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

### 1.2 Installation Requirements

The minimum requirements for RheoCompass™ are listed below, a system with higher specifications will result in faster operation of the software.
Compatible operating systems:

- Microsoft Windows 7-SP1 (64bit)
- Microsoft Windows 8 (64bit)
- Microsoft Windows 8.1 (64bit)
- Microsoft Windows 10 (64bit)
- Microsoft Windows Server 2012 (Windows 8 Server)
- Microsoft Windows Server 2016 (Windows 10 Server)

Recommended hardware:

- Intel™ i5, 2.67 GHz or higher
- 8 GB RAM or more
- RheoCompass is a 64bit application

Please note that additional hard disk space is required to store your measurement data.

The instruments of the MCR xx2 series can be connected via Ethernet or USB. To use the Ethernet connection, a network interface card or a network connection is required. Further, the TCP/IP protocol needs to be available.
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 de-activated. 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 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 pre-defined 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:

<table>
<thead>
<tr>
<th>Adjust drive inertia</th>
<th>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:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image.png" alt="Image showing the Adjust drive inertia function parameters" /></td>
</tr>
<tr>
<td></td>
<td>The drive inertia is stored in the device and not in the software. Re-adjust all measuring systems after any drive inertia adjustment.</td>
</tr>
<tr>
<td>Function</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
</tbody>
</table>
| 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.  

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 pre-defined 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 &lt;Setup&gt;, &lt;Accessories&gt;, 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 &lt;Setup&gt;, &lt;Measuring set&gt;, &lt;Calibrations&gt; for retrieval (see chapter 3.1.4).
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, normal 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 pre-defined 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 type and click "Create". 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")

If the new moving profile will be very similar to an existing one, highlight that profile 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 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.

The "Usable devices" can be selected in any of the other tabs. The settings for the moving profiles are defined for air bearing or ball bearing instruments separately. Further, the Automatic Sample Changer ASC requires a separate moving profile.

3.1.3.3 Moving Profiles – Measuring Position

The "Device group" shows the devices for which the settings can be used, if the option "Moving profile should contain settings for this device group" is activated. To edit settings for a new device group, select the group from the list and activate the check-mark.
The available settings can vary depending on the selected device group, e.g. because the device has a normal force sensor.

**Lift-Drive Settings**

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 movement to the measuring position depending on the current gap value (Position) measured by the device. Between the steps defined by the position values, the velocity and normal 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. This setting is e. g. recommended, if the sample is heated or cooled before start of the measurement to make sure that the normal force will be kept constant during the equilibrium time.

Scenario 1: I want the system to go to the default gap with controlled normal 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 normal force value in the range of 2–5 N for sensitive materials. The velocity and normal 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 normal 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 normal 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 normal force value is measured; this value should be kept until the start of the measurement.

Select the setting "Set normal 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 normal force value. The more solid-like the sample, the smaller the velocity should be and the higher the normal 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 normal 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 normal force of 40 N for both lines.

**Measuring Drive Settings**
The "Measuring drive settings" allow to lock the measuring system during and after movement either at any position or at a defined angle. Further, it is possible to apply a rotation during the movement and limit torque or speed, if required.

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 measuring 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.

3.1.3.4 Moving Profiles – Waiting Position

The "Device group" shows the devices for which the settings can be used, if the option "Moving profile should contain settings for this device group" is activated. To edit settings for a new device group, select the group from the list and activate the check-mark.

The waiting position is used in the test definition, if a defined position is required during e.g. thermal equilibrium or 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.

3.1.3.5 Moving Profiles – Loading Position

The "Device group" shows the devices for which the settings can be used, if the option "Moving profile should contain settings for this device group" is activated. To edit settings for a new device group, select the group from the list and activate the check-mark.

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

**Lift Drive Settings**

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 movement to the loading position depending on the current gap value (Position) measured by the device. Between the steps defined by the position values, the velocity and normal force will be ramped linearly. If the option "Continue lift drive control after positioning" is activated, the settings will be used after the loading position has been reached. This option is very rarely used for the loading position.

**Measuring Drive Settings**

The "Measuring drive settings" allow to lock the measuring system during and after movement either at any position or at a defined angle. Further, it is possible to apply a rotation during the movement and limit torque or speed, if required.
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 default mode for moving to the loading position is "No setting"; for automated raising of the measuring system after a measurement, it is recommended to use a rotation at 5 to 10 rpm to avoid a normal force overload. 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 the loading position.

3.1.3.6 Moving Profiles – During Measurement

The "Device group" shows the devices for which the settings can be used, if the option "Moving profile should contain settings for this device group" is activated. To edit settings for a new device group, select the group from the list and activate the check-mark.

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 normal 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 Moving Profiles – Zero-Gap Setting

The "Device group" shows the devices for which the settings can be used, if the option "Moving profile should contain settings for this device group" is activated. To edit settings for a new device group, select the group from the list and activate the check-mark. The available settings can vary depending on the selected device group, e.g. because the device has a normal force sensor.

The settings for the zero-gap procedure can affect the accuracy of all gap setting and should therefore not be changed. 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.

More details...
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 "Normal force detection" has been selected, the measuring system will move down until the normal force limit is measured. Then the device will back up until the value given for "Normal force for touching" is measured. This is the zero position which is used for all gap setting until the next zero-gap procedure is started.

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 device will back 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.

### 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 not 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 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 un-check 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 s–ettings

   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 pre-defined 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 coefficients using a polynomial fit. The coefficients 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 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.

![Search field for the database (RheoFinder)](image)

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 applications, test types and material properties in the cover flow under "Start". If you want to assign a template to certain categories, go to the tab "Application, Test Type, Material Property". Disable the option "Do not limit..." and enable the relevant groups. 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.

You may also want to assign the template to certain hardware, e.g. a template created for a special accessory and an air bearing device. To do this, go to the tab "Hardware" and select the category in the appropriate hardware row. If the template matches several hardware types, add the necessary number of types using the (+) sign and make the selections there are well. To delete rows, click the (-) sign.

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

<table>
<thead>
<tr>
<th>Rheoplus / US200</th>
<th>RheoCompass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature settings</td>
<td>Device</td>
</tr>
<tr>
<td>Waiting before starting</td>
<td>Wait</td>
</tr>
<tr>
<td>Measurement window</td>
<td>Measurement</td>
</tr>
</tbody>
</table>

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 pre-defined 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 pre-defined 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:
4 RheoFinder

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:

![Replace test definition by test]

4.3 Templates

Templates are available for complete projects, macros, procedures, views 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 "New 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 Creating, Editing and Assigning Project Templates

Project templates are always generated from the existing projects.

1. To create a new template from a project, open an existing project or template, e.g. one of the templates delivered with the software.

2. Move data that you want to keep with the 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 template.

3. Go to the home button. Select "Save as > Save as project template" from the application menu. Enter a name for the 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 template, continue with the next step, otherwise skip to step 7.
5. Close the currently opened project and open the template. This will automatically create a new project.

6. Make all required changes to the template and save it again as a template under a new name. To avoid loss of data, overwriting database items is not allowed. The previous template can be deleted from the database in the RheoFinder area of the software.

7. Go to the RheoFinder and select "Project templates" in the category "Templates". Find the new template in the list and highlight it.

8. Enter any additional information you might require in the details Pane. For automatic naming of the projects generated from this 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".

10. To edit a project template select the template in RheoFinder, project templates and click Edit in the ribbon RheoFinder. After applying any changes Close the project template from the Rh button to take over any changes.

By default, all new templates are shown for all test types in the cover flow under "Start". If you want to assign a template to a certain test type, go to the tab "Application, Test Type, Material Property". Disable the option "Do not limit..." and enable the relevant groups. Windows and View do not use the filter by Application or Material property.

You may also want to assign the template to certain hardware, e.g. a template created for a special accessory and an air bearing device. To do this, go to the tab "Hardware" and select the category in the appropriate hardware row. If the template matches several hardware types, add the necessary number of types using the (+) sign and make the selections there as well. To delete rows, click the (-) sign.

4.3.2 Using Project Templates

To create a project based on a template, go to "Start" in the navigation. Scroll through the cover flows for a suitable group of applications and tests. Then select the template in the details pane and double-click, the software will create a new project based on this template and automatically switch to the project view.
4.3.3 Creating and Assigning Window and View Templates

Templates can be created separately for table, diagram and report templates, 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 "Application, Test Type, Material Property". Disable the option "Do not limit..." and enable the relevant groups. Windows and view do not use the filter by Application or Material property.

You may also want to assign the template to certain hardware, e.g. a template created for a special accessory and an air bearing device. To do this, go to the tab "Hardware" and select the category in the appropriate hardware row. If the template matches several hardware types, add the necessary number of types using the (+) sign and make the selections there are well. To delete rows, click the (-) sign.

4.3.4 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".

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

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.
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 "Application, Test Type, Material Property". Disable the option "Do not limit..." and enable the relevant groups. Procedures do not use the filter by Application or Material property.

You may also want to assign the procedure to certain hardware, e.g. a procedure created for a special accessory and an air bearing device. To do this, go to the tab "Hardware" and select the category in the appropriate row. If the procedure matches several hardware types, add the necessary number of types using the (+) sign and make the selections there are well. To delete rows, click the (-) sign.
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 pre-define 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 "Application, Test Type, Material Property". Disable the option "Do not limit..." and enable the relevant groups. Macros do not use the filter by Application or Material property.

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.

You may also want to assign the macro to certain hardware. To do this, go to the tab "Hardware" and select the category in the appropriate row. If the macro matches several hardware types, add the necessary number of types using the (+) sign and make the selections there are well. To delete rows, click the (-) sign.

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 pre-defined 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 pre-defined 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 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.
5 The Actions

- Use a **pre-defined name** in the Details pane if the first part of the name is always the same.

**Example(s):**

<table>
<thead>
<tr>
<th>Default test name in Details pane</th>
<th>Behavior at test start</th>
</tr>
</thead>
</table>
| 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**  
... |
| Pre-defined 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 pre-defined name is taken over is taken over and a consecutive number is added -> **Creme 2**  
3rd test: The pre-defined name is taken over is taken over and a consecutive number is added -> **Creme 3**  
... |
| Pre-defined 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 pre-defined name is taken over and a consecutive number is added -> **Creme 2**  
3rd test: The pre-defined 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:

<table>
<thead>
<tr>
<th>Checkmark</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Checkmark]</td>
<td>Input field is shown at runtime</td>
</tr>
</tbody>
</table>
By default the following additional inputs are pre-defined in most project templates:

1. Name of the test
2. Operator
3. Sample
4. Batch no.
5. Description

<table>
<thead>
<tr>
<th>Checkmark</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>User can change input at runtime</td>
</tr>
<tr>
<td></td>
<td>Input is required; field must not be empty</td>
</tr>
</tbody>
</table>

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.
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.

![Combined measurement actions](image)

**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**

<table>
<thead>
<tr>
<th>Settings in the Details Pane</th>
<th>Name, Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

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
5 The Actions

- 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

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**:

  ![Duration settings](Image)

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

- **Max adjusting duration**:
  - 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.
5 The Actions

- **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:**

![Example](image.png)

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

<table>
<thead>
<tr>
<th>Max. adjusting duration</th>
<th>Automatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Averaging over</td>
<td>Relative point duration exactly Constant</td>
</tr>
<tr>
<td>Timeout</td>
<td>Automatic</td>
</tr>
</tbody>
</table>

**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.

![Graph](image.png)

**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 pre-defined 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 pre-defined variable (e.g., viscosity) becomes constant. Use case 1: Flow curve.

- Go to the next interval if a pre-defined 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](image)

Set variable:

- Duration: by steady state

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

Settings with 'Auto-detect':

- Steady state
  Steady State Action
  Next interval
  For variable: Shear Strain
  Condition: Constant slope
  ✔️ Auto-detect

'User-defined' settings:

- Steady state
  Steady State Action
  Next interval
  For variable: Shear Strain
  Condition: Constant slope
  ✔️ Auto-detect

- Settings of condition
  Number of points per inspection value: 3
  Allowance: 0.2 %
  Total inspection time: 6.000 s

Visualization of settings:

[Image of graph showing Allowance, Inspection definition, Total inspection time, and inspection definition]

- 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
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:

<table>
<thead>
<tr>
<th>Data points</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number:</td>
<td>1000</td>
</tr>
<tr>
<td>Duration:</td>
<td>By steady state</td>
</tr>
<tr>
<td>Point:</td>
<td>1</td>
</tr>
<tr>
<td>Timeout:</td>
<td>1000,000 s</td>
</tr>
</tbody>
</table>

Set value:

<table>
<thead>
<tr>
<th>Variable</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear Stress</td>
<td></td>
</tr>
<tr>
<td>Profile:</td>
<td>Constant</td>
</tr>
<tr>
<td>Values:</td>
<td>5 Pa</td>
</tr>
</tbody>
</table>

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':

- Steady state

Steady State Action

Next interval

For variable: Shear Strain

Condition: Constant slope

☑ Auto-detect

'User-defined' settings:

- Steady state

Steady State Action

Next interval

For variable: Shear Strain

Condition: Constant slope

Settings of condition

Number of points per inspection value: 3
Total inspection time: 6.000 s
Allowances: 0.2 %

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 \( t_{\text{cycle}} = \frac{1}{f} \).
    - Example at 1 Hz: \( t_{\text{cycle}} = 1 \) s
    - Example at 0.1 Hz: \( t_{\text{cycle}} = 10 \) s
  - It takes several cycles to adjust the amplitude. We recommend setting a time of:
    - \( t_{\text{mp}} = 10 \times t_{\text{cycle}} \) at about 1 Hz (10 s)
    - \( t_{\text{mp}} = 6 \times t_{\text{cycle}} \) 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.
  - **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 |
      |------------|------------------------|
      | \( f \geq 10 \) Hz | 4 s within the tolerance |
      | \( 10 > f \geq 0.5 \) Hz | \text{at} 10 Hz: 4 s within the tolerance \text{linear interpolated max. adjusting time} @0.5 Hz: 13 s within the tolerance |
      | \( 0.5 \) Hz > f | \text{at} 0.5 Hz: 13 s within the tolerance \text{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

<table>
<thead>
<tr>
<th>Frequency [Hz]</th>
<th>Periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;= 50</td>
<td>50</td>
</tr>
<tr>
<td>2 &lt;= f &lt; 50</td>
<td>50 periods at 50Hz</td>
</tr>
<tr>
<td></td>
<td>in-between linear interp.</td>
</tr>
<tr>
<td></td>
<td>1 Period at 2Hz</td>
</tr>
<tr>
<td>2</td>
<td>&gt; 1 (linear interp.)</td>
</tr>
<tr>
<td>&lt; 2</td>
<td>1</td>
</tr>
</tbody>
</table>

- Example for averaging time

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

**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)

**Fig. 5 - 18 Example of manual settings in RheoCompass**
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.

<table>
<thead>
<tr>
<th>Recommended</th>
<th>Use a standard template of the rheometer software</th>
</tr>
</thead>
<tbody>
<tr>
<td>High frequency</td>
<td>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).</td>
</tr>
<tr>
<td>Low frequency</td>
<td>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.</td>
</tr>
<tr>
<td>Surface</td>
<td>Avoid sample slip by using sandblasted (/S) or serrated measuring systems (/P3)</td>
</tr>
</tbody>
</table>

### 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
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
<table>
<thead>
<tr>
<th>Point No.</th>
<th>Temperature (°C)</th>
<th>Fundamental Angular Frequency (rad/s)</th>
<th>Storage Modulus (G’ [Pa])</th>
<th>Loss Modulus (G’’ [Pa])</th>
<th>Angular Frequency (rad/s)</th>
<th>3rd Harmonic Angular Frequency (rad/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25.83</td>
<td>1</td>
<td>9506.6</td>
<td>15707</td>
<td>3</td>
<td>23501</td>
</tr>
<tr>
<td>2</td>
<td>25.84</td>
<td>1</td>
<td>9512.2</td>
<td>15721</td>
<td>3</td>
<td>23509</td>
</tr>
<tr>
<td>3</td>
<td>25.85</td>
<td>1</td>
<td>9515.1</td>
<td>15733</td>
<td>3</td>
<td>23518</td>
</tr>
<tr>
<td>4</td>
<td>25.86</td>
<td>1</td>
<td>9520.1</td>
<td>15738</td>
<td>3</td>
<td>23526</td>
</tr>
<tr>
<td>5</td>
<td>25.87</td>
<td>1</td>
<td>9523.7</td>
<td>15745</td>
<td>3</td>
<td>23526</td>
</tr>
<tr>
<td>6</td>
<td>25.87</td>
<td>1</td>
<td>9527.7</td>
<td>15753</td>
<td>3</td>
<td>23536</td>
</tr>
<tr>
<td>7</td>
<td>25.88</td>
<td>1</td>
<td>9531.2</td>
<td>15761</td>
<td>3</td>
<td>23545</td>
</tr>
<tr>
<td>8</td>
<td>25.89</td>
<td>1</td>
<td>9533.3</td>
<td>15766</td>
<td>3</td>
<td>23548</td>
</tr>
<tr>
<td>9</td>
<td>25.91</td>
<td>1</td>
<td>9539.6</td>
<td>15774</td>
<td>3</td>
<td>23553</td>
</tr>
</tbody>
</table>
4. Define additional windows for the harmonics

Further screen shots:

Diagrams 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

- Amplitude sweep, cooled on soft elastomeric film
- Amplitude sweep, LAOS & Fourier Coefficients (example)
- Measurements at large amplitudes in the non-linear region (large amplitude oscillatory shear):
  - Amplitude sweep
  - Waveform and Lissajous figure
  - Fourier Coefficients (higher harmonics)
- Amplitude sweep, LAOS & Fourier Coefficients

Some calculated variables

<table>
<thead>
<tr>
<th>Loss Modulus for Minimum Shear $G''_{min}$ (Pa)</th>
<th>Loss Modulus for Large Shear $G''_{max}$ (Pa)</th>
<th>Ratio for Shear Thinning $\eta_{th} / \eta_{vis}$</th>
<th>Ratio for Shear Hardening $\eta_{har} / \eta_{vis}$</th>
<th>Ratio for Stress Thinning $\sigma_{th} / \sigma_{vis}$</th>
<th>Ratio for Stress Hardening $\sigma_{har} / \sigma_{vis}$</th>
</tr>
</thead>
</table>

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 feature 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 **Stabilisation**. 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:

![Image of setup interface]

Change the factor according to the signal strength:

![Image of setup interface]

Setup of the measuring set configuration:

![Image of configuration details]

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:

\[ UBNC = \text{Offset} + \text{Factor} \times \text{DSP Size value} \times \left( \frac{10 \text{ V}}{10,000} \right) \]
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.

<table>
<thead>
<tr>
<th>Design of the analysis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input data</strong></td>
<td>Click link to define the input data or drag and drop to input</td>
</tr>
<tr>
<td><strong>Result data</strong></td>
<td>Click link to define the result data</td>
</tr>
<tr>
<td><strong>Step</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Method</strong></td>
<td>A <strong>Method</strong> is a <strong>Basic analysis method</strong>.</td>
</tr>
<tr>
<td><strong>Macro</strong></td>
<td>A <strong>Macro</strong> is a ready to use <strong>Analysis macro</strong> consisting of one or multiple analysis methods. For more information on Macros, have a look at the section in this chapter.</td>
</tr>
</tbody>
</table>
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:

![Action Camera Diagram]

**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**

![Video options Diagram]

**Fig. 5 - 22 Video options**

![Picture options Diagram]

**Fig. 5 - 23 Picture options**
3. In `<Settings>` the settings of the Video input device are defined.

![Device settings](image)

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.

<table>
<thead>
<tr>
<th>Adjust drive inertia</th>
<th>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:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image" alt="Select a device function: Adjust drive inertia" /></td>
</tr>
<tr>
<td></td>
<td><img src="image" alt="Device function parameters" /></td>
</tr>
<tr>
<td></td>
<td>The drive inertia is stored in the device and not in the software.</td>
</tr>
</tbody>
</table>
## 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.

![Device function parameters](image)

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 pre-defined project template found in the **New template, Verification and adjustment** category of the **App manager**.

- Motor adjustment, verification by air check (MCR with CC, CP, DP, PP, ST)
- Motor adjustment, verification by air check (MCR with PR pressure cell)
- Motor adjustment, verification by air check (MCR with SER)
- Motor adjustment, verification by air check (MCR with SRF)
- Motor adjustment, verification by air check (MCR with UXF)
- Motor adjustment, verification by air check (TwinDrive with CC, CP, DP, PP)
- Motor adjustment, verification by air check (TwinDrive with SRF)
- Motor adjustment, verification by air check (TwinDrive with UXF)
- Motor and encoder adjustment, verification by air check (MCR with CC, CP, DP, PP, ST)
- Motor and encoder adjustment, verification by air check (TwinDrive with CC, CP, DP, PP)

## 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 pre defined 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**.

![Set value screenshot]

### 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

<table>
<thead>
<tr>
<th>Place-holder</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(DATE)</td>
<td>Current date</td>
</tr>
<tr>
<td>(DATEANDTIME)</td>
<td>Current date and time</td>
</tr>
<tr>
<td>(TIME)</td>
<td>Current time</td>
</tr>
<tr>
<td>(PROJECT)</td>
<td>Project name</td>
</tr>
<tr>
<td>(TESTNAME)</td>
<td>Test name</td>
</tr>
<tr>
<td>(LOGIN)</td>
<td>User name</td>
</tr>
<tr>
<td>(BATCHNO)</td>
<td>Batch no.</td>
</tr>
<tr>
<td>(DESCRIPTION)</td>
<td>Description</td>
</tr>
<tr>
<td>(CUSTOMER)</td>
<td>Customer</td>
</tr>
<tr>
<td>(CUSTOMERNO)</td>
<td>Customer no.</td>
</tr>
<tr>
<td>(DELIVERYDATE)</td>
<td>Delivery date</td>
</tr>
<tr>
<td>(DEPARTMENT)</td>
<td>Department</td>
</tr>
<tr>
<td>(EXPIRATIONDATE)</td>
<td>Expiration date</td>
</tr>
<tr>
<td>(INSPECTIONLOT)</td>
<td>Inspection lot</td>
</tr>
<tr>
<td>(LABJOURNAL)</td>
<td>Lab journal</td>
</tr>
<tr>
<td>(MANUFACTURINGDATE)</td>
<td>Manufacturing date</td>
</tr>
<tr>
<td>(MANUFACTURER)</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>(OPERATOR)</td>
<td>Operator</td>
</tr>
<tr>
<td>(ORDerno)</td>
<td>Order no.</td>
</tr>
<tr>
<td>(PROJECTNO)</td>
<td>Project no.</td>
</tr>
<tr>
<td>(REFERENCENO)</td>
<td>Reference no.</td>
</tr>
<tr>
<td>(REFERENCESAMPLE)</td>
<td>Reference sample</td>
</tr>
<tr>
<td>(RETAINTESAMPLE)</td>
<td>Retained sample</td>
</tr>
<tr>
<td>(SAMPLE)</td>
<td>Sample</td>
</tr>
<tr>
<td>(SAMPLEID)</td>
<td>Sample ID</td>
</tr>
<tr>
<td>(SAPNO)</td>
<td>SAP no.</td>
</tr>
<tr>
<td>(SHORTNAME)</td>
<td>Short name</td>
</tr>
<tr>
<td>(SUPPLIER)</td>
<td>Supplier</td>
</tr>
</tbody>
</table>
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.
  - **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 pre-defined 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 - 26 Example*

*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:

<table>
<thead>
<tr>
<th>Checkmark</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Checkmark" /></td>
<td>Input field is shown at runtime</td>
</tr>
<tr>
<td><img src="image2.png" alt="Checkmark" /></td>
<td>User can change input at runtime</td>
</tr>
<tr>
<td><img src="image3.png" alt="Checkmark" /></td>
<td>Input is required; field must not be empty</td>
</tr>
</tbody>
</table>
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
5. The Actions

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

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.

<table>
<thead>
<tr>
<th>Name of setting</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving profile</td>
<td>Use this setting to select a Moving profile for the test and actions of type Measurement and Move to...</td>
</tr>
<tr>
<td></td>
<td>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 pre-defined 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 &lt;Setup&gt;, Moving profiles, New.</td>
</tr>
<tr>
<td>Normal force dynamic</td>
<td>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).</td>
</tr>
<tr>
<td>Name of setting</td>
<td>Function</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| **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**      | 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**                | 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. |
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

<table>
<thead>
<tr>
<th>Name of setting</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>TruRate™ (rotation, strain control)</td>
<td>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.</td>
</tr>
<tr>
<td>TruStrain™ (oscillation)</td>
<td>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.</td>
</tr>
<tr>
<td>TwinDrive</td>
<td>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.</td>
</tr>
</tbody>
</table>
- **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](image)

         **Fig. 5 - 32 Value within tolerance**

       - **List box with possible conditions**:
         
         ![Fig. 5 - 33 All conditions](image)

         **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 pre-defined 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 "onmouseover" 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.

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

<table>
<thead>
<tr>
<th>Design</th>
<th>Input data</th>
<th>Analysis steps</th>
<th>Result data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step</td>
<td>Step number of the Analysis action. An Analysis action contains one or multiple steps</td>
<td>Method</td>
<td>Macro</td>
</tr>
<tr>
<td>Method</td>
<td>Basic analysis method</td>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>

Details 2

See JoeFlow 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). The first click will select all measuring points. Part of the curve can be selected with the second and third clicks by holding the shift key.

![Interactive analysis](image1)

**Fig. 7 - 1** Interactive analysis

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 (Fig. 7 - 2 with example of Carreau-Yasuda regression).

![Diagram with legend and analysis](image2)

**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 info pane is then showing the corresponding regression long result (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 pre-defined 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 pre-defined 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.

![Details - New analysis macro](image)

**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 pre-define 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:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curve derivatives</td>
<td>Calculates the derivatives of a curve. The 1st derivative is saved in variable 1, the second in variable 2.</td>
</tr>
<tr>
<td>Curve inflection points</td>
<td>Calculates the inflection points of a curve.</td>
</tr>
<tr>
<td>Curve maximum</td>
<td>Calculates the curve maximum.</td>
</tr>
<tr>
<td>Curve minimum</td>
<td>Calculates the curve minimum.</td>
</tr>
<tr>
<td>Curve slope</td>
<td>Calculates the curve slope between the first and the last input data point after sorting the input data ascending by the s-value.</td>
</tr>
<tr>
<td>Preload</td>
<td>Calculates the tolerance envelope for a device.</td>
</tr>
<tr>
<td>Equation editor</td>
<td>Used for defining equations and calculating the result values of these equations for each input data point.</td>
</tr>
</tbody>
</table>

**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:

1. Calculate recovery after a given time
   - The recovery ratio in [%] is calculated for a pre-defined 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 visco-elastic 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 pre-defined 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 pre-defined in the project template and should not be changed.
7 Analysis Methods, Macros and Steps

• 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 pre-defined 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 pre-defined 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, ...

• **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, ...

**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:

![Diagram](image)

### 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>

Mode:

1. Use a Fixed operant

• Example: Add a fixed value to the viscosity variable; \( \text{eta} = \text{eta} + 2.5 \) with \( a = 2.5 \)

• Calculation:
  - Addition: \( x + a \)
  - Subtraction: \( x - a \)
  - Multiplication: \( x \times a \)
  - 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: \( x / x_1 \)
  - Normalizing to maximum of all points: \( x / x_{\text{max}} \)
• **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

<table>
<thead>
<tr>
<th>Use the &lt;Input&gt; tab</th>
<th><img src="image.png" alt="Image" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>or use drag and drop</td>
<td><img src="image.png" alt="Image" /></td>
</tr>
</tbody>
</table>

• **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 pre-defined 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.

<table>
<thead>
<tr>
<th>Burgers model</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Burgers Model Diagram]</td>
</tr>
</tbody>
</table>

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:

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:

<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 \( J_{\text{max}} \) 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               | average time        | strain |
+--------------------+---------------------+--------+
| x                  | x                   | 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               | average time        | strain |
+--------------------+---------------------+--------+
| x                  | x                   | x      |
```
Additionally, a $J_{\text{max}}$ 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.

- **Settings for the time variable**
  
  - Average time, $t_{\text{av}}$: The average time, $t_{\text{av}}$, is taken as the time, and therefore no strain correction is needed. However, a $J_{\text{max}}$ correction is still applied. This setting gives the best results, but requires $t_{\text{av}}$ to be contained in the measuring data.
  
  - Time $t$: Time $t$ is taken as the time, and both strain and $J_{\text{max}}$ corrections are applied. This setting can also be used if $t_{\text{av}}$ 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 $J_{\text{max}}$ 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.

**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 $J_r(t)$ for any point in the creep phase:
   
   - $J_r(t) = 0$
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 $J_{\text{max}}$ of creep phase:
   - $J_{\text{max}} = \max(J(t, \tau_0))$

7. Calculation of $J_r(t)$ for any point in recovery phase:
   - $J_r(t) = J_{\text{max}} - J(t, \tau_0)$

8. Creep phase:
   - $J(t) = J_0 + J_m(t) + J_n(t)$, $\tau_0 = \text{const.} > 0$

9. Recovery phase:
   - $J(t) = J_{\text{max}} - J_0 - J_m(t) + J_{\text{drift}}(t)$, $\tau_0 = \text{const} = 0$
   - with $J_m(t) = \sum(J_{m_i} \cdot (1 - \exp(-(t-t_0)/\Lambda_i))$ $i=1...3$
   - $J_n(t) = (t-t_0)/\eta_0$
   - $J_{\text{drift}}(t) = ((t-t_0)/\tau_0) \cdot \frac{d(\gamma_{\text{drift}})}{dt}$

The resulting values $J_0$, $J_{m_i}$, $\Lambda_i$, $\eta_0$ and $\frac{d(\gamma_{\text{drift}})}{dt}$ 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:
  - $\gamma_0 = J_0 \cdot \tau_0$
  - $D_n = \tau_0 / \eta_0$

- Recovery phase:
  - $J_{e0} = J_0 + \sum(J_{m_i})$ $i=1...3$
  - $J_e = J_0 + \sum(J_{m_i})$ $i=1...3$
  - $J_v = J_{\text{max}} - J_e$

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):
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:

<table>
<thead>
<tr>
<th>Data generation</th>
<th>Averaging/Corrections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Set shear stress ( \tau ) to 0 in recovery interval</td>
</tr>
<tr>
<td></td>
<td>Set creep compliance ( J(t) ) to 0 in recovery interval</td>
</tr>
<tr>
<td></td>
<td>Apply strain and ( I_{\text{max}} ) correction</td>
</tr>
<tr>
<td>Time variable used for calculation from measuring data:</td>
<td>Average time ( t_{\text{avg}} ) (recommended if contained in measuring data)</td>
</tr>
<tr>
<td>Measurement settings for 'Averaging' in 'Data Generation':</td>
<td>Setting was 'Automatic'</td>
</tr>
<tr>
<td>Data generation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measuring profile

<table>
<thead>
<tr>
<th>Shear rheological measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 91 Points</td>
</tr>
<tr>
<td>0.01...25 s</td>
</tr>
<tr>
<td>2 183 Points</td>
</tr>
<tr>
<td>0.01...25 s</td>
</tr>
<tr>
<td>( \tau )</td>
</tr>
<tr>
<td>50 Pa</td>
</tr>
<tr>
<td>( \sigma )</td>
</tr>
<tr>
<td>0 Pa</td>
</tr>
</tbody>
</table>

Averaging/Corrections
7.2.1.12 Curve Crossover

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

**<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 used to determine a crossover 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 crossover $G'(\gamma) = G''(\gamma)$**

- **Frequency sweep with determination of the curve crossover $G'(\omega) = G''(\omega)$**

- **Temperature ramp in oscillation with determination of the curve crossover $G'(T) = G''(T)$. 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

<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 \( T_g \)
7.2.1.14 Curve Inflection

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

<table>
<thead>
<tr>
<th>Calculation Settings</th>
<th>Variables</th>
<th>Text Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method specific tabs at the right hand side of the Details pane</td>
<td>- For more details see bullet points below</td>
<td></td>
</tr>
</tbody>
</table>

**<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>

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>

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>

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.
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.

**<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 pre-defined 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.

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](image)

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:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiply viscosity by factor 0.98 and save as new viscosity</td>
<td>( \eta = \eta \times 0.98 )</td>
</tr>
<tr>
<td>Multiply viscosity by factor 0.98 and save as new variable ( Y )</td>
<td>( Y = \eta \times 0.98 )</td>
</tr>
<tr>
<td>Get through variables</td>
<td>( T = T )</td>
</tr>
<tr>
<td>Definition of a ratio</td>
<td>( \Delta = G_{\text{complex}}/G' )</td>
</tr>
</tbody>
</table>
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 pre-defined 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**

<table>
<thead>
<tr>
<th>Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Distribution:</strong></td>
</tr>
<tr>
<td><strong>Number of interpolated values:</strong></td>
</tr>
<tr>
<td><strong>Interval no.:</strong></td>
</tr>
<tr>
<td><strong>Initial point no.:</strong></td>
</tr>
<tr>
<td><strong>Final point no.:</strong></td>
</tr>
</tbody>
</table>

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 \([A·s/m^2]\).

- 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
7 Analysis Methods, Macros and Steps

<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 ";".

<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 = 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 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.

**<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.
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>**

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Intervals/Points</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Click here to define input data" /></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 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.
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

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
<th>Intervals/Points</th>
<th>From</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lauer</td>
<td>Flow curve</td>
<td>Range</td>
<td>2</td>
</tr>
</tbody>
</table>

*<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.

<Limiter>

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. At
Only one data point is allowed as input data. There are two options to define the **Additional input**.

<table>
<thead>
<tr>
<th>Drag and drop to define additional input (green symbol)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td>Click &lt;Input Data&gt;, dynamic x-values</td>
</tr>
</tbody>
</table>

*Dynamic x-values: x-values are taken from data points on additional input*
Example:

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](image)

### 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:

<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.
• Calculate a master curve

- Use this mode to calculate:
  • Reduced variables
  • Shift factors $a_T$ and $b_T$ used for the Arrhenius or WLF regression

• Calculate values from a master curve
Use this method to convert reduced variables into frequency sweep variables

<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

      Frequency sweep at reference temperature T0

      Test | Result
      -------------------
      PS168N 210C | <All results>

      Name Info | Remarks | Parameters | Input Data | Result Data

- 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 cannot 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>`.

<table>
<thead>
<tr>
<th>Templates:</th>
<th>Template name</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMTA-torsion, temperature ramp with master curve - TTS</td>
<td></td>
</tr>
<tr>
<td>DMTA-torsion, temperature ramp with master curve - TTS (example)</td>
<td></td>
</tr>
<tr>
<td>Frequency sweep, melt with master curve - TTS</td>
<td></td>
</tr>
<tr>
<td>Frequency sweep, melt with master curve - TTS (example)</td>
<td></td>
</tr>
</tbody>
</table>

**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, ...).

• It is very difficult to shift curves of crystalline polymers and of polymers undergoing a phase transition (see remarks below).

### 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.

**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**

![Example](image)

**Weighting of data**

![Weighting of data](image)

**Result without data weighting:**

G’ only

![Result without data weighting](image)
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:

<table>
<thead>
<tr>
<th>Target value</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Settings</td>
<td>Use Automatic settings by default. If the default does not work, try with Manual settings.</td>
</tr>
<tr>
<td>Shift directions</td>
<td>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).</td>
</tr>
<tr>
<td>Range</td>
<td>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.</td>
</tr>
</tbody>
</table>

Input Variables:

<table>
<thead>
<tr>
<th>Variable mode</th>
<th>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.</th>
</tr>
</thead>
</table>
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 $M_w$, 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.

<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.

The parameters recommended for this method are marked with \(\text{Mw} = K \times \text{eta}^a\). Select the parameter identical with the measuring temperature.

### 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 \(\text{Mw},\ MMD\) 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
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:

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.
Analysis Methods, Macros and Steps

Example:

Material parameters

<table>
<thead>
<tr>
<th>Material group</th>
<th>Material</th>
<th>Kernel Function</th>
<th>beta</th>
<th>alpha</th>
<th>K</th>
<th>s</th>
<th>Me</th>
<th>Rouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>EP [unfluorinated]</td>
<td>EP 100 -c</td>
<td>(Wassermann/Graessley)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>9.35E-20</td>
<td>3.48</td>
<td>1710</td>
</tr>
<tr>
<td>FEP [FEP fluorinated]</td>
<td>FEP 340 -c</td>
<td>(Wu)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>2.75E-13</td>
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<td>HDPE</td>
<td>HDPE 160 -c</td>
<td>(Carrot/Guibet)</td>
<td>Single-Exp.</td>
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<td>6.08E-20</td>
<td>3.42</td>
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<td>Single-Exp.</td>
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<td>3.6</td>
<td>1250</td>
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<tr>
<td>HDPE</td>
<td>HDPE 190 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>6.91E-20</td>
<td>3.41</td>
<td>1250</td>
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<tr>
<td>LDPE</td>
<td>LDPE 190 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>6.91E-20</td>
<td>3.41</td>
<td>1250</td>
</tr>
<tr>
<td>LLDPE [linear]</td>
<td>LLDPE 190 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>6.91E-20</td>
<td>3.45</td>
<td>1250</td>
</tr>
<tr>
<td>LLDPE [metalloscope]</td>
<td>LLDPE 220 -c</td>
<td>(Carrot/Guibet)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>1.15E-21</td>
<td>3.67</td>
<td>1250</td>
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<tr>
<td>PA</td>
<td>PA-Nylon 190 -c</td>
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<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>5.56E-15</td>
<td>3.4</td>
<td>3000</td>
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<tr>
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<td>PA-66 270 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>3.64E-19</td>
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<td>1500</td>
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<tr>
<td>PA</td>
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<td>(Carrot/Guibet)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
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<td>PC</td>
<td>PC</td>
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<td>Single-Exp.</td>
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<td>2.38E-21</td>
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<td>1500</td>
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<tr>
<td>PETTE</td>
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<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>1.84E-21</td>
<td>3.4</td>
<td>1500</td>
</tr>
<tr>
<td>PIB</td>
<td>PIB MELT 150 -c</td>
<td>(Wassermann/Graessley)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>3.74E-20</td>
<td>3.43</td>
<td>9400</td>
</tr>
<tr>
<td>PMMA</td>
<td>PMMA 220 -c</td>
<td>(Carrot/Guibet)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>1.00E-19</td>
<td>3.4</td>
<td>5000</td>
</tr>
<tr>
<td>PPC</td>
<td>PPC-PAC 125 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>5.92E-19</td>
<td>3.4</td>
<td>5000</td>
</tr>
<tr>
<td>PP</td>
<td>PP 185 -c</td>
<td>(Carrot/Guibet)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>8.71E-23</td>
<td>3.77</td>
<td>3500</td>
</tr>
<tr>
<td>PP</td>
<td>PP 200 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>6.91E-20</td>
<td>3.23</td>
<td>3500</td>
</tr>
<tr>
<td>PP [iso-tactic]</td>
<td>PP 190 -c</td>
<td>(Wassermann/Graessley)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>3.42E-22</td>
<td>3.6</td>
<td>6520</td>
</tr>
<tr>
<td>PP [s-tactic]</td>
<td>PP 190 -c</td>
<td>(Wassermann/Graessley)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>1.82E-22</td>
<td>3.6</td>
<td>6520</td>
</tr>
<tr>
<td>PP [iso-polymer]</td>
<td>PP 200 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>6.91E-20</td>
<td>3.23</td>
<td>3500</td>
</tr>
<tr>
<td>PS</td>
<td>PS 150 -c</td>
<td>(Wassermann/Graessley)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>2.38E-17</td>
<td>3.36</td>
<td>17400</td>
</tr>
<tr>
<td>PS</td>
<td>PS 160 -c</td>
<td>(Carrot/Guibet)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>7.43E-18</td>
<td>3.36</td>
<td>17400</td>
</tr>
<tr>
<td>PS</td>
<td>PS 160 -c</td>
<td>(McGorry/Timinillo)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>1.26E-17</td>
<td>3.36</td>
<td>17400</td>
</tr>
<tr>
<td>PS</td>
<td>PS 170 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>1.73E-18</td>
<td>3.36</td>
<td>17400</td>
</tr>
<tr>
<td>PS</td>
<td>PS 200 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>6.91E-20</td>
<td>3.41</td>
<td>17400</td>
</tr>
<tr>
<td>PS [iso-tactic]</td>
<td>PS 200 -c</td>
<td>(Single-Exp.)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>6.91E-20</td>
<td>3.41</td>
<td>17400</td>
</tr>
<tr>
<td>PTFE</td>
<td>PTFE 380 -c</td>
<td>(Timinillo)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>5.37E-20</td>
<td>3.4</td>
<td>4667</td>
</tr>
<tr>
<td>PVDF</td>
<td>PVDF 200 -c</td>
<td>(Carrot/Guibet)</td>
<td>Single-Exp.</td>
<td>1.7</td>
<td>0.01</td>
<td>7.88E-19</td>
<td>3.4</td>
<td>22700</td>
</tr>
</tbody>
</table>
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):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entanglement molar mass Me:</td>
<td>100 g/mol</td>
</tr>
<tr>
<td>Entanglement relaxation time ( \lambda_e ):</td>
<td>0.05 s</td>
</tr>
<tr>
<td>Glass spectrum parameter ( H_g ):</td>
<td>10000 Pa</td>
</tr>
<tr>
<td>BSW exponent ( n_e ):</td>
<td>100</td>
</tr>
<tr>
<td>Plateau modulus ( G^0 ):</td>
<td>100000000 Pa</td>
</tr>
</tbody>
</table>

7.2.1.35 MRF Analysis

MRF analysis is used if either the set variable Current I or the magnetorheological variables are not included in the measuring data.

<Calculation>

Select the calculation mode:

- Calculate magnetic flux density \( B \) from current \( I \)
- 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
  Tolerance ±: 3 %

• Constant absolute tolerance with target value and tolerance
  - Enter Target value and Tolerance [Unit]:

  
  Target value: 2000
  Tolerance ±: 60
• Constant relative tolerance with upper and lower boundary

  - Enter Upper boundary and Lower boundary:

    | Upper boundary | Lower boundary |
    |----------------|----------------|
    | 1997           | 2003           |

<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*

<table>
<thead>
<tr>
<th>Regression model</th>
<th>Typical curve function</th>
<th>Application</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrhenius</td>
<td>Eta(T), aT(T)</td>
<td>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.</td>
<td>$y = a \cdot e^{\left(\frac{1}{T} - \frac{1}{T_r}\right)}$</td>
</tr>
</tbody>
</table>
| Auto-Regression  | all                    | Curve regression with an auto selection of any regression model based on a weighted least-square function. | }
<table>
<thead>
<tr>
<th>Regression model</th>
<th>Typical curve function</th>
<th>Application</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bingham</td>
<td>Tau (shear rate)</td>
<td><strong>The Bingham regression</strong> 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. <strong>Related models</strong> 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 $x \to \infty$.</td>
<td>$y = a + b \cdot x$</td>
</tr>
<tr>
<td>Blau</td>
<td></td>
<td><strong>The Blau regression</strong> 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.</td>
<td>$y = a \cdot \left( \coth \frac{x}{b} \right)^{c}$</td>
</tr>
<tr>
<td>Carreau</td>
<td>Eta (shear rate)</td>
<td><strong>The Carreau regression</strong> 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 <strong>equivalent</strong> to the Carreau-Gahleitner regression with the parameter $b=2$.</td>
<td>$y = \frac{y_\infty - y_0}{\left( 1 + \omega \cdot \alpha \right)^2} + y_\infty$</td>
</tr>
<tr>
<td>Carreau-Gahleitner</td>
<td>Eta (shear rate), Eta* (omega)</td>
<td><strong>The Carreau-Gahleitner regression</strong> 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 <strong>Carreau</strong> regression described in the previous chapter.</td>
<td>$y = \frac{y_\infty - y_0}{\left( 1 + \omega \cdot \alpha \right)^2} + y_\infty$</td>
</tr>
</tbody>
</table>
### 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:**

\[
y = \frac{\eta_{0} - \eta*}{[1 + (\lambda \omega)^{a}]^{b} \omega^{\frac{1}{a}}} + y_{\infty}
\]

<table>
<thead>
<tr>
<th>Regression model</th>
<th>Typical curve function</th>
<th>Application</th>
<th>Formula</th>
</tr>
</thead>
</table>
| 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:** | \[
y = \frac{\eta_{0} - \eta*}{[1 + (\lambda \omega)^{a}]^{b} \omega^{\frac{1}{a}}} + y_{\infty}
\] |

**With:**

- \( \eta_{0} \): Zero shear viscosity proportional to molar mass
- \( n \): Power law exponent = qualitative measure for the macro molecules to orient in shear direction unit to reduce friction resistance
- \( a \): Width of transition range = proportional to MMD and PDI
- \( \lambda \): Molar mass number, small MMD/Mw
- \( \gamma \): Relaxation time = time dependent recovery of internal stresses

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.

### 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.

\[
y^{\frac{1}{n}} = a + b \cdot x^{\frac{1}{n}}
\]
<table>
<thead>
<tr>
<th>Regression model</th>
<th>Typical curve function</th>
<th>Application</th>
<th>Formula</th>
</tr>
</thead>
</table>
| 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. | $y = a + b \cdot x^\frac{1}{2}, \quad \tau_0 = a^2$
$\eta_m = b^\frac{3}{2} \cdot (\frac{\delta}{\frac{2}{3} \delta})^2, \quad \delta = \frac{a_1}{\lambda}$ |
| 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. | $y = \frac{y_0 - y_\infty}{1 + a_2x^p} + y_\infty$
$\alpha = c^p$ |
| 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. | $y = a \cdot x + b \cdot x^p$
$p > 1$ |
<p>| Eyring-Prandtl-Ree  |                        | <strong>The Eyring-Prandtl-Ree regression</strong> describes the flow behavior of a material whose viscosity is approaching a constant value for $x \to 0$. The model has been developed with the assumption that molecules change their position in the direction of the applied stress. | $y = a \cdot \sinh \left( \frac{x}{b} \right)$ |
| Herschel-Buckley    | Tau (shear rate)       | <strong>The Herschel-Bulkley regression</strong> describes the flow curve of a material with a yield stress and shear thinning or shear thickening behavior at stresses above the yield stress. | $y = a + b \cdot x^p$ |</p>
<table>
<thead>
<tr>
<th>Regression model</th>
<th>Typical curve function</th>
<th>Application</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOCCC 2000 / Windhab</td>
<td>Tau (shear rate)</td>
<td>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'.</td>
<td>$y = a + b \cdot x + c \cdot \left(1 - e^{-\frac{x}{b}}\right)$</td>
</tr>
<tr>
<td>Krieger-Dougherty</td>
<td>Eta(volume concentration)</td>
<td>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.</td>
<td>$y = \frac{y_a - y_\infty}{1 + \alpha x} + y_\infty$</td>
</tr>
<tr>
<td>Newton</td>
<td>Tau (shear rate)</td>
<td>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.</td>
<td>$y = a \cdot x$</td>
</tr>
<tr>
<td>Ostwald/Power Law</td>
<td>Eta (shear rate), Eta* (omega)</td>
<td>The Power law (Ostwald) regression can be used to represent the flow curves of shear thinning or shear thickening materials. If the exponent b is equal to one, the equation is identical to the Newton model. For a shear thinning material b is smaller than one and larger for shear thickening materials.</td>
<td>$y = a \cdot x^p$</td>
</tr>
</tbody>
</table>
| 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. | $y = a \cdot x + b \cdot x^p$  
$0 < p < 1$ |
<table>
<thead>
<tr>
<th>Regression model</th>
<th>Typical curve function</th>
<th>Application</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steiger-Ory</td>
<td>Tau (shear rate)</td>
<td>The Steiger-Ory regression describes shear thinning materials.</td>
<td>[ y = a \cdot x + b \cdot x^3 ]</td>
</tr>
<tr>
<td>Settin</td>
<td></td>
<td>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.</td>
<td>[ y = a \cdot x^b \cdot e^{c/x} ]</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td>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.</td>
<td>[ y = a \cdot b^{x^c} ]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>[ \frac{c}{a} &gt; 1, a &gt; 0 ]</td>
</tr>
<tr>
<td>Tscheuschner</td>
<td>Tau (shear rate)</td>
<td>The Tscheuschner regression has been developed to describe the flow behavior of chocolate in a broader range than the Casson equation.</td>
<td>[ y = a + b \cdot x + c \cdot x^p ]</td>
</tr>
<tr>
<td>Vinogradov-Malkin</td>
<td>Eta (shear rate)</td>
<td>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.</td>
<td>[ y = \frac{y_0 - y_\infty}{1 + a \cdot x^b} + y_\infty ]</td>
</tr>
<tr>
<td>WLF</td>
<td>aT(T)</td>
<td>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.</td>
<td>[ y = e^{a(\ln(x-x_0)/b)} ]</td>
</tr>
</tbody>
</table>
<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 pre-defined 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**.
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
7 Analysis Methods, Macros and Steps

- 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.

<number>
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.

7.3 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 pre-define an automated naming dependent on the test input and information.

**Examples of ready-to-use analysis macros:**

<table>
<thead>
<tr>
<th>Macro in the analysis action</th>
<th>Macros in the RheoFinder (Macro Designer)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interpolation, shear rate 1x-1</strong></td>
<td><strong>Open the macro in edit mode or create a new one</strong></td>
</tr>
<tr>
<td><strong>Interpolation, shear rate 50x-1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Interpolation, shear rate 5x-1</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Interpolation, user defined</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Molar mass, relative</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Rearrange, merging</strong></td>
<td></td>
</tr>
</tbody>
</table>

- **Interpolation, shear rate 1x-1**: Interpolation of all shear rotational variables at the shear rate of 1x-1 whereas shear rate and viscosity are stored in the result field.
- **Interpolation, shear rate 50x-1**: Interpolation of all shear rotational variables at the shear rate of 50x-1 whereas shear rate and viscosity are stored in the result field.
- **Interpolation, shear rate 5x-1**: Interpolation of all shear rotational variables at the shear rate of 5x-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.
- **Molar mass, relative**: Calculation of the relative Molar mass from a viscosity curve based on the k-value of a polymer.
- **Rearrange, merging**: Rearrange or merge all data defined as input data (Examples: Copy all intervals of the incoming data into one). This Macro is also used to

- **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.

<table>
<thead>
<tr>
<th>Name of Macro</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Averaging</td>
<td></td>
</tr>
<tr>
<td>Averaging all variables, over data points</td>
<td>Rheological variables are calculated from the average of motor variables within a single test result.</td>
</tr>
<tr>
<td>Averaging all variables, over results</td>
<td>Rheological variables are calculated from the average of motor variables over several test results.</td>
</tr>
<tr>
<td>Averaging complex viscosity, over data points</td>
<td>Calculation of the average value of complex viscosity within a single test result.</td>
</tr>
<tr>
<td>Averaging viscosity, over data points</td>
<td>Calculation of the average value of viscosity within a single test result.</td>
</tr>
<tr>
<td>Cloud point</td>
<td></td>
</tr>
<tr>
<td>Cloud point</td>
<td>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.</td>
</tr>
<tr>
<td>Pour point, midpoint</td>
<td>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.</td>
</tr>
<tr>
<td>Pour point, onset</td>
<td>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.</td>
</tr>
<tr>
<td>Conversions</td>
<td></td>
</tr>
<tr>
<td>Conversion Cox-Merz, Eta(gamma-dot) -&gt; Eta*(omega)</td>
<td>Conversion of the shear viscosity into complex viscosity based on the empirical Cox-Merz rule (only valid for linear unfilled polymers).</td>
</tr>
<tr>
<td>Name of Macro</td>
<td>Function</td>
</tr>
<tr>
<td>---------------</td>
<td>----------</td>
</tr>
<tr>
<td><strong>Conversion</strong> Cox-Merz, eta*(omega) -&gt; eta(gamma-dot)</td>
<td>Conversion of the complex viscosity into shear viscosity based on the empirical Cox-Merz rule (only valid for linear unfilled polymers).</td>
</tr>
<tr>
<td><strong>Conversion</strong> frequency sweep, G', G'' -&gt; G(t)</td>
<td>Conversion of the measured storage G' and loss modulus G'' into a relaxation modulus G(t).</td>
</tr>
<tr>
<td><strong>Conversion</strong> frequency sweep, G', G'' -&gt; H(lambda)</td>
<td>Conversion of the measured storage G' and loss modulus G'' into a continuous relaxation time spectrum H(lambda).</td>
</tr>
<tr>
<td><strong>Conversion</strong> mirror relation, Eta(t) -&gt; Eta(gamma-dot)</td>
<td>Conversion of transient viscosity function Eta(t) into a shear viscosity (should be used with the specific project template).</td>
</tr>
<tr>
<td><strong>Conversion</strong> relaxation modulus with correction, G(t) -&gt; H(lambda))</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Conversion</strong> relaxation modulus, G(t) -&gt; G', G''</td>
<td>Conversion of the measured relaxation modulus G(t) into storage and loss moduli G' and G''.</td>
</tr>
<tr>
<td><strong>Conversion</strong> relaxation modulus, G(t) -&gt; H(lambda))</td>
<td>Conversion of the measured relaxation modulus G(t) into a continuous relaxation time spectrum H(lambda).</td>
</tr>
<tr>
<td><strong>Conversion</strong> spectrum, H(lambda) -&gt; G(t)</td>
<td>Conversion of the calculated continuous relaxation time spectrum H(lambda) into a relaxation modulus G(t).</td>
</tr>
<tr>
<td><strong>Conversion</strong> spectrum, H(lambda) -&gt; G', G''</td>
<td>Conversion of the calculated continuous relaxation time spectrum H(lambda) into storage G' and loss modulus G''.</td>
</tr>
<tr>
<td><strong>Creep analysis</strong></td>
<td></td>
</tr>
<tr>
<td>Creep (Burgers generalized)</td>
<td>Regression of a creep curve based on a generalized Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance.</td>
</tr>
<tr>
<td>Creep (Burgers model)</td>
<td>Regression of a creep curve based on a standard Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance.</td>
</tr>
<tr>
<td>Creep and recovery (Burgers generalized)</td>
<td>Regression of a creep and recovery curve based on a generalized Burgers model with the curve regions: Instantaneous, viscoelastic and Newtonian compliance.</td>
</tr>
<tr>
<td>Creep and recovery with drift correction (Burgers generalized)</td>
<td>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.</td>
</tr>
<tr>
<td>Creep with drift correction (Burgers generalized)</td>
<td>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.</td>
</tr>
<tr>
<td>Creep with drift correction (Burgers model)</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Rate of curing</strong></td>
<td></td>
</tr>
<tr>
<td>Curing, rate of cross-linkage (X)</td>
<td>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 &lt;all variables&gt; to display).</td>
</tr>
<tr>
<td>Name of Macro</td>
<td>Function</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Curing, t_Rp (X)</strong></td>
<td>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 &lt;all variables&gt; to display).</td>
</tr>
<tr>
<td><strong>Corrections</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Correction</strong> of CSR, CSS factor</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Correction</strong> of phase angle (PR cell)</td>
<td>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.</td>
</tr>
<tr>
<td><strong>Curve cross over</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Curve cross over G', G''</strong> (gamma)</td>
<td>Calculation of the cross-over between the functions G'(gamma) and G''(gamma).</td>
</tr>
<tr>
<td><strong>Curve cross over G', G''</strong> (omega)</td>
<td>Calculation of the cross-over between the functions G'(omega) and G''(omega).</td>
</tr>
<tr>
<td><strong>Curve cross over G', G''</strong> (tau)</td>
<td>Calculation of the cross-over between the functions G'(tau) and G''(tau).</td>
</tr>
<tr>
<td><strong>Curve cross over G', G''</strong> (T)</td>
<td>Calculation of the cross-over between the functions G'(temperature) and G''(temperature).</td>
</tr>
<tr>
<td><strong>Curve cross over G', G''</strong> (t)</td>
<td>Calculation of the cross-over between the functions G'(t) and G''(t).</td>
</tr>
<tr>
<td><strong>Curve difference</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Curve difference gap</strong> (d_1 – d_final)</td>
<td>Calculation of the gap difference between the first and last measured points.</td>
</tr>
<tr>
<td><strong>Curve derivatives</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Curve derivatives</strong> (lin, 3% smoothing)</td>
<td>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 &lt;all variables&gt; to display).</td>
</tr>
<tr>
<td><strong>Curve derivatives</strong> (lin, auto smoothing)</td>
<td>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 &lt;all variables&gt; to display).</td>
</tr>
<tr>
<td><strong>Curve derivatives</strong> (log, 3% smoothing)</td>
<td>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 &lt;all variables&gt; to display).</td>
</tr>
<tr>
<td><strong>Curve derivatives</strong> (log, auto smoothing)</td>
<td>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 &lt;all variables&gt; to display).</td>
</tr>
<tr>
<td><strong>Curve inflections</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Curve inflection point</strong></td>
<td>Calculation of the curve inflection point.</td>
</tr>
<tr>
<td>Name of Macro</td>
<td>Function</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Curve inflection point</strong>&lt;br&gt;<em><em>Eta</em>(T)</em>*</td>
<td>Calculation of the Eta*(T) curve inflection point.</td>
</tr>
<tr>
<td><strong>Curve inflection point G'(T)</strong></td>
<td>Calculation of the G'(T) curve inflection point.</td>
</tr>
<tr>
<td><strong>Curve inflection point G'(T), linear</strong></td>
<td>Calculation of the G'(T) curve inflection point in a linear diagram.</td>
</tr>
<tr>
<td><strong>Curve minimum and maximum</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Curve maximum</strong></td>
<td>Calculation of the curve maximum of any variable.</td>
</tr>
<tr>
<td><strong>Curve maximum Delta(T)</strong></td>
<td>Calculation of the delta(T) curve maximum.</td>
</tr>
<tr>
<td><strong>Curve maximum Eta(t)</strong></td>
<td>Calculation of the eta(t) curve maximum.</td>
</tr>
<tr>
<td><strong>Curve maximum G”(gamma)</strong></td>
<td>Calculation of the G”(gamma) curve maximum.</td>
</tr>
<tr>
<td><strong>Curve maximum G”(T)</strong></td>
<td>Calculation of the G”(T) curve maximum.</td>
</tr>
<tr>
<td><strong>Curve minimum</strong></td>
<td>Calculation of the curve minimum of any variable.</td>
</tr>
<tr>
<td><strong>Curve minimum Delta(T)</strong></td>
<td>Calculation of the delta(T) curve minimum.</td>
</tr>
<tr>
<td><strong>Curve minimum, FN(d)</strong></td>
<td>Calculation of the FN(d) curve minimum.</td>
</tr>
<tr>
<td><strong>Curve rise</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Curve rise Eta 10%</strong></td>
<td>Calculation of a 10 % Eta curve raise based on the initial value.</td>
</tr>
<tr>
<td><strong>Curve rise Eta 50%</strong></td>
<td>Calculation of a 50 % Eta curve raise based on the initial value.</td>
</tr>
<tr>
<td><strong>Curve rise Eta 90%</strong></td>
<td>Calculation of a 90 % Eta curve raise based on the initial value.</td>
</tr>
<tr>
<td><strong>Curve rise G’ 10%</strong></td>
<td>Calculation of a 10 % G’ curve raise based on the initial value.</td>
</tr>
<tr>
<td><strong>Curve rise G’ 50%</strong></td>
<td>Calculation of a 50 % G’ curve raise based on the initial value.</td>
</tr>
<tr>
<td><strong>Curve rise G’ 90%</strong></td>
<td>Calculation of a 90 % G’ curve raise based on the initial value.</td>
</tr>
<tr>
<td><strong>Curve slope</strong></td>
<td></td>
</tr>
<tr>
<td><em><em>Curve slope G</em>(omega)</em>*</td>
<td>Calculation of the G*(omega) curve slope.</td>
</tr>
<tr>
<td><strong>Curve slope G’(omega)</strong></td>
<td>Calculation of the G’(omega) curve slope.</td>
</tr>
<tr>
<td><strong>Curve slope lin-lin</strong></td>
<td>Calculation of the curve slope of any variable in a linear diagram.</td>
</tr>
<tr>
<td><strong>Curve slope log-log</strong></td>
<td>Calculation of the curve slope of any variable in a logarithmic (x-axes) and linear (y-axes) diagram.</td>
</tr>
<tr>
<td><strong>Dahlquist criterion</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Dahlquist criterion, lower limit</strong></td>
<td>Calculation of the lower limit for the Dahlquist criterion. The limit is used to evaluate a PSA or hotmelt in the used-temperature range.</td>
</tr>
<tr>
<td><strong>Dahlquist criterion, recommended</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Dahlquist criterion, upper limit</strong></td>
<td>Calculation of the upper limit for the Dahlquist criterion. The limit is used to evaluate a PSA or hotmelt in the use-temperature range.</td>
</tr>
<tr>
<td><strong>Flow stress, Flow transition, Yield stress, Yield point</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Flow stress TAU_f, curve cross over G’=G”</strong></td>
<td>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 &gt; TAU_y. The result is invalid if the calculated flow stress is lower than the yield stress.</td>
</tr>
<tr>
<td>Name of Macro</td>
<td>Function</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Flow stress $\tau_f$, upward inflection, $\gamma(\tau)$</td>
<td>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.</td>
</tr>
<tr>
<td>Flow transition $\tau_f$, peak $G''$</td>
<td>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.</td>
</tr>
<tr>
<td>Yield stress $\tau_y$, onset $G'$ (log)</td>
<td>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 &quot;yield point&quot; are applied. Below the yield stress, the material shows reversible viscoelastic behavior.</td>
</tr>
<tr>
<td>Yield stress $\tau_y$, upward inflection, $\gamma(\tau)$</td>
<td>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 &quot;yield point&quot; are applied. Below the yield stress, the material shows reversible viscoelastic behavior.</td>
</tr>
<tr>
<td>Yield stress $\tau_y$, onset $G'$ (lin)</td>
<td>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 &quot;yield point&quot; are applied. Below the yield stress, the material shows reversible viscoelastic behavior.</td>
</tr>
<tr>
<td>Hysteresis area</td>
<td></td>
</tr>
<tr>
<td>Hysteresis area (1-up, 2-down)</td>
<td>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.</td>
</tr>
<tr>
<td>Hysteresis area (1-up, 3-down)</td>
<td>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.</td>
</tr>
<tr>
<td>Inertia criteria</td>
<td></td>
</tr>
<tr>
<td>Inertia criteria (Ratio = $M / M_{el}$)</td>
<td>The inertia criteria defines whether the measured result is valid at higher frequencies.</td>
</tr>
<tr>
<td>- excellent if $M / M_{el} &gt; 2%$</td>
<td></td>
</tr>
<tr>
<td>- acceptable if $M / M_{el} &gt; 0.5%$</td>
<td></td>
</tr>
<tr>
<td>- poor if $M / M_{el} &lt; 0.5%$</td>
<td></td>
</tr>
<tr>
<td>Integration</td>
<td></td>
</tr>
<tr>
<td>Integration</td>
<td>Calculation of the integral value below a curve.</td>
</tr>
<tr>
<td>Integration, $FN(d)$</td>
<td>Calculation of the $FN(d)$ integral value.</td>
</tr>
<tr>
<td>Interpolation</td>
<td></td>
</tr>
<tr>
<td>Interpolation, shear rate 100s-1</td>
<td>Interpolation of all shear rotational variables at the shear rate of 100s-1, whereas shear rate and viscosity are stored in the result field.</td>
</tr>
<tr>
<td>Interpolation, shear rate 1s-1</td>
<td>Interpolation of all shear rotational variables at the shear rate of 1s-1, whereas shear rate and viscosity are stored in the result field.</td>
</tr>
<tr>
<td>Interpolation, shear rate 50s-1</td>
<td>Interpolation of all shear rotational variables at the shear rate of 50s-1, whereas shear rate and viscosity are stored in the result field.</td>
</tr>
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<th>Name of Macro</th>
<th>Function</th>
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<tbody>
<tr>
<td>Interpolation, shear rate 50s-1</td>
<td>Interpolation of all shear rotational variables at the shear rate of 50s-1, whereas shear rate and viscosity are stored in the result field.</td>
</tr>
<tr>
<td>Interpolation, user defined</td>
<td>Interpolation of all shear rotational variables at the shear rate &lt;user defined&gt;, whereas shear rate and viscosity are stored in the result field.</td>
</tr>
<tr>
<td>Linear-viscoelastic range</td>
<td>Calculation of the limit of the linear viscoelastic range based on a boundary definition of 3%.</td>
</tr>
<tr>
<td>Linear-viscoelastic range LVER, limit (3%)</td>
<td>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.</td>
</tr>
<tr>
<td>Linear-viscoelastic range LVER, limit (3%) and proposal</td>
<td>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.</td>
</tr>
<tr>
<td>Linear-viscoelastic range LVER, proposal</td>
<td>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%.</td>
</tr>
<tr>
<td>Molar mass, cross-linked elastomer (Mooney-Rivlin)</td>
<td>Input: Density needed as input variable (to be defined in &quot;Start&quot; as additional input. Output: Mw=Average molar mass between two links; X=Link concentration; Y=Polymerization density.</td>
</tr>
<tr>
<td>Molar mass, relative</td>
<td>Calculation of the relative molar mass from a viscosity curve based on the k-value of a polymer.</td>
</tr>
<tr>
<td>Plateau modulus</td>
<td>Calculation of the plateau modulus with input data = frequency sweep or master curve. ( G_n = G' @ \tan(\delta)_{\text{min}} ).</td>
</tr>
<tr>
<td>Polydispersity index</td>
<td>Calculation of the polydispersity index (= 100000/G') based on curve cross-over of a frequency sweep with G' = G&quot;.</td>
</tr>
<tr>
<td>PVC Gelation</td>
<td>Calculation of the final gelation point of a curing PVC plastisol sample.</td>
</tr>
<tr>
<td>PVC, Final Gelation</td>
<td>Calculation of the initial fusion point of a curing PVC plastisol sample.</td>
</tr>
<tr>
<td>PVC, Initial Fusion</td>
<td>Calculation of the initial gelation point of a curing PVC plastisol sample.</td>
</tr>
<tr>
<td>PVC, Initial Gelation</td>
<td>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.</td>
</tr>
<tr>
<td>Curve regression</td>
<td>Curve regression used for temperature sweeps of non-curing samples according to the WLF model.</td>
</tr>
</tbody>
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<table>
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<tr>
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<tr>
<td>Regression, auto</td>
<td>Curve regression with auto selection of any regression model.</td>
</tr>
<tr>
<td>Regression, e function</td>
<td>Curve regression based on an exponential function.</td>
</tr>
<tr>
<td>Regression, Quemada</td>
<td>Curve regression according to the Quemada model.</td>
</tr>
<tr>
<td>Regression, Tau, Casson-Steiner</td>
<td>Curve regression for a flow curve according to Casson-Steiner.</td>
</tr>
<tr>
<td>Regression, Tau, Ellis</td>
<td>Curve regression for a flow curve according to Ellis.</td>
</tr>
<tr>
<td>Regression, Tau, Newtonian viscosity</td>
<td>Select function tau(shear rate) as input data to calculate the Newtonian viscosity.</td>
</tr>
<tr>
<td>Regression, Tau, Phillips-Deutsch</td>
<td>Curve regression for a flow curve according to Phillips-Deutsch.</td>
</tr>
<tr>
<td>Regression, Tau, Sisko</td>
<td>Curve regression for a flow curve according to Sisko.</td>
</tr>
<tr>
<td>Regression, Tau, Steiger-Ory</td>
<td>Curve regression for a flow curve according to Steiger-Ory.</td>
</tr>
<tr>
<td>Regression, Tau, Tscheuschner</td>
<td>Curve regression for a flow curve according to Tscheuschner.</td>
</tr>
<tr>
<td>Regression, Eta(temperature), Arrhenius</td>
<td>Curve regression for eta(T) according to Arrhenius.</td>
</tr>
<tr>
<td>Regression, Eta(temperature), Stettin</td>
<td>Curve regression for eta(T) according to Settin.</td>
</tr>
<tr>
<td>Regression, Eta(volume concentration), Krieger-Dougherty</td>
<td>Curve regression for eta(volume concentration) according to Kieger-Dougherty.</td>
</tr>
<tr>
<td>Regression, Eta, Carreau</td>
<td>Curve regression for viscosity according to Carreau.</td>
</tr>
<tr>
<td>Regression, Eta, Carreau-Gahleitner</td>
<td>Curve regression for viscosity according to Carreau-Gahleitner.</td>
</tr>
<tr>
<td>Regression, Eta, Carreau-Yasuda</td>
<td>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.</td>
</tr>
<tr>
<td>Regression, Eta, ceramic suspensions</td>
<td>Curve regression for viscosity for ceramic slurries.</td>
</tr>
<tr>
<td>Regression, Eta, Cross</td>
<td>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.</td>
</tr>
<tr>
<td>Regression, Eta, power law slope</td>
<td>Curve regression for viscosity according to the power-law model.</td>
</tr>
<tr>
<td>Regression, Eta, Vinogradov-Malkin</td>
<td>Curve regression for viscosity according to Vinogradov-Malkin.</td>
</tr>
<tr>
<td>Regression, yield stress, Bingham</td>
<td>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.</td>
</tr>
<tr>
<td>Regression, yield stress, Casson (advanced)</td>
<td>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.</td>
</tr>
</tbody>
</table>
### Analysis Methods, Macros and Steps

<table>
<thead>
<tr>
<th>Name of Macro</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression, yield stress, Casson (standard)</td>
<td>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.</td>
</tr>
<tr>
<td>Regression, yield stress, Herschel-Bulkley</td>
<td>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.</td>
</tr>
<tr>
<td>Regression, yield stress, IOCCC2000 / Windhab</td>
<td>Curve regression for yield stress analysis according to the IOCCC2000/Windhab method for characterization of chocolate.</td>
</tr>
</tbody>
</table>

### 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

- **Tc, crystallization temperature**: Calculation of the crystallization temperature based on a curve cross-over in G'(T) and G''(T).
- **Tg, endpoint G'(T)**: Calculation of the glass-transition temperature endpoint Tg_endpoint based on an upward bend in G'(T).
- **Tg, midpoint G'(T)**: Calculation of the glass-transition temperature midpoint Tg_midpoint based on an inflection point in G'(T).
- **Tg, onset G'(T)**: Calculation of the glass-transition temperature onset Tg_onset based on a downward bend in G'(T).
- **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
### 7.4 Analysis Action

A short instruction for the Analysis action can be found in Chapter 5, "Ch 5.3, Action Analysis".

<table>
<thead>
<tr>
<th>Name of Macro</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thixotropy, all, 3ITT-Rot-Rot-Rot (DIN-SPEC91143-2)</td>
<td>Calculation of the Thixotropy. Test conditions according to DIN-SPEC91143-2 with three rotational intervals.</td>
</tr>
<tr>
<td>Thixotropy, recovery after 30s, 3ITT-Osc-Rot-Osc</td>
<td>Calculation of the recovery after 30s. Test with oscillatory load in the 1st and 3rd intervals and shear in the 2nd interval.</td>
</tr>
<tr>
<td>Thixotropy, recovery after 60s, 3ITT-Rot-Rot-Rot (DIN-SPEC91143-2)</td>
<td>Calculation of the recovery after 60s. Test conditions according to DIN-SPEC91143-2 with three rotational intervals.</td>
</tr>
<tr>
<td>Thixotropy, recovery until 25%, 3ITT-Osc-Rot-Osc</td>
<td>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.</td>
</tr>
<tr>
<td>Thixotropy, recovery until 25%, 3ITT-Rot-Rot-Rot (DIN-SPEC91143-2)</td>
<td>Calculation of the recovery until 25% of the initial viscosity value. Test conditions according to DIN-SPEC91143-2 with three rotational intervals.</td>
</tr>
<tr>
<td>Thixotropy, recovery until 50%, 3ITT-Osc-Rot-Osc</td>
<td>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.</td>
</tr>
<tr>
<td>Thixotropy, recovery until 50%, 3ITT-Rot-Rot-Rot (DIN-SPEC91143-2)</td>
<td>Calculation of the recovery until 50% of the initial viscosity value. Test conditions according to DIN-SPEC91143-2 with three rotational intervals.</td>
</tr>
<tr>
<td>Thixotropy, recovery until 90%, 3ITT-Osc-Rot-Osc</td>
<td>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.</td>
</tr>
<tr>
<td>Thixotropy, recovery until $G''=G''$, 3ITT-Osc-Rot-Osc</td>
<td>Calculation of the recovery until $G''=G''$. Test with oscillatory load in the 1st and 3rd intervals and shear in the 2nd interval.</td>
</tr>
</tbody>
</table>
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. Move the mouse point over the ribbon item to see additional information about the ribbon function.

- **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.

Details - Regression, viscosity, Carreau-Yasuda - Text Data

Analysis result short text

\[ \eta_0 = 6124.4 \text{ Pa s}, \eta_\infty = 0.0001 \text{ Pa s}, \lambda = 0.17476, \alpha = 0.54224, n = 0.3058 \]

Analysis result text

Regression rheology

**Project:** Frequency Sweep 2
**Input data:** PP 230°C, PP 230°C, Interval 1, From point 1
**Result data:** Regression, viscosity, Carreau-Yasuda

**Carreau-Yasuda:** \( y = \frac{(y_0 - y_\infty)}{(1 + (\lambda^2) \alpha^2) + (1 - \alpha^2)} + y_\infty \) for \( y_0 - y_\infty > 0 \)

**ANALYSIS RESULTS:**

- Name Info
- Additional Info
- Text Data
- Configuration
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 pre-define 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]

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]

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
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**

- **Pre-defined Report templates** are already included in RheoCompass

**Editing the Report**

- **Edit the items of the pre-defined 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 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

<table>
<thead>
<tr>
<th>Name</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project info</strong></td>
<td></td>
</tr>
<tr>
<td>Project</td>
<td>Project name</td>
</tr>
<tr>
<td>Date (last modified)</td>
<td>Project Info -&gt; Modified</td>
</tr>
<tr>
<td><strong>Test info</strong></td>
<td></td>
</tr>
<tr>
<td>Test, name</td>
<td>Test name -&gt; Test -&gt;</td>
</tr>
<tr>
<td>Test, sample</td>
<td>Test info -&gt; Next test -&gt; Test info type -&gt; Test definition</td>
</tr>
<tr>
<td>Test, batch No</td>
<td>Test info -&gt; Batch no. -&gt; Test info type -&gt; Test definition</td>
</tr>
<tr>
<td>Test, created (date)</td>
<td>Test info -&gt; Next test -&gt; Created -&gt; Test definition</td>
</tr>
<tr>
<td>Test, manufacturing date</td>
<td>Test info -&gt; Next test -&gt; Manufacturing data - Long format of the complete test definition</td>
</tr>
<tr>
<td>Test, description</td>
<td>Test info -&gt; Next test -&gt; Description- &gt; Test definition</td>
</tr>
<tr>
<td>Measuring definition</td>
<td>Measuring definition-&gt;Next test-&gt;Test definition-&gt;Result - Short format of test definition with measurement definition only</td>
</tr>
<tr>
<td>(V 1.15)</td>
<td></td>
</tr>
<tr>
<td>Test, measuring system</td>
<td>Test info -&gt; Next test -&gt; Test type info -&gt; Measuring system name</td>
</tr>
<tr>
<td>Test, signature</td>
<td>Test info -&gt; Test info type -&gt; Signature -&gt; Type of signature with user / date</td>
</tr>
</tbody>
</table>
### Data point value

| Value of variable xy | Value -> Next test -> Test definition -> Measurement -> Specific interval -> Specific data point  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data value -&gt; Variable -&gt; Unit -&gt; Number format -&gt; Valid digits</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
</tr>
<tr>
<td></td>
<td>Insert a text (1st line) and data item (2nd line):</td>
</tr>
</tbody>
</table>

#### Example:

![Image](image.png)

#### Text and data-type item in content area of report:

The data will be displayed for the `<next test>`

#### Definition of the data point:

- data
- data value

![Image](image2.png)

### Analysis Result Info

| Short result text | Result text data -> next test -> test definition -> result (analysis) -> Analysis short result text |

### Measuring set configuration

<table>
<thead>
<tr>
<th>Measuring set configuration (short)</th>
<th>Measuring set configuration (short)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Configuration</td>
</tr>
<tr>
<td></td>
<td>• Device</td>
</tr>
<tr>
<td></td>
<td>• Measuring cell</td>
</tr>
<tr>
<td></td>
<td>• Measuring system</td>
</tr>
</tbody>
</table>

### CSS or CSR factor

<table>
<thead>
<tr>
<th>Data-&gt;Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable-&gt;All variables-&gt;CSR / CSS factor</td>
</tr>
</tbody>
</table>
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 pre-define 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.

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.

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 Result 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 result 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 result 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

Some calculated variables

| Loss Modulus for Minimum Strain $G'' [\text{Pa}]$ | Loss Modulus for Large Strain $G'' [\text{Pa}]$ | Ratio for Shear Thinning $\Delta s = s_{\text{lin}} [\text{]}$ | Ratio for Shear Thickening $\Delta s_{\text{thick}} [\text{]}$ | Ratio for Strain Stiffening $\Delta s_{\text{stiff}} [\text{]}$ | Ratio for Stress Softening $\Delta s_{\text{soft}} [\text{]}$

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
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](image)

**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](image)

**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](image)
To show the **Fourier Coefficients**, a new axis is defined with three Fourier coefficients but different selections of the **Harmonics** (see screen shot 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 pre-define 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**.

### 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.

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 pre-defined 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 pre-defined 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: \( t_{\text{int}} = 40 \) s if 0.1 Hz and 4 cycles
  - \( t_{\text{int}} = \text{cycles/frequency} \)
- 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:

<table>
<thead>
<tr>
<th>Example</th>
<th>Waveform generator</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Example Image" /></td>
<td><img src="image2.png" alt="Waveform Generator Image" /></td>
</tr>
</tbody>
</table>

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

![Graph showing stress vs. strain in a LAOS transient experiment.](image)
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

The RheoCompass™ software complies with Windows 7 (SP1), Windows 8 or Windows 8.1. Please note that to work in compliance with 21 CFR Part 11, a number of measures is required on operating system level. This version of the RheoCompass™ software is not compatible with 32 bit operating systems.

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 pre-defined standard roles and three roles for the signatures.

RheoCompass™ administrators: RheoCompass™ administrators are authorized to setup, install and modify all components of the software.

RheoCompass™ experts: RheoCompass™ experts are authorized to modify all application related components.

RheoCompass™ lab assistants: RheoCompass™ lab assistants are authorized to perform, format and delete measuring data.

RheoCompass™ Lab managers: RheoCompass™ Lab managers are authorized to modify application related standard components.

RheoCompass™ users: RheoCompass™ 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:


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.

- Start - Test - Delete test
- Rheo finder - Item - Delete

**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 admin is "User must change password at next logon".

Add new user dialog

![](image)

**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.

![Diagram](image)

*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.

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Created</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database</td>
<td>RheoCompassDB</td>
<td>10/20/2014 11:20:50 AM</td>
</tr>
<tr>
<td>Differential</td>
<td>RheoCompassDB</td>
<td>10/21/2014 8:14:00 AM</td>
</tr>
<tr>
<td>Differential</td>
<td>RheoCompassDB</td>
<td>10/22/2014 7:38:21 AM</td>
</tr>
<tr>
<td>Differential</td>
<td>RheoCompassDB</td>
<td>10/23/2014 8:22:34 AM</td>
</tr>
</tbody>
</table>

- 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 Paa\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 Paa\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:

![Backup settings for main database 'RheoCompassDB4' with all archives]

- Start backup automatically every day at 03:00:00
- Delete backups older than [1] month(s) automatically
- Backup now

- Copy last backup file of each month to external directory when starting RheoCompass (e.g., to a file server with network share)
  - Target path:

Media data are not included in the backup and therefore not backed up automatically. Media data are saved in the following folder on your hard disc and must be backed up manually and copied manually in case of a PC replacement.

- Media path: C:\ProgramData\Anton Paar\RheoCompass\Media_RheoCompassDB3

Restore options:

![Restore a RheoCompass database]

- Restoring is done to main database 'RheoCompassDB4' with all associated archives. You can use one of two alternative restore methods.

**Method 1 (recommended): Select an internal backup set to be restored:**

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Created</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database</td>
<td>RheoCompassDB4</td>
<td>11/18/2014 4:42:09 PM</td>
</tr>
<tr>
<td>Differential</td>
<td>RheoCompassDB4</td>
<td>11/19/2014 3:00:02 AM</td>
</tr>
<tr>
<td>Differential</td>
<td>RheoCompassDB4</td>
<td>11/20/2014 7:48:18 AM</td>
</tr>
<tr>
<td>Database</td>
<td>RheoCompassDB4</td>
<td>11/20/2014 11:20:50 AM</td>
</tr>
<tr>
<td>Differential</td>
<td>RheoCompassDB4</td>
<td>11/21/2014 7:59:14 AM</td>
</tr>
<tr>
<td>Database</td>
<td>RheoCompassDB4</td>
<td>11/24/2014 6:10:24 AM</td>
</tr>
<tr>
<td>Database</td>
<td>RheoCompassDB4</td>
<td>11/24/2014 11:20:50 AM</td>
</tr>
<tr>
<td>Differential</td>
<td>RheoCompassDB4</td>
<td>11/25/2014 8:12:18 AM</td>
</tr>
<tr>
<td>Differential</td>
<td>RheoCompassDB4</td>
<td>11/27/2014 8:04:31 AM</td>
</tr>
<tr>
<td>Database</td>
<td>RheoCompassDB4</td>
<td>11/27/2014 11:20:50 AM</td>
</tr>
<tr>
<td>Database</td>
<td>RheoCompassDB4</td>
<td>11/28/2014 5:05:51 AM</td>
</tr>
<tr>
<td>Database</td>
<td>RheoCompassDB4</td>
<td>12/1/2014 8:28:46 AM</td>
</tr>
<tr>
<td>Database</td>
<td>RheoCompassDB4</td>
<td>12/1/2014 11:20:43 AM</td>
</tr>
</tbody>
</table>

- Restore now

**Method 2: Select an external backup file to be restored:**

- Restore from file...

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

A database backup file always contains 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 pre-defined for the 21 CFR Part 11 user of the RheoCompass™ software.
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 and 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.

![Diagram](image)

*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 pre-defined 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 Application, Test type, Material Property
   • 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 Application, Test type, Material Property

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 pre-defined 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 screen shot without measurement action)

Signature Action

- Action for signing the reported test result (example screen shot 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 tests can be found. The RheoFinder allows filtering by project, date, user or any other pre-defined 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

![Image of RheoFinder interface]

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

![Screen capture of a table with columns for 'Approved', 'State', 'Approved by', 'Submitted', 'Submitted by', 'Reviewed', 'Reviewed by', 'Approved', 'Approved by', 'State', and 'Created'.]

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Notifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit trail</td>
<td>• Computer date or time modified</td>
</tr>
<tr>
<td></td>
<td>• Failed login</td>
</tr>
<tr>
<td></td>
<td>• License expired</td>
</tr>
<tr>
<td></td>
<td>• License expires soon</td>
</tr>
<tr>
<td></td>
<td>• License issuer date not read</td>
</tr>
<tr>
<td></td>
<td>• License validity period not found</td>
</tr>
<tr>
<td></td>
<td>• License version invalid</td>
</tr>
<tr>
<td></td>
<td>• Service license</td>
</tr>
<tr>
<td></td>
<td>• User is logged in</td>
</tr>
<tr>
<td></td>
<td>• User logged in</td>
</tr>
</tbody>
</table>
### Examples for Logbook (Audit trail) entries:

<table>
<thead>
<tr>
<th>Category</th>
<th>Notifications</th>
</tr>
</thead>
</table>
| **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 |
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 RheoComp™ 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 RheoComp™ 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 RheoComp™ 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 un-permitted 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 result 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 result 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:

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-41e5b66e4c2bc</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 result definition window a result file is created and stored in the pre-defined 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:

```xml
<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 Result Definition Window

The Automation result 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 result 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 result definition.

A result element consists of a user defined Label and a Data type.

![Automation result definition table]

Click the Ribbon Window, Save as template to save the currently selected Automation result definition as a template.

Open the RheoFinder category Automation result 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 *.RhT au.

11.5.4 Creating the Result File

How to define and create the Result file:

1. Make sure a Result 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:

<table>
<thead>
<tr>
<th>Email to</th>
<th><a href="mailto:key-rheocompass@anton-paar.com">key-rheocompass@anton-paar.com</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Device serial number</td>
<td></td>
</tr>
<tr>
<td>Software serial number</td>
<td></td>
</tr>
<tr>
<td>Company name</td>
<td></td>
</tr>
<tr>
<td>Contact person</td>
<td></td>
</tr>
<tr>
<td>Email address</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality management (21 CFR Part 11)</td>
<td>160445</td>
</tr>
<tr>
<td>Media Window, Media Explorer</td>
<td>104911</td>
</tr>
<tr>
<td>Report Designer</td>
<td>104910</td>
</tr>
<tr>
<td>Raw Data (LAOS)</td>
<td>104916</td>
</tr>
<tr>
<td>TruStrain™</td>
<td>104912</td>
</tr>
<tr>
<td>TruRate™</td>
<td>104914</td>
</tr>
<tr>
<td>Vertical Movement Profile (Tack, Penetration)</td>
<td>104917</td>
</tr>
<tr>
<td>Polymer Analysis Package</td>
<td>104920</td>
</tr>
<tr>
<td>Interfacial Analysis Package</td>
<td>104918</td>
</tr>
</tbody>
</table>
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.