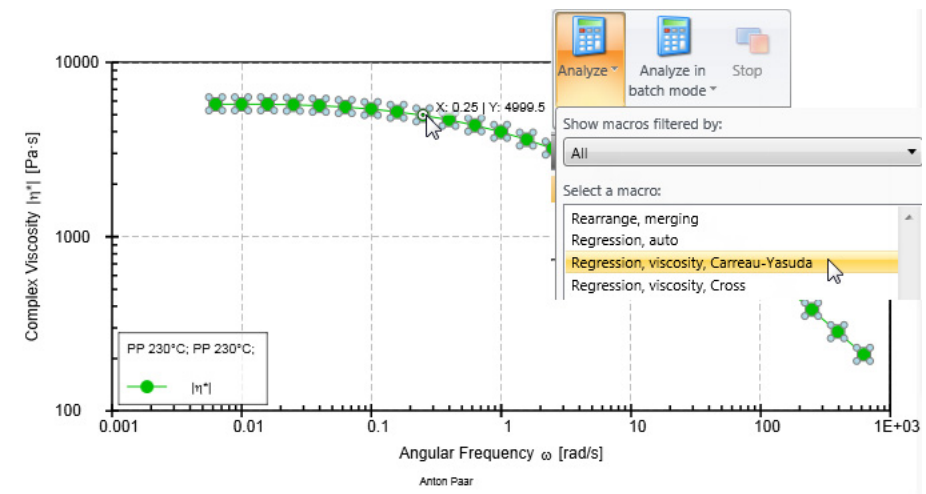
With the first click, all measuring points are selected. Part of the curve can be selected with the second and third click by holding the shift key. The calculator icon in the curve ribbon is then used to select the appropriate analysis macro. The regressed curve is presented immediately together with the parameters in the diagram legend.
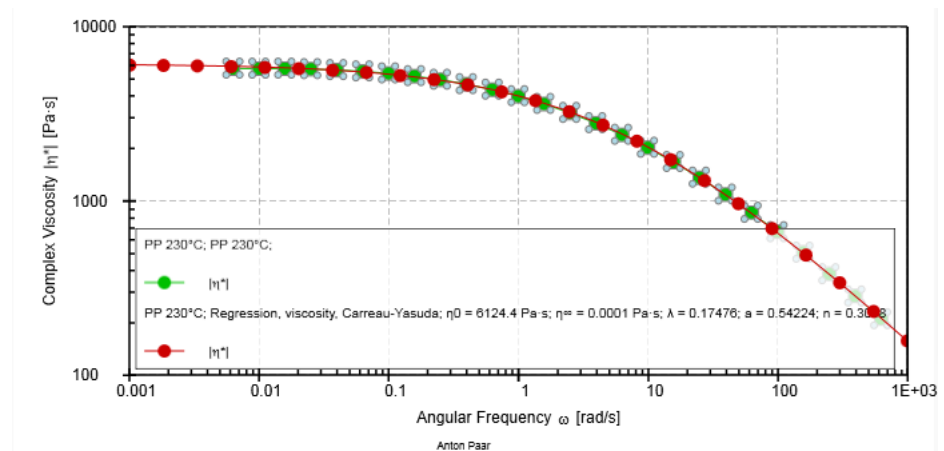
For further information, the analysis result is selected in the navigation pane. The info pane then shows the corresponding regression long result.

Read the chapter *"Ch 8.3, Report Designer Window"* in this manual for further info about how to add a **Diagram** or **Data** such as **Analysis results** to a report, and how to print this to **PDF**.

Automation Using Auto-Display

For each window of type **Diagram** or **Table**, the next test result can be shown automatically.

To predefine the next measurement, click the <**Auto-Display**> tab in the **Navigation pane**.

Use the option **Multi-display mode** from the ribbon **Presentation** to show all new results without removing previous results from the window.
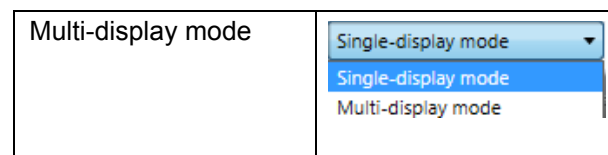
Multi-display mode	Single-display mode ▼
	Single-display mode
	Multi-display mode

By adding or removing **Actions** from the **Test definition** the **Auto-display** of the windows might be reset. Thus it is advisable to check all **Auto-display** settings for all **Windows** after any modification of the **Test definition**.

Example: Auto-Display with two **Test definitions** contained in the project. The **Result names** are taken from the name of the actions of type **Analysis** or **Measurement**. Every time a new measurement is started, the previous result is removed from the window and the new results from **Test definition 1, Frequency sweep, Interval 1** are displayed automatically.
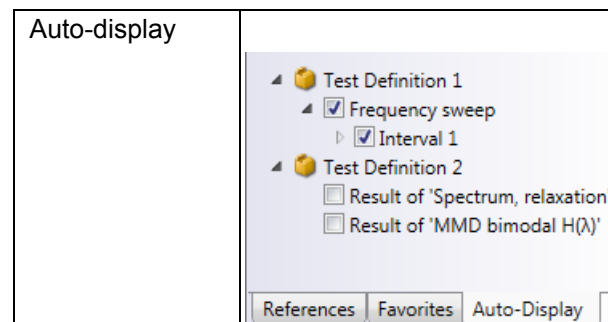
Auto-display	
	▲ 🟠 Test Definition 1
	▲ ☑ Frequency sweep
	▷ ☑ Interval 1
	▲ 🟠 Test Definition 2
	☐ Result of 'Spectrum, relaxation'
	☐ Result of 'MMD bimodal H(λ)'
	References | Favorites | Auto-Display

Results selected manually in the data tree of the **Navigation pane** are permanently shown in the window.

8.2 Media Explorer Window

The **Media Explorer** manages and displays pictures or sequences filmed by connected CCD cameras such Digital Eye. You are also given the option of simultaneous video recording with multiple cameras, e.g. for flow visualization, with two cameras filming a sheared sample; one from below, and one from the side. Pictures and video sequences can be optionally displayed directly in the diagram, assigned to the measuring points at which they were recorded.

Requirements

The media window is an optional feature of RheoCompass™. To check whether the license feature is enabled, click on About RheoCompass and check whether the feature **Usage of camera** is **Enabled**. To request a trial license, including the feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

There is some shared functionality between the **Media window** and the **Diagram Window**. Therefore it is advisable to add the **Media window** to the same **View** as the Diagram window.

All functions of the media window are found in the **Ribbon Media**. Move the cursor over the ribbon item to see additional information about the ribbon function.

The Media window has 4 different modes:

- **Library**, used to show or edit media content such as **Pictures** or **Videos** or the current **Project**

    - **Details pane**: Assignment of test and Video or Picture
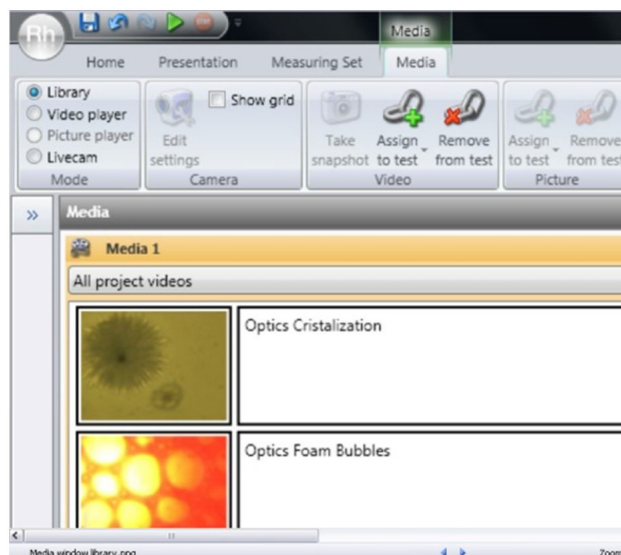
- **Video player**, used to playback video

    - **Details pane**: Assignment of test and Video or Picture

- **Picture player**, used to playback pictures

  - **Details pane: Camera settings** and selection of the **Video input device**

- **Livecam**, used for recording or showing a live image

  - **Details pane: Camera Settings** And Selection Of The **Video Input Device**

Recording Of Pictures And Video

For any further information about how to record pictures or videos simultaneously to a measurement please refer to the chapter *"Ch 5.4, Action Camera"* in this manual.

Playback of Video Recorded with a Measurement

Follow these step-by-step instructions:

- Make sure **Media window** and **Diagram** are in the same **View**
- Switch **Media window** to mode **Video player**
- Select the **Measurement** in the **Diagram**
- To playback the video, click **Ribbon Curve, Video, Play** and select the video stream
- A large **Marker** on the curve will show the position of the video while shown in the Media window

Extract a picture from the video stream:

- Select the **Measurement** in the **Diagram**
- Select video: Click **Ribbon Curve, Video, Play** and select the video stream
- Click on the **Media window** to enable the Ribbon controls
- Click **Ribbon Media, Video, Take Snapshot** to take snapshots from the video stream
- To add the snapshots to the Diagram:
  -Select the **Measurement** in the **Diagram**
  -Click **Ribbon Diagram, Picture, Insert from media** and select any picture from the list

-The picture is now added to the diagram with a connecting line between picture and data point
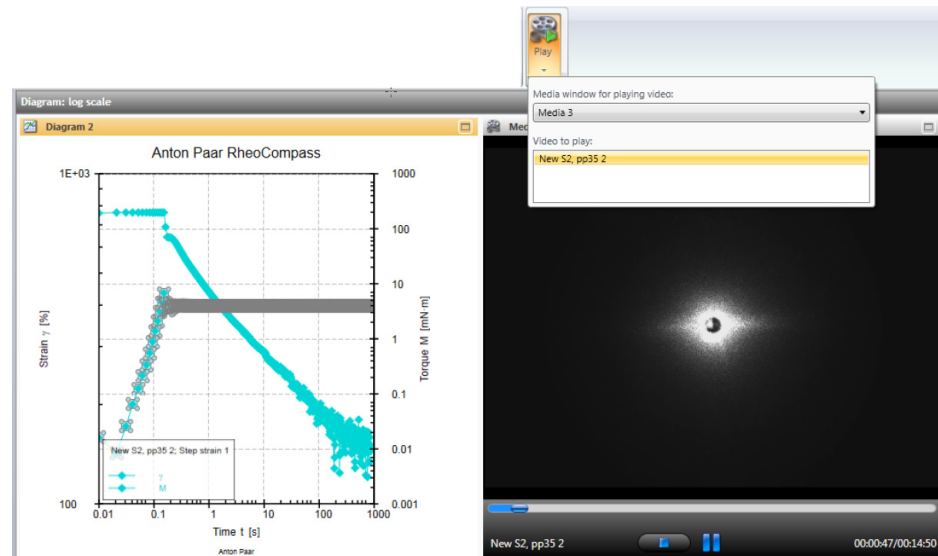
Adding Pictures to a Curve in a Diagram

To add a picture to a curve in a diagram that has been recorded with a measurement, simply follow these step-by-step instructions:

• Open a diagram
• Click **Ribbon, Diagram, Picture, Insert from project media**
• Select the item from the list of pictures related to the measuring point

Where to Find the Media Data (Pictures and Videos)

All media content is stored in a specific folder and not in the RheoCompass database. Keep this in mind when migrating a computer or for your backup-and-restore strategy.

To open the path click **Rh, Options, Backup, Open media path**.

How to Export a Project with Pictures and Video

Whenever a project is exported, the pictures and videos are exported as well (Rh1.15 or any higher). The file can then be imported by any other Client and all data is restored in the local computer.

8.3   Report Designer Window

Use the **Report designer** to generate comprehensive measuring reports in a flexible fashion. Items such as **Table**, images (company logos), test related **Data**, **Shape**, **Text**, **Barcode** are available. **Diagrams** are placed in a **Pinboard** which is a kind of micro-page within the main page of the report. Once the report is finished you can **Export** it in **PDF** format or assign it to a test.

Requirements

The **Report Designer** window is an optional feature of RheoCompass™. To check whether the license feature is enabled, click on **About RheoCompass** and check whether the feature **Report Designer** is **Enabled**. To request a trial license including the feature please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

The Report designer is not available for the **Light version** of RheoCompass. However, any Light version can easily be upgraded.

The **Report** is used in combination with automated tests, including measurement, analysis and export to **XPS** or **PDF** at the end of a test definition to summarize the results. The report page(s) are then automatically exported to PDF or linked to the test stored in the **RheoFinder**.

To automatically export a **Report as PDF or XPS** add an **Export** action to the test definition. For any further information on **Actions** please refer to *"Ch 5, The Actions"* in This Manual.

To Add A Report

• Add **New view**
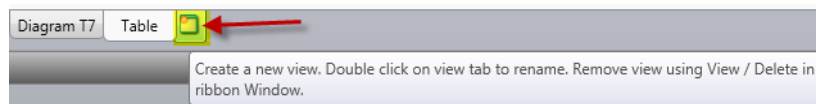
• Change the name of the view from 'View' to 'Report'.

• Click the ribbon **Window, Window, New report**

Report Templates

• Predefined **Report templates** are already included in RheoCompass
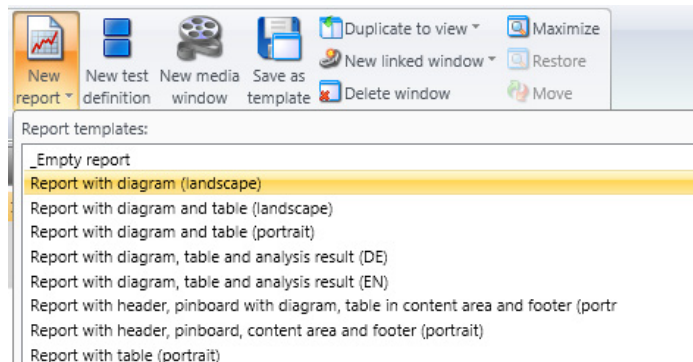
Editing the Report

• Edit the items of the predefined report using the ribbon function

 • **Report** to add new items or

- **Presentation** to format text items or the report page(s)
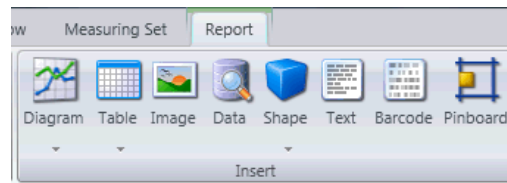
Some Things to Remember when Creating a New Report

- Header and footer

  - The report consist of a **Header**, a **Footer** and a **Content** area in-between. The size of the header and footer is variable.
  - The header and the footer are identical for all pages.

- Adding a **Diagram**

  - Before adding a diagram, be sure to add a **Pinboard** (micro-page). Next, add the diagram to the Pinboard. Otherwise the diagram will have the width of the page and will not be not scalable. If the diagram displays a scroll bar, increase the height of the item or remove obsolete data from the linked diagram.

- Adding a **Table**

  - Add the table at the end of the report, once you have finished the main part. Do not add the table to a pinboard.
  - You may duplicate existing tables to prepare a specific table for the report or reference the original table. This is quite helpful if only a part of the measurement is presented in a table, e.g. Table 1, Interval 1; Table 2, Interval 2, etc. Report-specific tables can be hidden behind the report window in the same view if only used for the report.

- Linked windows such as tables and diagrams

  - Diagrams and tables presented in the report are 'linked windows' of any table or diagram window contained in the current project.
  - Make sure the original window is set up to show the '**Next test**' and '**Next analysis**' by default. This is done in the '**Auto-Display**' tab of the diagram or table window (see figure below):
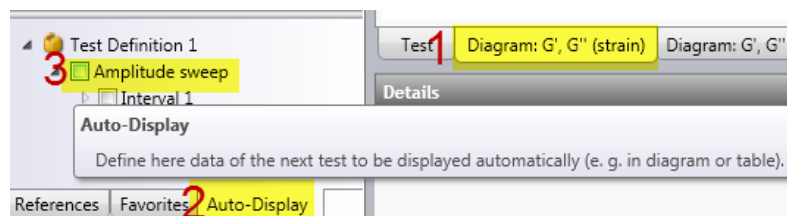
- Adding a specific **Data** item to a report (no need to use a table for presenting single values of results)

  - Single measuring points as well as analysis results are easily added by using the **Data** item from the ribbon **Report**. With the Data item there is access to all data stored in the database. Use the placeholder <**Next test**>

(4) to ensure that the latest test result is presented in the report window. You may combine a 'Data' item (2) with a 'Text' item (1) to comment on the values presented in the report.

- Example with **Text** for commenting on the analysis result (1) and **Analysis short result** in the next line (3, 4).
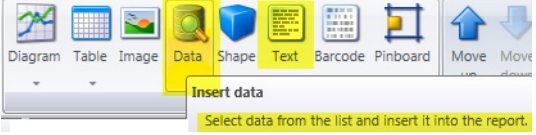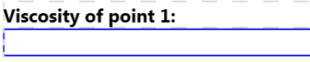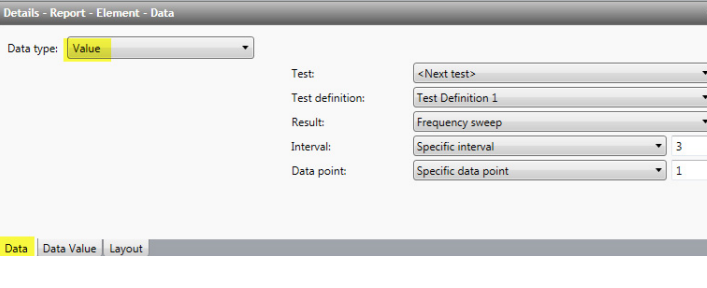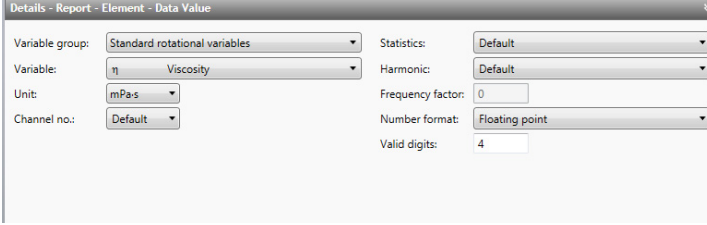
List with the most important data items provided by the Report Designer

Name	Data Type
Project info	
Project	Project name
Date (last modified)	Project Info -> Modified
Test info	
Test, name	Test name -> Test ->
Test, sample	Test info -> Next test -> Test info type -> Test definition
Test, batch No	Test info -> Batch no.-> Test info type -> Test definition
Test, created (date)	Test info -> Next test -> Created -> Test definition
Test, manufacturing date	Test info -> Next test -> Manufacturing data - Long format of the complete test definition
Test, description	Test info -> Next test -> Description- > Test definition
Measuring definition (V 1.15)	Measuring definition->Next test->Test definition->Result - Short format of test definition with measurement definition only
Test, measuring system	Test info -> Next test -> Test type info -> Measuring system name
Test, signature	Test info -> Test info type -> Signature -> Type of signature with user / date

Data point value		
Value of variable xy	Value -> Next test -> Test definition -> Measurement -> Specific interval -> Specific data point Data value -> Variable -> Unit -> Number format -> Valid digits Example:	
	Insert a text (1st line) and data item (2nd line):	
	Text and data-type item in content area of report: The data will be displayed for the \<next test\>	**Viscosity of point 1:**
	Definition of the data point: - data - data value	

Analysis Result Info	
Short result text	Result text data -> next test -> test definition -> result (analysis) -> Analysis short result text
Measuring set configuration	
Measuring set configuration (short)	Measuring set configuration (short) • Configuration • Device • Measuring cell • Measuring system
CSS or CSR factor	Data->Value Data Value-> Variable->All variables->CSR / CSS factor

8.4   Table Window

The table window is used to present one or more results selected in the **Project data tree**. To display any result or interval from a measurement, check the box in front of the item. The selected intervals and results are displayed in separate tabs.

Use the **Expander** icon in the header of the **Project data tree** to **Expand all tests currently displayed in the diagram**. Other options are **Collapse all tests** or **Expand all tests**.

To get an 'endless' long list with all intervals and results currently selected in a table it is advisable to add the table to a Report, e.g. click ribbon **Window, Report, Insert, Table (portrait)** to add a new report referenced to Table 1 or insert any other table into the report.

To edit the **Table properties** click the **Ribbon Table**. You can now add or remove variables and change all properties such as the scaling and other settings. Move the cursor over the ribbon item to see additional information about the ribbon function.

Read the chapter *"Ch 8.3, Report Designer Window"* in this manual for further info about how to add a **Table** or single values of the measurement as **Data** item to a report and how to print this to **PDF**.

Automation using Auto Display

For each window of type **Diagram** or **Table**, the next test result can be shown automatically.

To predefine the next measurement, click the <**Auto-Display**> tab in the **Navigation pane**.

Use the option **Multi-display mode** from the ribbon **Presentation** to show all new results without removing the previous results from the window.
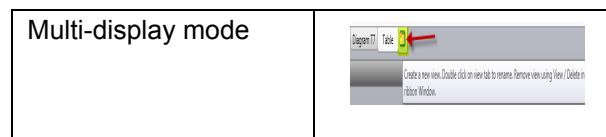
Multi-display mode	

By adding or removing **Actions** from the **Test definition**, the **Auto-display** of the windows might be reset. Thus it is advisable to check all **Auto-display** settings for all **Windows** after any modification of the **Test definition**.

Example: Auto-Display with two **Test definitions** contained in the project. The **Result names** are taken from the name of the actions of type **Analysis** or **Measurement**. Every time a new measurement is started, the previous result is removed from the window and the new result of **Test definition 1, Frequency sweep, Interval 1** is presented automatically.
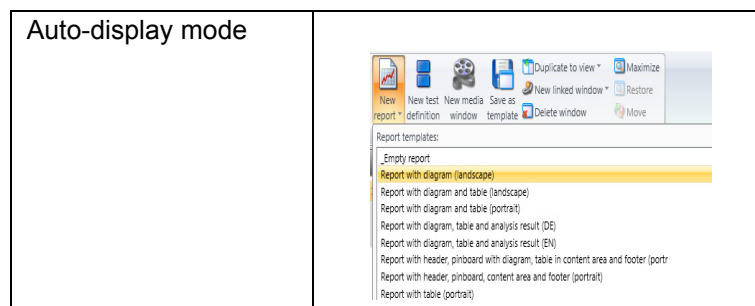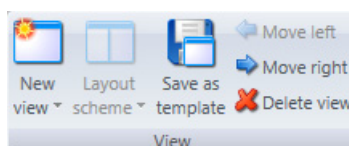
Auto-display mode	

Results selected manually in the data tree of the **Navigation pane** are permanently shown in the window.

8.5   View

Use a View to display a single or multiple Windows in one View.

To edit the **View tabs** and all related items use the **Ribbon View**. Move the cursor over the ribbon item to see additional information about the ribbon function.

To show a view during test execution use the **Action View** as described in this manual (see *"Ch 5.13, Action View"*).

8.6   Automation Definition Window

The **Lab Automation Service** is a license feature of RheoCompass.

The **Automation service** is used for **Data exchange** between the Anton Paar RheoCompass™ software and a **Customer software** in a Lab Information Management System.

The **Automation definition window** is used to define a list of measurement-result elements.

The automation results are stored in an xml **Result file** using the action **Export**.

A result element consists of a user-defined **Label** and a **Data type**.

Use the **Ribbon Automation** to **Insert**, **Move** or **Delete** elements in the Automation definition.

For more information about the Lab automation service, refer to *"Ch 11, Lab Automation Service"*.

9 Large Amplitude Oscillatory Shear (LAOS) Raw Data

9.1 Raw Data Recording while Simultaneously Generating a Measuring Point

Use this option to record the raw signal simultaneous to generating a measuring point in dynamic mode. One complete cycle with 512 raw data points is stored with each data point of the defined measuring profile. Raw data from any cycles during the adjustment phase are not recorded. All data is automatically processed and LAOS variables are provided in real time during the measurement.

Requirements

The **Raw data** feature is an optional feature of RheoCompass™ but is included for all MCR 502 and MCR 702 series rheometers. To check whether it is included, click on **About RheoCompass** and check whether the feature **Raw Data** is **Enabled**. To request a trial license including this feature, please use the contact form in *"Ch 12, License Features for Trial"* and provide all required information.

Performance

Due to the load of raw data points recorded with each measuring point, it is advisable to not store more than 20 tests in one **Project**. To define the limit, select: **RheoFinder, Projects,** Select **Project, Edit** or **Project template, Name Info, Limit**.

Additional Settings

To set the number of harmonics recorded in LAOS measurements Click **Rh, Options, Popular, LAOS calculation options**.

Project Template

Use the built-in project templates to perform **LAOS measurements** providing **All type of LAOS variables**. This is the recommended **Comfort function** for **LAOS recording**.

• There is no limitation in the number of recorded cycles.

• Raw data is provided for the measuring point only—not as a continuous stream, and therefore not useful for transient waveform analysis

• The normal force signal is not provided as LAOS data

To start a new measurement open a new project template. There are two predefined templates, one with and one without demo data.

Templates for LAOS	
	⌄ Amplitude sweep | LAOS & Fourier Coefficients | Example
	⌃ Amplitude sweep | LAOS & Fourier Coefficients
	Measurements at large amplitudes in the non linear region (large amplitude oscillatory shear):
	- Amplitude sweep
	- Waveform and Lissajous figure
	- Fourier-Coefficients (higher harmonics)

Some calculated variables

Loss Modulus for Minimum Strain G_M'' [Pa]	Loss Modulus for Large Strain G_L'' [Pa]	Ratio for Shear Thinning Δ_{thin} [1]	Ratio for Shear Thickening Δ_{thick} [1]	Ratio for Strain Stiffening Δ_{stiff} [1]	Ratio for Stress Softening Δ_{soft} [1]

Lissajous figures and waveform diagrams

In the test definition and the measurement action defined therein, there are no specific settings for LAOS experiments. Typically, the frequency is chosen to be in a moderate range (not much higher than 10 rad/s). Most LAOS tests are defined as amplitude sweeps with the final shear-strain measurement lying far outside the linear viscoelastic region (here 1000 %).

Test definition	
	1 26 Points
	γ γ 0.01...1000 %
	ω 1 rad/s

To obtain the raw sine wave for each of the 26 measuring points, the option **Get waveform** in the **Ribbon Measurement, Raw data** must be checked.
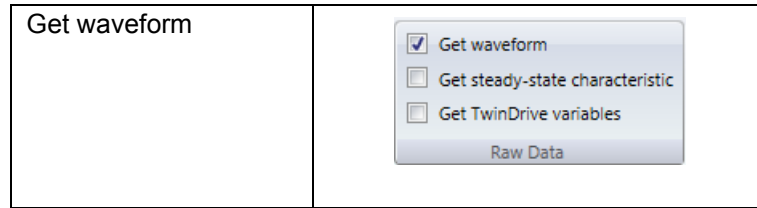
Get waveform	

Lissajous Figure and Waveform Data in the Dashboard

Open the **Dashboard** to see additional information, such as temperature, normal force and gap. In the raw "monitor" the Lissajous figures and waveforms are optionally displayed. To set up the parameters of the Dashboard, click **Dashboard, Ribbon Dashboard, Monitor settings**.

Dashboard with Lissajous figure and waveform	
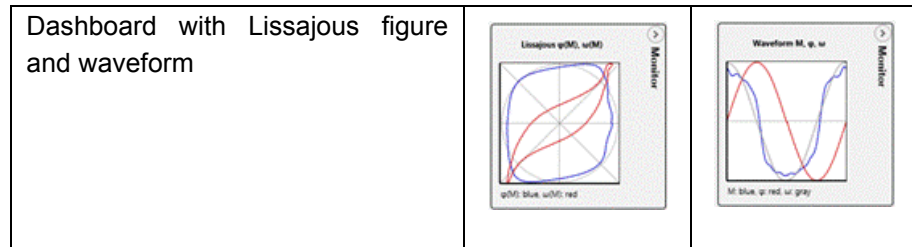
Presentation of Data in the Diagram(s)

To add any LAOS related variables to a table or diagram, select the variable group **Waveform and LAOS**.

Use the **Ribbon function, Statistics and harmonics** to define the variable. See example below.

It is possible to add multiple variables of the same type but with different meanings (**Statistics and harmonics**).

Ribbon settings	
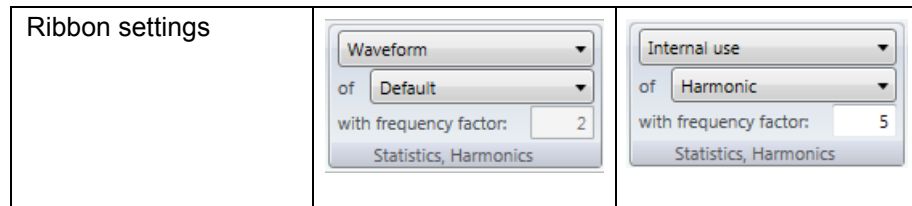
To show the **Fourier Coefficients**, a new axis is defined with three Fourier coefficients but different selections of the **Harmonics** (see screenshot and items marked in yellow)
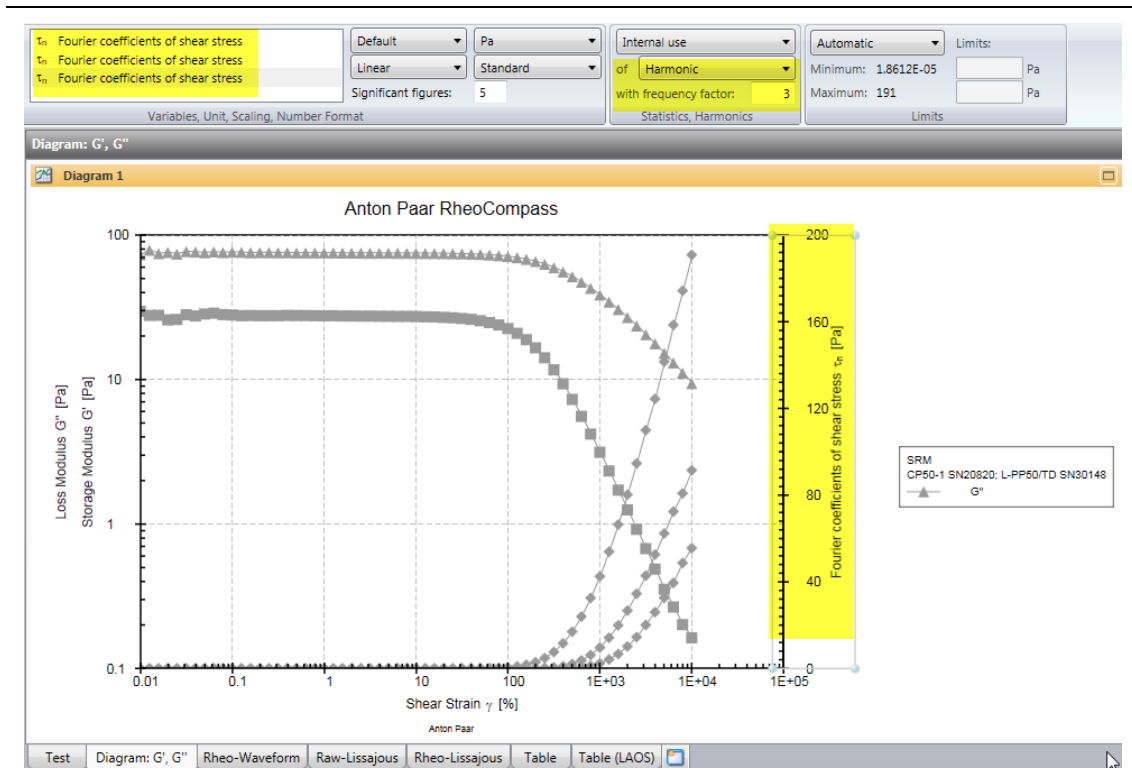
Displaying Waveforms in Other Diagrams using the Amplitude Sweep Diagram

To show the raw data of a single point in one of the diagrams prepared for raw data, proceed as follows:

- Select a single point in the **Diagram, Amplitude sweep**
- Click **Ribbon function, Curve, Show selection in other diagrams**
- Select the **Diagrams** of interest

- Check the option **Clear diagrams before applying** if you would like to show the selected point only:
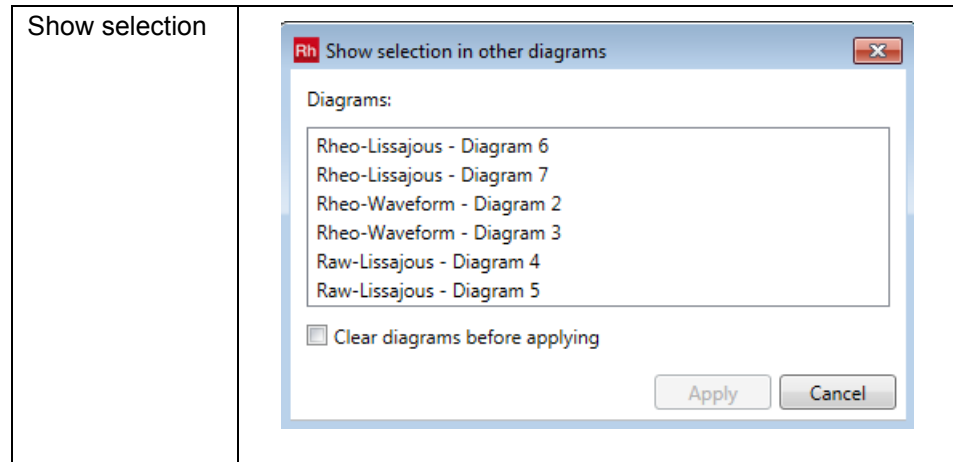
Show selection	

- Click **Apply**
- Switch to the other view to see the selection

View tabs containing other diagrams for raw data:

- **Rheo-Waveform** (containing rheological raw data)
- **Raw-Lissajous** (containing mechanical raw data)
- **Rheo-Lissajous** (containing rheological raw data)
- **Table (LAOS)** (containing LAOS data)
- **Table** (containing rheological measuring points)
  - Place the mouse pointer on "..." to display the raw values of the waveform
  - Use the context menu (right mouse key) to copy the table content (including raw data) and paste it into Excel or any other program

Automated display of the last waveform or Lissajous figure in the diagram

For each window of type **Diagram** or **Table**, the next test result can be shown automatically.

To predefine the next measurement, click the **<Auto-Display>** tab in the **Navigation pane**.

When adding or removing **Actions** from the **Test definition**, the **Auto-display** of the windows might get reset. Thus, it is advisable to check all **Auto-display** settings for all **Windows** after any modification of the **Test definition**.

For presenting the **Raw data** of the **Current measuring point**, select the Auto-Display parameter **Last point of the Interval** in each Diagram or Table window used for presenting **Raw data**.

Auto-display for **Last point**	
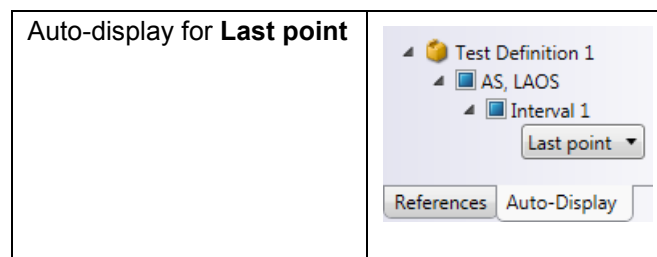
Nomenclature

What is the meaning of **for sinusoidal strain** and **for sinusoidal stress**?

• Strain-controlled tests

  • Shear strain (for sinusoidal strain) = the strain-controlled measurement has been performed with TruStrain = ON
  • Shear strain (for sinusoidal stress) = the strain-controlled measurement has been performed with TruStrain = OFF

• Stress-controlled tests

  • Shear stress (for sinusoidal stress) = the measurement has been performed in stress control

• Auto-detection

  • If **Shear strain** or **Shear stress** are selected, the default setting defined in **Rh, Options, Popular, LOAS calculation options** is used

9.2 Transient (Continuous) Measurement of Raw Data

The waveform recording is coupled with the measuring-point generation. The cycles during adjustment are not recorded and not visible. A new option for obtaining continuous raw data is presented here using the **Raw data sine wave generator**.

Limitations

Due to performance issues it is not advisable to record more than four cycles in one test. Processing of the resulting data is not supported by RheoCompass, but the data could be exported into other programs for further analysis.

Requirements

This new feature does not require the raw data license feature

Working with the Raw Data Sine Generator

Use the template Waveform | Sine generator for setting up a new test.

Project template	⌃ Waveform | Sine generator | Transient raw data recording Measurement of the the immediate response in shear stress or any other variable by presetting a sine wave.
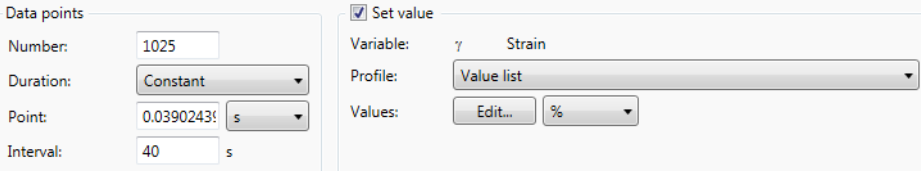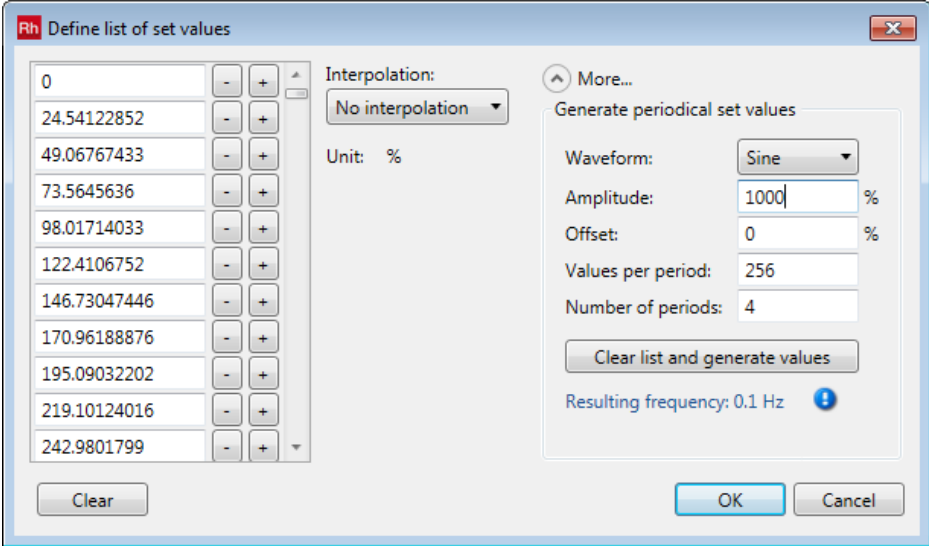
In this template, a sinusoidal strain waveform is defined using the Sine generator. The immediate response in shear stress or any other variable is measured over four cycles.

To change or define a new profile:

- Select the measurement action
- Click the cell containing the strain setting
- Click **Details pane**, **Set values, Values, Edit (Profile: Value List)**
- The list already contains the values of the predefined profile of this template
- Click More to see the sine generator
- Define your own profile
- Click **Clear list and generate values** to clear the list of predefined user values
- Auto-Create with parameters
  -Waveform type (currently only sine)
  -Offset value
  -Amplitude
  -Number of values per period
  -Number of periods
- Click **Clear list and generate values** to create a list containing the automatically created sinusoidal values

Hints on how to define the profile:

- Set the number of measuring points and the interval duration.
  -Example: t_int = 40 s if 0.1 Hz and 4 cycles
  -t_int = cycles/frequency
- Number of measuring points = values_period * cycles + 1:
  example 256 * 4 = 1025
- Edit the value list to generate a new sinusoidal waveform
- Example for 4 cycles with 4*256 data points:

Example	
Example	Data points — Number: 1025; Duration: Constant; Point: 0.0390243... s; Interval: 40 s. Set value ✓ — Variable: γ Strain; Profile: Value list; Values: Edit... %
Waveform generator	**Define list of set values** — 0; 24.54122852; 49.06767433; 73.5645636; 98.01714033; 122.4106752; 146.73047446; 170.96188876; 195.09032202; 219.10124016; 242.9801799. Clear. Interpolation: No interpolation. Unit: %. More... Generate periodical set values — Waveform: Sine; Amplitude: 1000 %; Offset: 0 %; Values per period: 256; Number of periods: 4. Clear list and generate values. Resulting frequency: 0.1 Hz. OK / Cancel
Note	The number of values is limited. An error may occur at test start if the command is too long

LAOS transient	

10 Quality Management (21 CFR Part 11)

10.1 Introduction

This chapter describes the features and settings to use the RheoCompass™ under QM regulations like GLP / GMP or 21 CFR Part 11.

If you require further assistance or would like to make any suggestions you are welcome to contact Anton Paar GmbH rheocompass@anton-paar.com

10.2 Safety Instructions

Make sure you read and understand all the safety instructions given in this section and throughout the manuals before installing and operating the equipment. Follow the instructions in this manual at all times.

The manual contains important advice and warnings. Read them carefully and follow all instructions to avoid danger to yourself and others and / or damage to the equipment.

General Information

- The RheoCompass™ software by Anton Paar GmbH has been developed for controlling Anton Paar rheometers. It is used for the recording, evaluation and presentation of measurement data.

- All measurement data obtained with this equipment should be checked for plausibility before consequential actions are taken based on this data.

- Before using the software read all safety instructions and information regarding the use of the equipment. Follow the instructions at all times.

- Anton Paar GmbH and its suppliers shall not be liable for any damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or other pecuniary loss) arising from the use or inability to use this product, even if Anton Paar GmbH has been advised of the possibility of such damages. In any case, Anton Paar GmbH's liability shall be limited to the amount actually paid by you for this product. This limitation does not apply to damages which were caused by Anton Paar GmbH with intent or due to gross negligence. Likewise, claims which are based on mandatory legal rules regarding product liability remain unaffected.

10.3 Requirements

Please note that in order for RheoCompass™ software to work in compliance with 21 CFR Part 11, a number of measures is required on operating system level.

To work in compliance with the regulation 21 CFR Part 11 it is essential to install a RheoCompass™ license with the Signature feature. The feature is not included in a standard RheoCompass™ Professional license.

The RheoFinder is your window to the SQL Database where all RheoCompass™ data is stored.

All elements of the RheoFinder such as projects, tests and templates and all items of the Setup category such as configurations, devices, accessories, measuring systems are stored in one Microsoft SQL 2012 Database which is installed together with the RheoCompass™ software.

Each of the RheoCompass™ objects is unique based on a so called Globally Unique Identifier GUID.

Example: Even if two tests have the same name the GUID of the two tests is unique. GUIDs are usually stored as 128-bit values, and are commonly displayed as 32 hexadecimal digits with groups separated by hyphens, such as {21EC2020-3AEA-4069-A2DD-08002B30309D}.

All events are recorded in the Logbook (Audit trail) of the RheoFinder. The Logbook (Audit trail) is stored in the SQL database.

It is the responsibility of the user (system administrator) to set all options according to the company policy in compliance with the regulation. Use the options dialog of RheoCompass™ Rh->Options to set it up accordingly.

10.4 Description

Login

Access to the RheoCompass™ software is protected by a Login function which requires a user name and password to be entered at the start-up of the software. There are two login types: RheoCompass™ login and Windows login. We strongly recommend to use the RheoCompass™ login in combination with the 21 CFR Part 11 feature of the RheoCompass™ software.

A RheoCompass™ administrator has the right to add new users and to assign a role to a user.

Login options such as Password policy and Automatic logout and Electronic signature are defined in the Rh > Options dialog by any RheoCompass™ administrator (role).

There are predefined Roles which determine the rights regarding the administration of the RheoCompass™ software itself as well as the available commands for executing a measurement (project). The permissions of the role are displayed by selecting the specific role. It is even possible to duplicate existing roles and define user specific roles with special permissions.

Logbook (Audit Trail)

Every event in the RheoCompass™ software which is relevant to CFR 21 part 11 generates a log entry in the Logbook (Audit trail) which contains a description of the event. Logging options are defined in the Rh > Options dialog by any RheoCompass™ administrator (role).

Older events are archived automatically based on the settings in Rh > Options > Archive.

Backup and Restore

The entire Database with all Archives including all settings and elements of RheoCompass™ is stored in Weekly full backups and Daily differential backups. An optional function allows to copy the backup file to an External directory when starting RheoCompass™ – e.g. a network location. Restoring a backup is possible on any computer. Backups are stored locally for 1 month (default setting). Local backups older than one month are deleted (maximum number of full local backups is 6).

Electronic Signature

Project templates including their test definitions can be electronically signed (Approval). The settings of the test definition is then locked by the user with the role RheoCompass™ Approver. Projects generated from the approved Project templates are protected as well.

Tests can be signed within the Test definition using an action Signature. There are three levels of signatures: Submit, Review, Approve with the option to Sign positive or Sign negative. The signature needs to be confirmed with the Password of the user and an optional Comment.

Data Safety

Each data element stored in the Microsoft SQL 2012 data base of RheoCompass™ is protected against data manipulation. RheoCompass™ elements changed within the Microsoft SQL2012 database are prompted with an error Database manipulation detected when starting RheoCompass™ the next time. Furthermore a Logbook (Audit trail) entry is generated with details of the manipulated element.

10.5 Installation and Setup

10.5.1 Installation

Software Installation

Whether the software RheoCompass™ is installed with or without the 21 CFR Part 11 feature depends on the license file and the features in this file. The 21 CFR Part 11 feature can either be included with the first installation of the RheoCompass™ software, or added later on by changing the license file. For the first installation please follow the procedure described in RheoCompass™ software manual.

For adding the 21 CFR Part 11 feature to an existing installation please use the program on the installation medium RheoCompass™.LicenseHelper.exe.

RheoCompass™.LicenseHelper.exe
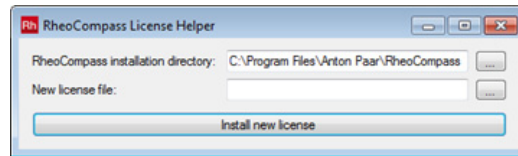
1. Select the program folder

2. Select the new license file

3. Click Install new license

To check if the license feature is properly installed click? > Drop down button > About RheoCompass™. If the 21 CFR Part 11 feature is installed the license feature Signature is enabled.

License details
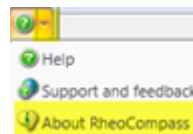
After the installation the user is prompted to enter a name and password for the very first time. A role RheoCompass™ administrator is assigned to this user. The same user is now allowed to start RheoCompass™, login and do the user administration for other RheoCompass™ users (*Chapter 10.5.2, "User Administration"*).

10.5.2 User Administration

In the category <Setup>, <User administration> the Roles and Users are defined. The Electronic signature is defined with the Add user dialog.

Roles

Standard roles: The RheoCompass™ software comes with five predefined standard roles and three roles for the signatures.

RheoCompass™ administratorsRheoCompass™ administrators are authorized to setup, install and modify all components of the software.

RheoCompass™ expertsRheoCompass™ experts are authorized to modify all application related components.

RheoCompass™ lab assistantsRheoCompass™ lab assistants are authorized to perform, format and delete measuring data.

RheoCompass™ Lab managersRheoCompass™ Lab managers are authorized to modify application related standard components.

RheoCompass™ usersRheoCompass™ users are authorized to perform measurements.

Roles for signatures: For approving, reviewing or submitting tests using an electronic signature one of following roles should be applied to the user:

RheoCompass™ 21 CFR Part 11 approversRole for approving according to 21 CFR Part 11 and releasing templates using an electronic signature.

RheoCompass™ 21 CFR Part 11 reviewersRole for reviewing according to 21 CFR Part 11 using an electronic signature.

RheoCompass™ 21 CFR Part 11 submittersRole for submitting according to 21 CFR Part 11 using an electronic signature.

The permissions of the roles are listed in the Permissions tab of the details pane.

Permissions of a role
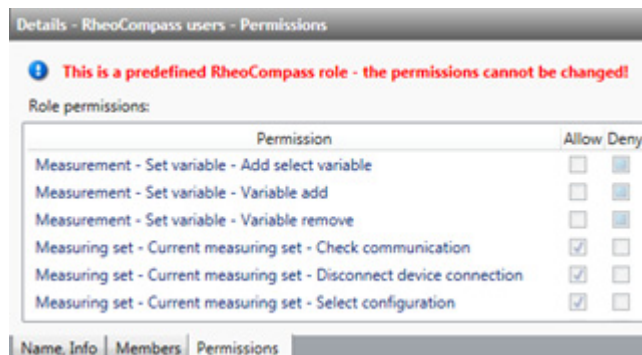
User defined roles: To define a user defined role select any of the standard roles and click Duplicate in the Setup ribbon. The standard role is then duplicated. Next edit the tabs Name, Info, Members and Permissions to customize the new role.

Deletion of Items in RheoCompass:

To avoid accidental deletion of tests it is advisable to set the permissions of the user roles accordingly.

Users and Electronic Signatures

The user in combination with the password builds the basis for the electronic signature.

It is the responsibility of the administrator to define New users and to define the Role membership for each user.

To define a new user in the Setup category choose Users in User administration. Now click New in the Setup ribbon and define Name, Info as well as Role Memberships. The permissions of the currently selected user are listed in the Effective permissions tab of the details pane.

One option to be set by the administrator is "User must change password at next logon".

Add new user dialog

10.5.3 Options

You can enable different system Security settings to ensure data security and to protect your data and settings against unauthorized access. It is the responsibility of the RheoCompass™ administrator to set all options according to the company policy in the options dialog of RheoCompass™ Rh > Options.

10.5.3.1 Backup and Restore

The impact of electronic record and electronic signature regulations also means that data must be backed up effectively to avoid data loss, as 21 CFR Part 11 has specific requirements that involve backup and recovery (restore) of your data.

Backup and restore are focused on storing and restoring audit trail, system, application and user files.

- Storing means copying from the local RheoCompass™ SQL database source to a target medium.

- Restoring means copying from media containing stored files to the primary location of the files.
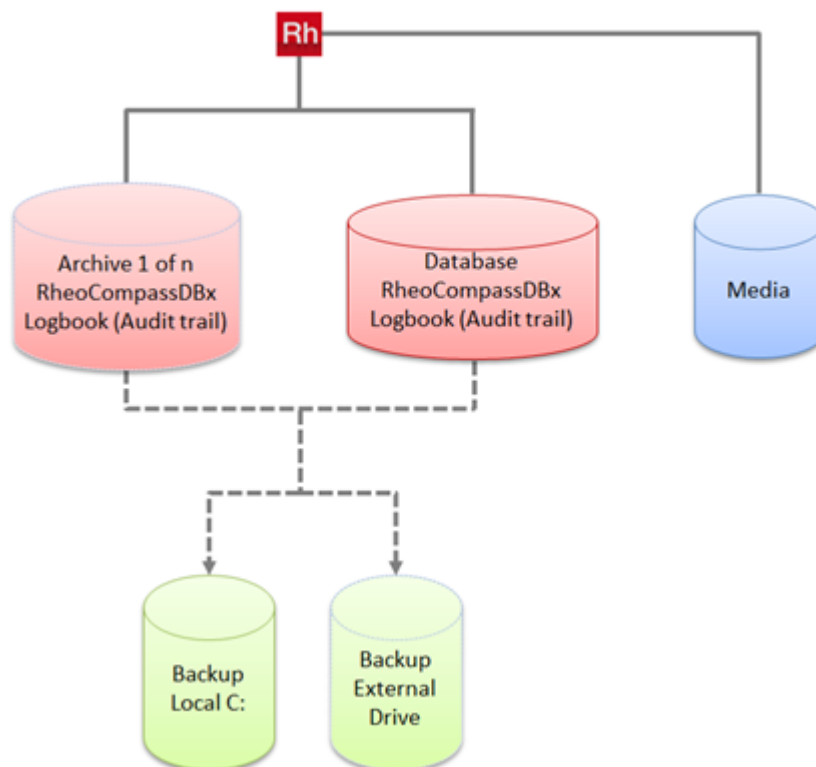
Fig. 10 - 1   RheoCompass™ with associated SQL Main database, SQL Archives and Backups stored in a separate file.

The Backup file is used to restore the RheoCompass™ SQL database. Furthermore Backup & restore is a convenient method to migrate RheoCompass™ from computer A to computer B. The backup path is C:\ProgramData\Anton Paar\RheoCompass™\DBBackups. This path can not be changed by the user. For special handling of media files like video and pictures have a look at the section Media files.

A full or differential backup is performed depending on the user defined settings.

- Weekly full backup

- Daily differential backup

Benefit: The weekly and all differentials are stored in a single backup file. There is a backup for each day without the need to fully backup the database every day.

Type	Name	Created
Database	RheoCompassDB	10/20/2014 11:20:50 AM
Differential	RheoCompassDB	10/21/2014 8:14:00 AM
Differential	RheoCompassDB	10/22/2014 7:38:21 AM
Differential	RheoCompassDB	10/23/2014 8:22:34 AM

• Backups older than one month are deleted automatically depending on the default setting
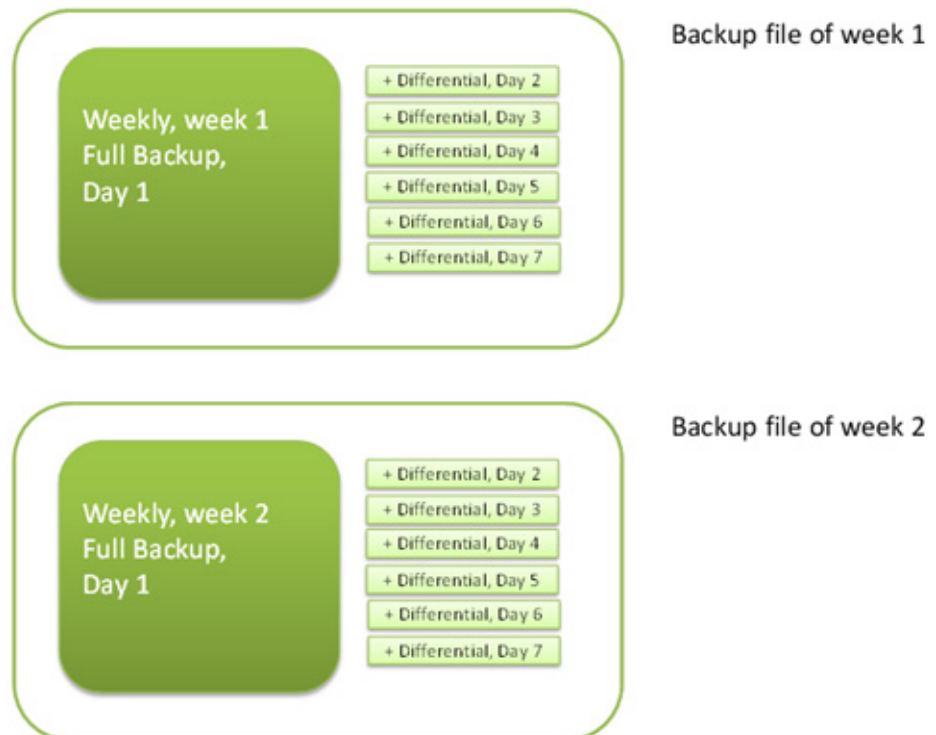
Fig. 10 - 2   Figure: Weekly full backup with daily differential backups.

Settings for backup:

• Time to start the next backup: If the computer is down at that time (which is quite obvious at 3 am) the next backup is executed with the start of RheoCompass™ in the morning. It is not recommended to change this parameter.

• Delete backup older than x month: Time period after which a backup is deleted. Please keep in mind that typical backup files are several GB in total including all archives of the main database and the Logbook (Audit trail). The default value is one month.

Delete backup

- Copy last backup to external drive: Option to automatically copy the current backup to a backup or network drive (user defined target path). Use this option and store the data in a safe place.

  Benefit: Additional external backup file in case of a defective HD or SSD.

  Copy to external

Media files such as video and pictures:

- Please take a note that media files are not stored in the SQL 2012 database and are not included in the backup file. Media files such as pictures and video are saved locally in the folder defined by the RheoCompass™ administrator. The default path for media files is dependent on the version of RheoCompass™ and the version number of the database.

  Example:
  C:\ProgramData\Anton Paar\RheoCompass™\Media_RheoCompassDB.

The Restore function is used to restore a RheoCompass™ database with audit trail, system, application and user files.

- There are two methods for restoring a database. **Note**: Only Windows administrators are allowed to restore a RheoCompass database

  - Method 1 is based on the List of recent backup in the Restore category of the Rh > Options dialog.
  - Method 2 allows to select any Backup file from a folder.

- Backup files are stored in
  C:\ProgramData\Anton Paar\RheoCompassx.xx\DbBackups\
  (this is a hidden Windows folder) and in a customer defined folder which is typically pointing to a network drive (see backup settings).

- Benefit: Migrate a complete RheoCompass™ with all settings to a new computer using Backup & restore.

Backup options:

Restore options:

10.5.3.2 Archive

The RheoCompass™ software works with a main database which is limited in size and any number of archives. Each archive is a separate database and is used as an automatic extension to the main database. An archive contains projects or Logbook entries (Audit trail).

In RheoFinder all projects and events (Audit trail) from the main database and from associated archives are displayed in a list.

By unchecking archives the performance of a large database is improved. The unchecked items are no longer used in RheoFinder.

- Use Show archive to enable the archive to be presented in the RheoFinder. If the option is disabled the archived files are no longer visible in the RheoFinder. It is recommended to uncheck the Show archive flag to improve the performance of the RheoFinder in a steadily growing database.

    Benefit: Unchecking archived projects improves the performance of a large database

Project archive(s):	
Name	Use in RheoFinder
RheoCompassDB3_Project_Archive_10	☑

A database backup file always contains of the main database and all associated archives.

Project Archive(s):

- New project archive: To create a new archive click New. This function is optional. A new archive is created by the RheoCompass™ software whenever the main database is full. The parameter for archiving are defined in the Archive category. Make sure the size of the main database is limited to < 10 GB (default is 3.5 GB).

- Export and delete project archive: Use this function to reduce the size of the local archive(s) and export it to a user defined path. The archive is then no longer assigned to the main database of RheoCompass™. Projects contained in the exported and deleted archive are no longer visible in the RheoFinder.

- Import project archive: An exported and deleted archive can be re-imported at any time. The imported archive is assigned to the main database and the data can then be displayed in the RheoFinder.

Audit Trail Archive(s):

- New audit trail archive: To create a new archive click New. This function is optional. A new archive is created by RheoCompass™ depending on the settings in the Archive category.

- Export and delete audit trail archive: Use this function to reduce the size of the local archive(s) and export it to a user defined path. The archive is deleted and no longer assigned to the main database of RheoCompass™. Data contained in the exported and deleted archive are no longer visible in the RheoFinder.

Message if number of log entries in the database exceeds the defined value.

- Import audit trail archive: An exported and deleted archive can be re-imported at any time. It is assigned to the main database and the data can then be displayed in the RheoFinder.

Archive settings:

10.5.3.3   Logging (Audit Trail)

Most settings in the category Logging (Audit trail) are predefined for the 21 CFR Part 11 user of the RheoCompass™ software.

Logging options:

10.5.3.4 Popular

Most settings in the category Popular are not essential for the 21 CFR Part 11 compliance of the RheoCompass™ software. We recommend to have a closer look at the following parameters.

- The Anton Paar product improvement program is used to send error logs to Anton Paar for improving the quality of RheoCompass™. This option is unchecked by default.

- The Save documents option ensures that a test running for a longer time is saved frequently to avoid loss of data in the case of a software or hardware issue. Default value is auto save every 5 minutes.

Important popular settings:

10.5.3.5 Login

The Login category contains settings for the password, security and signature.
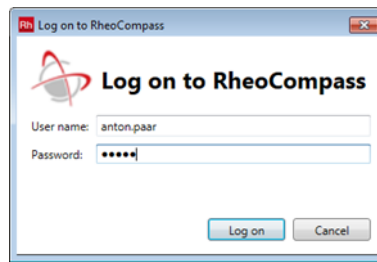
Log on to RheoCompass™:

Access to the RheoCompass™ software is protected by a Login function which requires a user name and a password to be entered at the start-up of the software. There are two login types: RheoCompass™ login and Windows login.

- RheoCompass™ account for login: We recommend to use the RheoCompass™ login in combination with the 21 CFR Part 11 feature of the RheoCompass™ software. Optionally, the Windows login can be used.

- Windows account for login: If the Windows account login is activated the current Windows user is logged in automatically with the Windows user name. If the user is not setup in RheoCompass™ this user is added automatically to the RheoCompass™ users list. A new role is assigned to this user depending on the settings of the Default RheoCompass™ role. If the Default RheoCompass™ role is not RheoCompass™ Administrator the user has restricted permissions. Any RheoCompass™ administrator is allowed to change the role of a user in <Setup>, <User administration> (see also chapter 5.2).

Default RheoCompass™ Role

Define a role for any user who is created automatically when RheoCompass is used the first time.

Password Policy:

Define your own company rules for the passwords such as:

- Enforce password history

- Password policy

- User account log out (user lock after a certain number or password attempts)

Electronic Signature:

Set the option whether RheoCompass™ allows signing tests and approving templates.

Automatic Log Out:

To log out a user after a certain time of inactivity enable this option. Logout is used to protect the software against unattended use. If the mouse is not used for a certain time RheoCompass™ is locked and can be unlocked by any RheoCompass™ user with the electronic signature (name and password).

10.5.4   Checklist

Before starting with the first measurements make sure to finish all administrative settings. This checklist includes the most recent settings to make sure your RheoCompass™ complies with the 21 CFR Part 11 regulations:

Check if license includes the quality management feature: > About RheoCompass™ > Quality management: Enabled

- Rh > Options > Login: Use RheoCompass™ login

- Rh > Options > Login: Set options for password policy

- Rh > Options > Login: Set options for automatic logout

- Rh > Options > Login: Enable/Disable electronic signature

- Rh > Options > Backup: Define external backup drive

- Rh > Options > Backup: Define media path

- Setup > Users: Add new user(s)

- Setup > Users: Define if user must change password at next login

- Setup > Users: Add role membership(s) to new users

- Setup > Users: If using signature for tests add 21 CFR Part 11 role for submit/review/approve to user(s)

- RheoFinder > Tests: Right click column header and add column for (State/Submitted/Reviewed/Approved...by)

10.6 Electronic Signature

The RheoCompass™ software ensures maximum data safety and traceability. Based on Microsoft SQL 2012 server technology, all data such as the measuring systems, accessories, project files, templates and test results are collected in one database.

A project template includes all definitions needed to run a test. The so called test definition is part of a project template and used to define the work flow. As a core element used for testing the sample the test definition is locked by approving a project template.

10.6.1 Locking of Test Definitions

This chapter describes the work flow about how to design a new project template and how to approve the template including the test definition.

One of the core functions of the RheoCompass™ software is the option to Lock a Test definitions by approving project templates. The intention behind locking a test definition is to avoid unwanted modifications of the test definition while working with it an generating measuring and analysis results.

Once approved by the lab manager the test definition is locked thereafter and electronically signed with the user name and password.

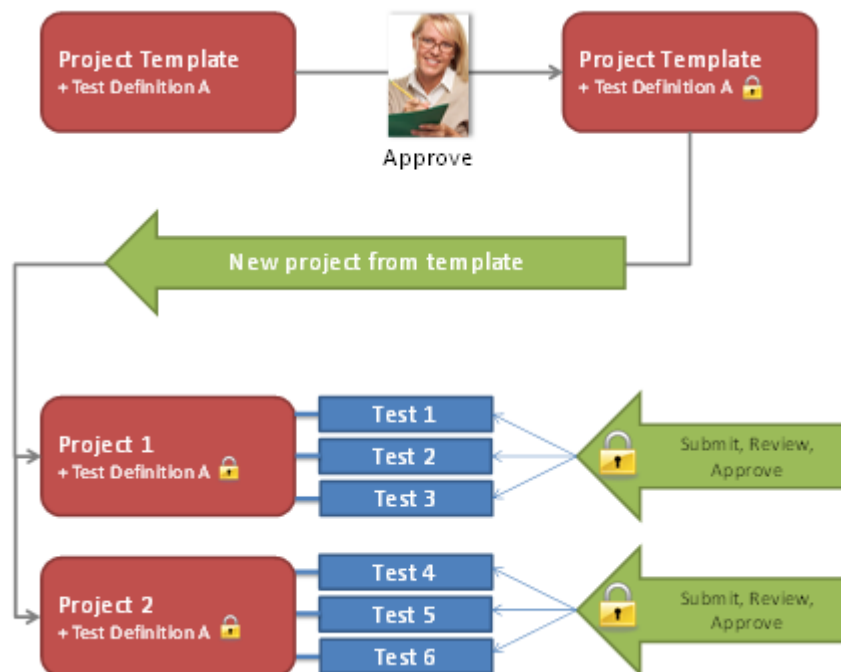The project template is now ready to use for creating new projects.

Fig. 10 - 3   Figure: Approval of project templates and tests

Creating a New Project Template

1. How to create a new approved project template for the very first time

    • Click the category New Project with ribbon filter Home > App Manager > Created by Anton Paar to see the predefined templates
    • Choose a suitable project template by defining the filter by Application and Test type or
    • Or use All for both and choose a filter by Material property
    • A double click at a project template will create and open a new project
    • Edit the test definition and other parameter in the project
    • Save the project as your own Project template: Rh > Save as > Project template
    • Click the category RheoFinder and sub-category Project templates
    • Select the new project template in the list view of the RheoFinder
    • Edit the parameter of the new project template such as Test types and Tags
    • Approve the template in the Approve tab

2. How to create a new project template from an existing project template (approved)

    • Open RheoFinder with sub-category Project templates
    • Select a project template and click Duplicate in the RheoFinder ribbon
    • Select the new project template in the list view of the RheoFinder
    • Change Name, Info of the duplicate
    • Edit the parameter of the new project template such as Test types and Tags

Editing an Existing Project Template

How to edit a project template

    • Only unsigned project templates that are not yet approved can be edited
    • Click the category RheoFinder and sub-category Project templates
    • Select the new project template in the list view of the RheoFinder, Project template category
    • Click the ribbon RheoFinder > Edit
    • Edit the test definition and other parameter in the project template
    • Close the project template to save it: Rh, Close project

Creating a New Project from an Approved Project Template

1. New project

    • Click the category New Project
    • Select the filter Home > AppManager > Created by any user and approved to show approved templates only
    • A double click at a project template will create and open a new project

2. RheoFinder

    • Open RheoFinder with sub-category Project templates
    • Select a project template and double click to open

Approval of a Project Template

How to approve a project template

- Click the category RheoFinder and sub-category Project templates
- Select the project template in the list view of the RheoFinder
- Click Approve in the <Approval> tab of the Details pane to approve a selected template

Note: Once approved the signature can no longer be changed.

Deactivating an Approved Project Template

This function is used to deactivate obsolete project templates using a comment and the electronic signature of a user with role **RheoCompass approver**. The templates are removed from the **My Apps** page and can no longer be opened. To review a deactivated project template, a duplicate can be created at any time. The duplicate has no approval requirements.

How to deactivate a project template:

1. Click the category **<RheoFinder>** and sub-category **<Project templates>**

2. Select the project template in the list view of the RheoFinder

3. Click **Deactivate** in the **<Approval>** tab of the **Details pane** to deactivate the project template.

10.6.2   Signing of Tests

Electronic Signature of a Test

Electronic signatures can be classified as ordinary manual signatures helping to verify the authenticity of electronic data in regulated process environments.

Depending on importance or impact, different signing roles can be assigned to a user. According to common regulations, you can choose between three different roles:

- RheoCompass™ 21 CFR Part 11 Submitters

- RheoCompass™ 21 CFR Part 11 Reviewers

- RheoCompass™ 21 CFR Part 11 Approvers

Once the electronic signature function has been activated, a test including measurement and analysis results can be signed as positive or negative by the submitter, followed by the reviewer and finally by the approver.

If a user of a higher level signs first, the signing states of the lower levels are set according to the evaluation of this higher level user.

Example: If a sample is signed as positive by the approver prior to a submitter or reviewer, the signing states of submitter and reviewer are consequently also set as positive.

Note: Once approved the signature can no longer be changed.

**Signing a Test using an Action**

RheoCompass™ offers a comfortable way to electronically sign a test as part of the predefined test definition. To add an action Signature to a test definition:

• Edit or create a new Project template

• Select the Test definition

• Click Ribbon Test > Insert > Signature

While executing a test the user is prompted to sign the test as part of the test definition. Depending on the test definition the test result with the report
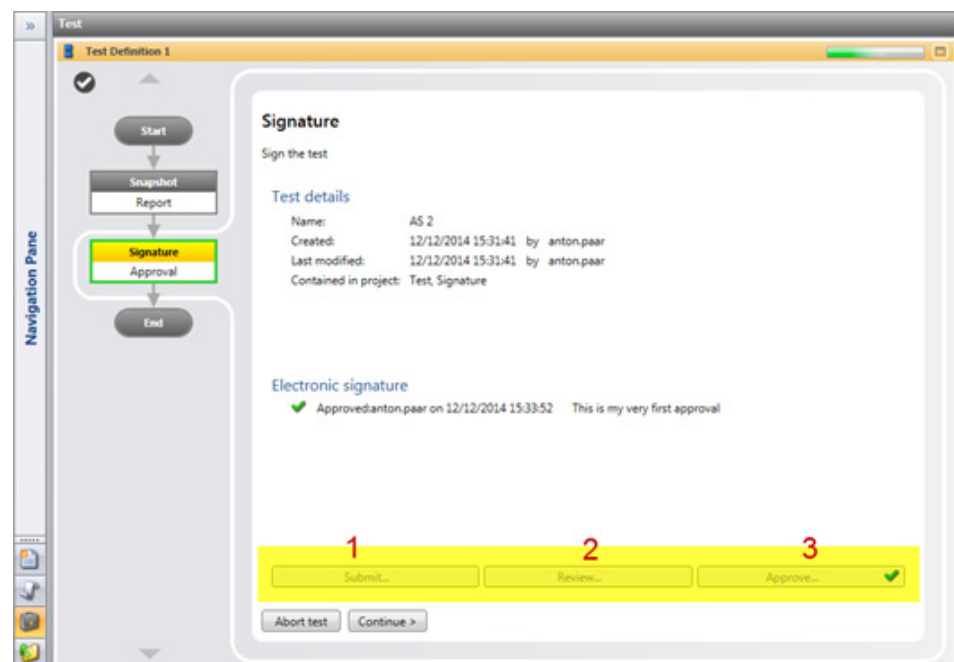
Snapshot Action

- Action to present the report before signing (example screenshot without measurement action)
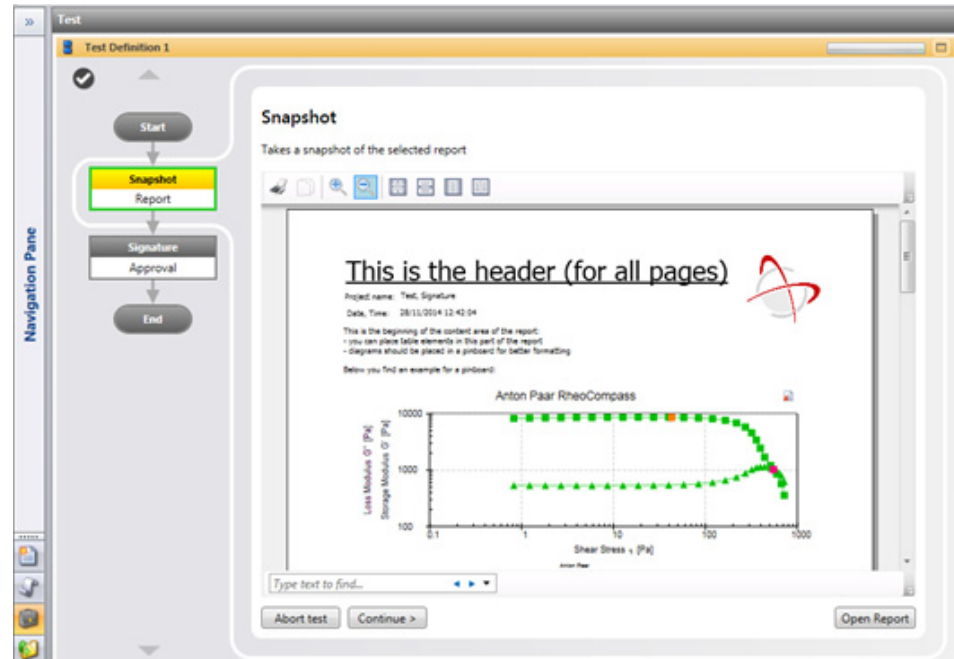
Signature Action

- Action for signing the reported test result (example screenshot without measurement action)

- Signature dialog (example for approval)

Approved Test

- Signed and locked test in the navigation pane
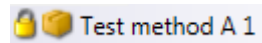
Signing Finished Tests in the Details Pane

To sign any test in a project:

- Click the test in the Navigation pane

- Open the Details pane

- Select the tab <Signature>

- Click Submit, Review or Approve

Signature

- Signature of tests in a project by manual selection in the Navigation pane
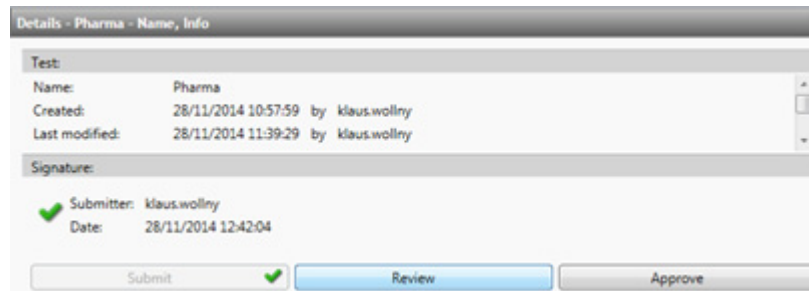
Signing Finished Tests in the RheoFinder

In RheoFinder all test can be found. The RheoFinder allows filtering by project, date, user or any other predefined filter. To sign a test:

- Select RheoFinder > Tests

- Search for the tests you would like to sign using a filter criteria or an instant text filter

- Select the test in the list view

- Select the tab <Signature>

- Click Submit, Review or Approve

Signature

- Signing of tests in the RheoFinder by manual selection in the list view

10.6.3 Signing States in the RheoFinder

With the RheoFinder, managing and retrieving your measuring data and templates in the database is as easy as generating them.

Easily defined filters – e.g. by year, batch number, operator – display the data you are looking for within seconds. The RheoFinder comes with full instant search functionality. Share your data with other RheoCompass™ users via XML-based files – the software's exchange format.

The signing state of a test is not displayed by default. Add the columns which are helpful for retrieving signed tests:

- Right mouse click on the column header

- Select any of the following items

  - State = The state illustrates the signing state by a Signal light
    - Grey = pending
    - Green = signed positive
    - Red = signed negative

  From left to right:

  - Submitted
  - Reviewed
  - Approved
  - Submitted, Submitted by
  - Reviewed, Reviewed by
  - Approved, Approved by

Signing state and additional columns

10.6.4   Checklist

Electronic signatures are used to approve Test definitions included in Project templates and Projects generated therefrom:

- Created user defined project templates and approve them to lock the Test definition

- Enable signing of tests to allow the users to electronically sign and submit, review and approve measuring results

- Check the signing state of tests using the RheoFinder

10.7   Logbook (Audit Trail)

10.7.1   Logging of Events

Using the audit trail function generates a log entry for all operating steps which leads to changes in measuring results.

Additionally all changes which are relevant for data integrity, manipulation or access control are documented in a log file as well.

Export Logbook (Audit Trail) as PDF

To export the list of log entries click **Ribbon Logbook, Export as PDF**

To reduce or filter the list use the **Ribbon Logbook, Filter**. The following filter can be set:

- Filter list by QM categories: Audit trail, Setup operations, Login

- Filter list by: Errors, Warnings

Further filtering such as 'Filter by year, month, week or day' is permitted in the upper-right corner of the RheoFinder.

Logged Categories:

The Logbook (Audit trail) consists of the following categories:

• Audit trail

• Login

• Setup operations

• Device communication

• Message

Category	Notifications
Audit trail	• Computer date or time modified • Failed login • License expired • License expires soon • License issuer date not read • License validity period not found • License version invalid • Service license • User is logged in • User logged in

Category	Notifications
Login	• Accessory import • Delete failed by file • Device component import • Filter import • Job list import • License expires • License expires soon • Login Message • Macro import • Measuring set configuration import • Measuring system import • Moving profile import • Object created • Object deleted • Object duplicated • Password changed • Password reset • Procedure import • Project import • Property changed • Property initialized • Role added • Role export • Role import • Role removed • Technical term import • Template info import • Template package import • Test import • User added • User export • User import • User removed • XML export failed by file
Setup operations	• Adjust measuring system inertia • Adjust measuring system inertia • Adjust drive inertia • Adjust motor • Download firmware • Set temperature input offset and span • Set user defined start angle • Archiving events • Create a database • Data point usage changed • First user has signed the test • Login options changed • Message • Second user has signed the test • Template approved • Test definition changed • Test signed • User has withdrawn the signature

Examples for Logbook (Audit trail) entries:

C01IB003EN-E

User logged in

Created:	2014-12-15 09:32:56.9696	Machine:	APG-A061612
Category:	Login	User:	anton.paar
Event no.:	070-0002	Object name:	User: anton.paar
Title:	**User is logged in**	Object ID:	c9a9dc18-a05c-4497-a5a6-aba788604865
Description:	User anton.paar is logged in.		

Test assigned

Created:	2014-12-12 15:33:52.9400	Machine:	APG-A061612
Category:	Audit trail	User:	anton.paar
Event no.:	153-0006	Object name:	Test: AS 2
Title:	**Test signed**	Object ID:	fc0b65f6-fd3a-40fd-b93f-d60cdb8a5702
Description:	This test is approved positive from user anton.paar on 12/12/2014 15:33:52 with statement 'null'.		

Property changed

Created:	2014-12-02 15:50:10.8530	Machine:	APG-A061612
Category:	Setup operations	User:	Klaus.Wollny
Event no.:	064-1452	Object name:	MeasuringSystem: New measuring system
Title:	**Property changed**	Object ID:	63f66cad-ad8f-4293-81e4-1623daf3b034
Description:	New measuring system: The property 'Name' was changed from 'New measuring system' to 'PP40'.		

10.7.2 Retrieving Tests, Templates and Audit Trail Entries

Use the RheoFinder to retrieve measuring data, templates or Logbook (Audit trail) logs in the database. Instant search or user defined filters, e.g. by year, batch number, operator help you to retrieve the data you are looking for.

Click the <RheoFinder> category and select the category of objects you are looking for such as:

- Category <Project Data> with object(s): Projects, Tests (contained in the projects), Videos, Pictures

- Category <Templates> with object(s): Project templates, Diagram templates, Table templates, Report templates, View templates

- Category <Recycle bin> with object(s): Recycle bin

- Category <Procedures and Macros> with object(s): Procedures (for tests) and Macros (for analysis)

- Category <Job Lists> with object(s): Job Lists

- Category <Logbook> (Audit trail) with object(s): Logbook (Audit trail)

- Category <Filters> with object(s): Filters

10.7.3 Database Manipulation

Any administrator of the Windows operating system could have access to the RheoCompass™ SQL Database using the Microsoft SQL Express. To protect the readable content of the database against data manipulation all RheoCompass™ database entries are protected using a MD5 checksum (hash code).

Any database manipulation is displayed when starting RheoCompass™ for the next time. The message window pops up with an error message reporting a checksum error with database manipulation.

Database manipulation error:

All database manipulations are then added to the Logbook (Audit trail) of the RheoFinder.

The RheoFinder with its filtering mechanism can be used to retrieve any log.

Logbook (Audit trail) with database manipulation entry:

10.7.4 Checklist

The RheoFinder is used to retrieve data and to check the Logbook (Audit trail):

• Check the Logbook (Audit trail) entries in the RheoFinder

• Retrieve data using the RheoFinder with instant search functionality or predefined filters

• Select the Logbook (Audit trail) in the RheoFinder to search for database manipulation

10.8 Working With RheoCompass™ Software in Compliance with CFR 21 Part 11

The implementation of appropriate procedures is largely the responsibility of the user; therefore, this chapter should be considered as an example.

Prior to starting work with the RheoCompass™ in 21 CFR Part 11 mode, it is necessary to configure the operating system and other environmental variables in a way that the requirements of CFR 21 part 11 can be met. In this chapter it is assumed that the RheoCompass™ software has been installed with the 21 CFR Part 11 function and that all settings have been made as described in the previous chapters. Namely, users with appropriate roles are defined, including at least one RheoCompass™ administrator.

Step-By-Step Instructions

1. Open the software and select the category <New project>.

   • Filter the Anton Paar templates by selecting an appropriate Application and Test type. Alternatively you can choose the filter by Material property.
   • Create a new Project with a double-click on one of the Project templates.

2. Customize the new Project

   • Make all settings in the new project (e.g. optimize the test definition, add a report, etc.) and run a few tests to check if everything runs smoothly.
   • Save the Project as your own user defined Project template (Rh > Save as > Project template).
   • Close the Project

3. To Protect the Project template against unpermitted modifications it should be approved.

   • Select RheoFinder > Project template
   • Search for the Project template you would like to sign using an instant text filter
   • Select the Project template in the list view
   • Select the tab <Approval>
   • Click Approve to open the approval dialog
   • After the Project template has been approved the Test definition in this template is protected against unauthorized modification

4. To create a Project from one of your user defined and approved templates:

   • Select the category <New project>
   • Change the filter in the ribbon Home, AppManager from Created by Anton Paar to Created by any user and approved
   • Create a new Project with a double-click on one of the approved Project templates

5. The new and approved project is then used to run a series of measurements.

   • Refer to (6.2) for signing the tests

6. Continue with (5) if you would like to create another Project from an approved Project template

10.8.1   Checklist

• Create a user defined approved project template and work with it:

- Created a new project by opening a new project using the App Manager

- Edit the project and save it as user project template

- Approve the user project template

  - Repeat steps 1-3 to create more user project templates

- Create a new project from an approved project template and start the tests

- Sign the tests

- Close the project

  - Repeat steps 1-3 to run more tests or to run tests based on any other approved project

11 Lab Automation Service

11.1 Introduction

The **Automation service** is used for **Data exchange** between the **Anton Paar RheoCompass™** software and a **Customer software** in a **Lab Information Management System**.

Based on an **Order file** a project is automatically opened and executed. The **Automation definition window** (2) is used to define the content of the **Result file** to be exported (3) for the **Customer software** waiting for the file.

The **RheoCompass automation service** has the following functions:

- Detect and manage **Order files** received from **Customer software**
- **Open** and **Close** projects defined in the order file
- Store **Result files** taken over by the **Customer software**
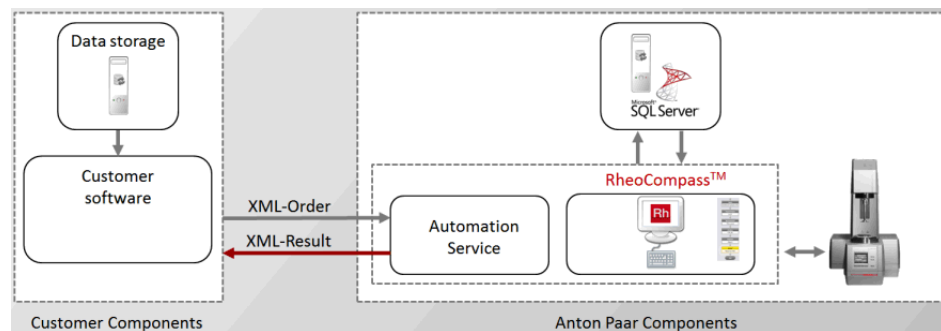- **Handle** the **Status** of the currently running project

Fig. 11 - 1   The RheoCompass Automation Service.

Order file:

XML-based **Order file** from a **Customer software** containing all information needed for the **Automation service** to **Start** a project. It contains the project name and some optional info such as additional sample information.

The format of the Order file is XML, UTF-8 based on the standard **ISO/IEC-10646**.

Result file:

XML-based **Result file** for a **Customer software** provided by the **Automation service**. This is independent of results from projects and tests. The **XML result** file provided by RheoCompass contains the measuring result details defined within the **Automation definition window** of the RheoCompass project file

The format of the Result file is XML, UTF-8 based on the standard **ISO/IEC-10646**.

11.2   Requirements

The software license feature **Lab Automation service** must be enabled by installing an appropriate license:

Licensed for:	Anton Paar Germany GmbH (Rh12C5227 - 1.11.0.0)
License details:	Lab automation service: Enabled

RheoCompass must be started using the **Command line parameter** 'OrderFileName=Name.xml'

whereas Name = any user-defined name such as Order.xml

11.3   Automated Backup

24 h Operation

In automation mode with 24 h operation it is not advisable to use the RheoCompass built-in database backup for Microsoft SQL Server Express.

The Express Edition can only perform error-free backup if no project is in use. The backup should be disabled in **Rh, Options, Backup**. Use an SQL Server maintenance plan instead or an external database-backup software.

8 h Operation

The automated backup can stay activated if RheoCompass is not in use between 2:30 am and 3:30 am. Also, after loading RheoCompass in the morning, allow 10 min for any backup tasks to be completed that may be pending.

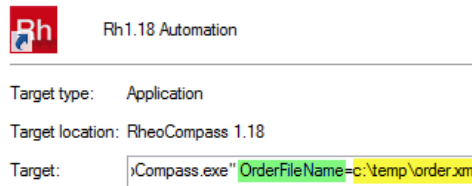## 11.4   Working with the Automation

11.4.1   Starting with Command Line

How to Start RheoCompass with an Icon Containing the Command-Line Parameter:

1. To prepare the shortcut, right-mouse-click the icon, then click **Properties** and tab <**Shortcut**>

2. Next add the command line;
   e.g.,"C:\Program Files\Anton Paar\RheoCompass 1.18\RheoCompass.exe"
   OrderFileName=C:\Temp\Automation\name.xml

11.4.2 Status

Once started in **Automation mode** the **Status bar** of RheoCompass™ indicates
that the software is in **Automation mode** and '**Waiting for order**...'

11.4.3 Project Name or Identifier in Order File

Once the automation file has been found in the directory defined in the command
line parameter, the project is opened and executed. The name defined in the
order file can be of the following types:

- **Project Template** identified by the **ID**:
  <**TemplateId**>59afe0c6-4718-45f2-9e3c-11dcf6e4c2bc</**TemplateId**>

- **Project Template** identified by the **Name**:
  <**TemplateName**>Automation Template</**TemplateName**>

- **Project** identified by the **ID**:
  <**ProjectId**>a82615a1-a665-42c1-af2b-41e5b666cf5b</**ProjectId**>

- **Project** identified by the **Name**:
  <**ProjectName**>Automation Project</**ProjectName**>

If a **Project template** is opened, a new project is created from the project
template with the **Default name** defined in the **Properties** of the project template.

11.4.4 Execution of Project and Creation of Result

The project is opened and the default test definition is executed.

Based on the **Automation definition window** a result file is created and stored
in the predefined path.

The order file is removed. Next, the project is closed and saved with the new test

11.5 Project Automation

For project automation some additional features are available in RheoCompass™.

11.5.1 Auto-Start and Auto-Close

Start the test definition automatically when opening a project, and close it with the action **End**.

How to set the **Auto-Start** and **Auto-Close** in the **Order file**:

1. AutoStartTestDefinition: Automatically open the project and go to the **Start** dialog in the default **Test definition**; value = true or false

2. AutoCloseProject: Automatically close the project after test execution of the default **Test definition**; value = true or false

3. ConfirmProject: A popup dialog for confirmation is shown while closing; value = true or false

Example:

<AutoStartTestDefinition>false</AutoStartTestDefinition>

<AutoCloseProject>true</AutoCloseProject>

<ConfirmProject>true</ConfirmProject>

Instead of defining the Auto-Start and Auto-Close in the Order file it can also be defined using the **Properties** of the **Project template**.

To add the automation feature **Edit** the project or project template in the **RheoFinder**

and change the settings in **Details, Automation**.

11.5.2 Input Data

The **Order file** is optionally used to transfer **Additional input** values from the customer software to RheoCompass™.

The additional inputs are displayed in the default test definition in the action Start.

Examples for additional input are BatchNo, Comment and Customer. For further information see the Automation order scheme provided with the installation of RheoCompass™.

The items are listed below the 'Start input collection'.

11.5.3   Automation Definition Window

The **Automation definition** is a **Window** type used to define the results stored in the **Result file**.

Automation results are stored in a **Result file** of type **XML** using the action **Export**.

Click the **Ribbon Window, New automation definition** to add a new window to the project or project template

Use the **Ribbon Automation** to **Insert**, **Move** or **Delete** elements in the Automation definition.

A result element consists of a user defined **Label** and a **Data type**.

Click the **Ribbon Window, Save as template** to save the currently selected **Automation definition** as a template.

Open the RheoFinder category **Automation definition templates** and click the **Ribbon** function **Home, Export, Export selected item** to **Export** the template and store it as a file. The file extension is ***.RhTau**.

11.5.4   Creating the Result File

How to define and create the Result file:

1. Make sure a **Automation definition window** is persistent in the project or project template

2. Add an Action **Export** to the **Default test definition**

3. Select the export type **Automation result** with format **XML** and the **Result definition window** in the **Details pane** of the **Action Export**

The Result file is stored automatically during the next test execution.

11.5.5 Advanced Functions of the Order File

For advanced functions of the order file have a look at the **Automation order scheme** provided with the installation of RheoCompass™.

11.6 Automation States

The **Automation status** of RheoCompass is shown in the status line of RheoCompass.

It is started with the Lab automation service license feature and the command line parameter.

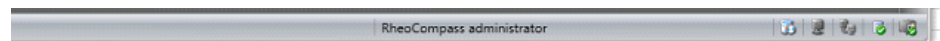The visualization uses 2 elements:

• a signal element showing the general automation state

• a status text element showing detailed status texts

Both elements are right-aligned to the existing status bar elements:

The following automation states are applicable:

1. Automation Off

No <Automation service> is started.

2. Automation ON, waiting for order

<Automation Service> scanning for any incoming orders.
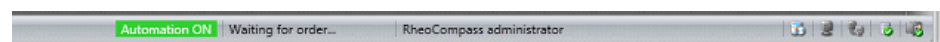
3. Automation ON, order received

Order received, syntax of order checked. With the information contained therein, a new project is created, or an existing project is opened. An error message appears if the syntax is incorrect.
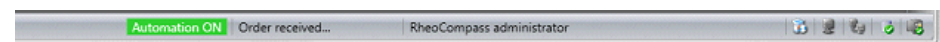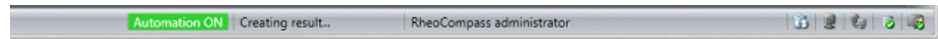

4. Automation ON, executing order

A project has been correctly created and started. The <Project Service> calls the method "BeginProject()" and can now start the test definition (automatically or manually).
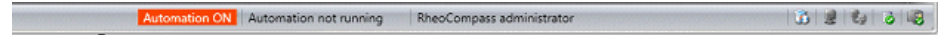

5. Automation ON, creating result

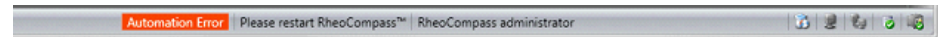Once the result file has been created, the automation task is finished.

6. Automation ON, order mechanism stopped or not started

7. Automation error, Error state

The Automation service has stopped accepting orders. A log entry is created with the error code.

11.7 Exporting Project Templates as Template Packages

This function enables sharing of **User-defined project templates**. Create your own template package and share it with any subsidiary or department of your company.

• Click **RheoFinder, More, Create template package** to start creating a new template package.

• Click **RheoFinder, More, Import template package** to start importing a template package created by a user.

Requirement: The shortcut is only visible to users with the role **RheoCompass administrator**.

12 License Features for Trial

Not all features of RheoCompass are included in the standard license. To obtain a license for a trial period, please contact key-rheocompass@anton-paar.com.

To check whether the license feature is enabled, click on **About RheoCompass** and check if the feature **Usage of camera** is **Enabled**.

Example for the license features of the Info about dialog:

Use the following form to provide the required information or send us a screenshot with the Info about and the required items marked:

Email to	**key-rheocompass@anton-paar.com**
Device serial number	
Software serial number	
Company name	
Contact person	
Email address	

Item	No
Quality management (21 CFR Part 11)	160445
Media Window, Media Explorer	104911
Report Designer	104910
Raw Data (LAOS)	104916
TruStrain™	104912
TruRate™	104914
Vertical Movement Profile (Tack, Penetration)	104917
Polymer Analysis Package	104920
Interfacial Analysis Package	104918

Installation of a New License:

The license file *.lic can be installed using the RheoCompass.LicenseHelper.exe installer. The "License Helper" is found on the USB drive for RheoCompass.

What Happens if the License Feature Expires?

If the time-restricted license feature expires, all other features are still functional. There is no need to install the original license.

Can I Edit the License File?

No. If the license file is edited it will be invalid and no longer readable.