SPS

Metrology

MANUAL

ComGage Level 2
Software

Contents

Manual   ComGage Level 2

1. Introduction

ComGage Level 2 is an easy-to-use metrology and process control software in production.
The software is used to check components with different characteristics. In addition, the software provides process control information via trend displays.
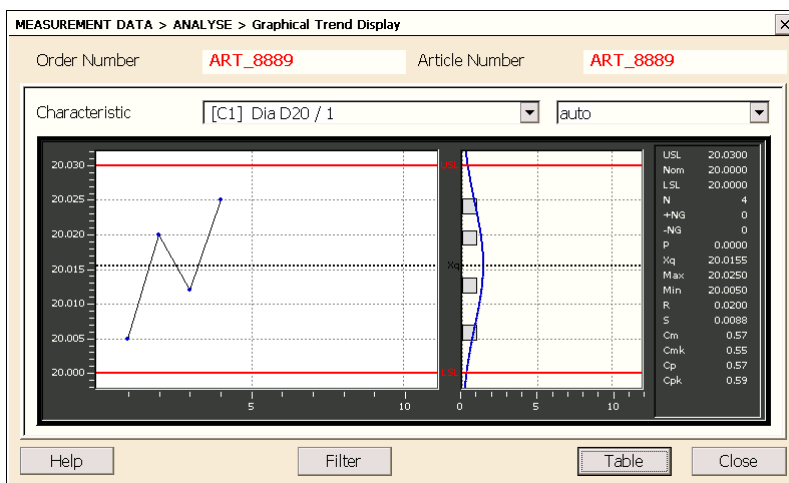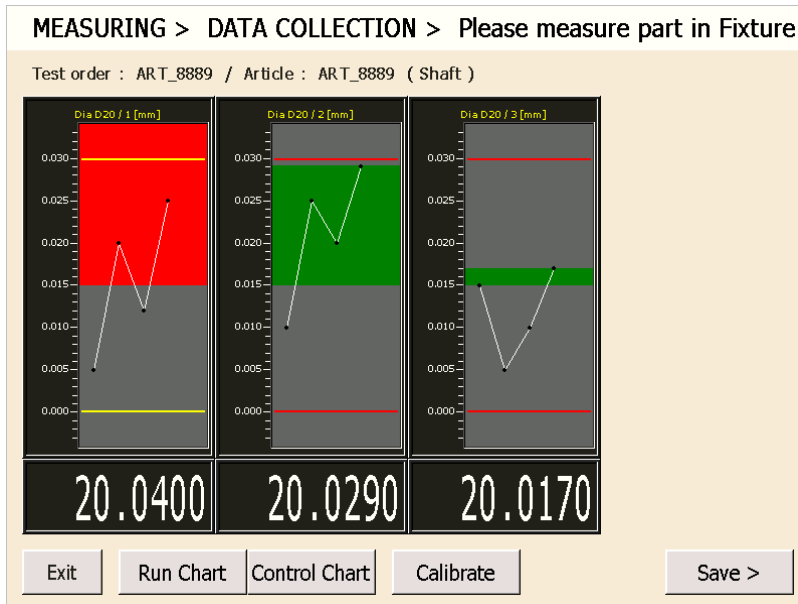
Features

- Simple and easy handling
- Applicable for :
    o simple hand gauge stations
    o multi gauging fixtures
- Measurement value collection by keyboard and from measuring and interface instruments
- Formula editor for linking the measuring inputs; static and dynamic measurement modes
- Simple control of measuring sequence
- Online trend displays and control charts
- Control of digital outputs and polling of digital inputs
- Printout of measurement values in tabular form
- Converter for MS-Excel, export functions for CSV file, QDAS and USB/COM port
- Available for Windows CE and standard Windows PC
- Supports several languages

2. General information on the ComGage Level 2 software

The ComGage Level 2 software was optimised for touch operation. So the onscreen keyboards for touch operation are displayed automatically when the input fields are clicked. The onscreen keyboard can be deactivated in the *Settings* menu.

Onscreen keyboard for entering values, designations and names :
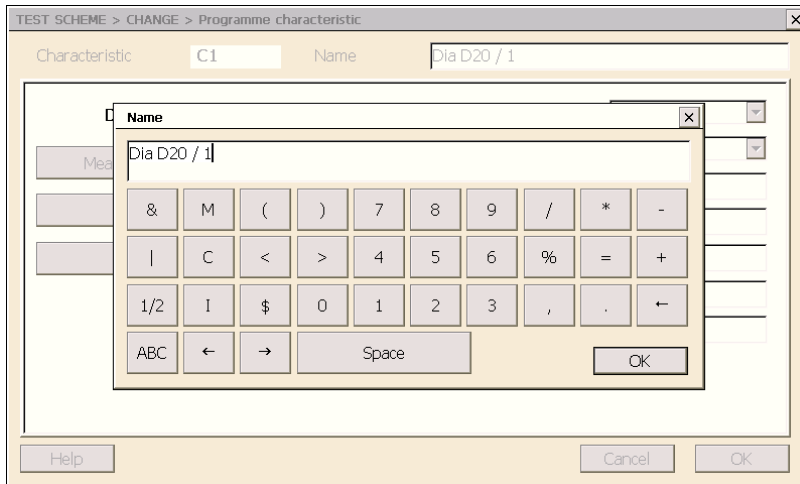
Onscreen keyboard for selecting parameters :

3.   Main menu of the ComGage Level 2 software

After the ComGage Level 2 software has been started, the main menu of ComGage Level 2 appears :

Caption

In the caption, the following information is shown :
- Program name
- Program version
- Current date and current time (only available under Windows CE)

Settings *button*

Via the ***Settings*** menu, the following settings can be made :
- Selection of the connected measuring and interface hardware
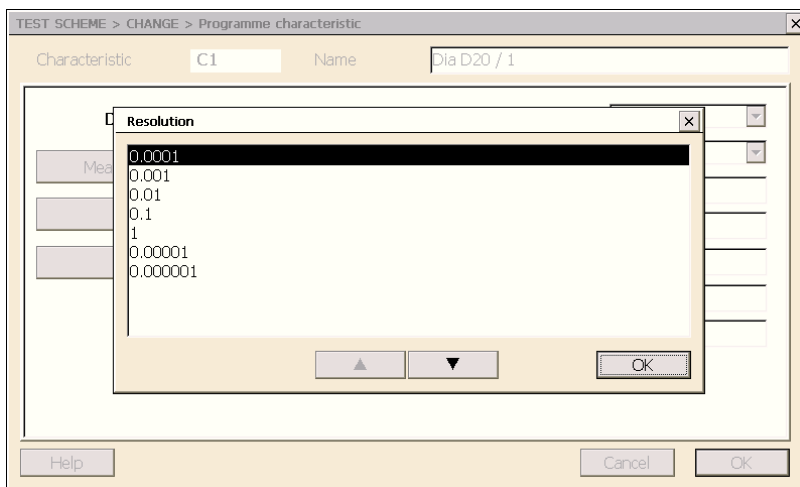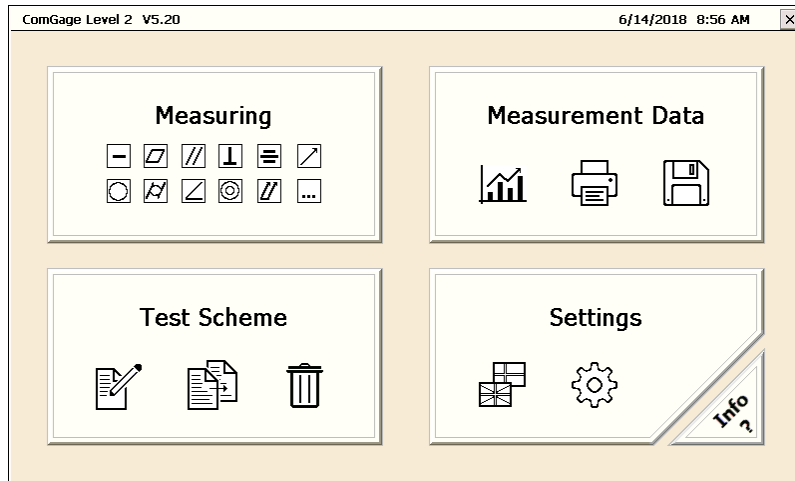- Configuration / mechanical adjustment of the connected measuring and interface hardware
- Selection of the data directories for saving test schemes, measurement data, …
- Selection of the ComGage Level 2 language (English, German, …)
- Setting a password to protect the settings and test schemes
- Adjustment of the automatic start of a test scheme when ComGage Level 2 is started
- Configuration of reference information
- Configuration of the system time (only available under Windows CE)

Test Scheme *button*

Via the *Test Scheme* menu, the test schemes can be managed :
- Creating new test schemes
- Changing existing test schemes
- Duplicating test schemes
- Deleting test schemes

Measuring *button*

In the ***Measuring*** menu, measurement data is calculated, visualised and collected.

Measurement Data *button*

Via the ***Measurement Data*** *button*, the collected measurement data can be managed :
- Visualising the collected measurement data as graphical SPC displays or as value tables
- Saving the collected measurement data as Excel file
- Printing the collected measurement data
- Deleting the collected measurement data

Button ☒

Closing the ComGage Level 2 software and returning to the Windows CE interface

4. Settings of the ComGage Level 2 software

Via the *Settings* menu, the settings of the ComGage Level 2 software can be configured.
Below, the individual menu items of the menu are described.
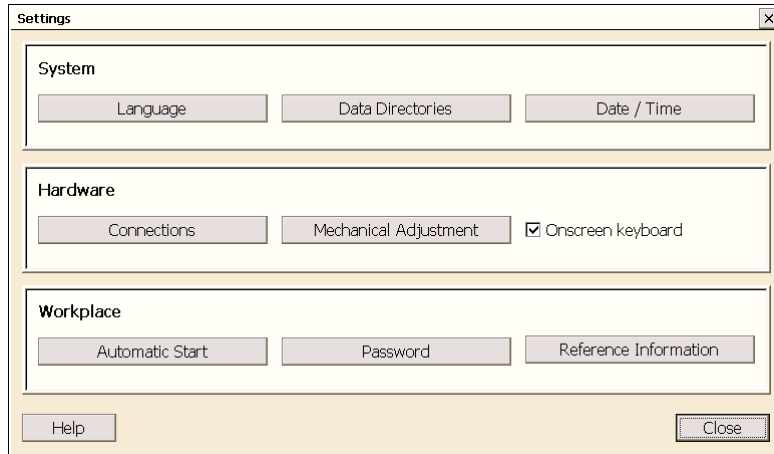
Via the *Close* button, you can leave the *Settings* menu and the ComGage Level 2 software returns to the main menu.

4.1 Language

The language can be chosen in the *Settings / Language* menu.
In the language selection window, a list of available languages is shown :
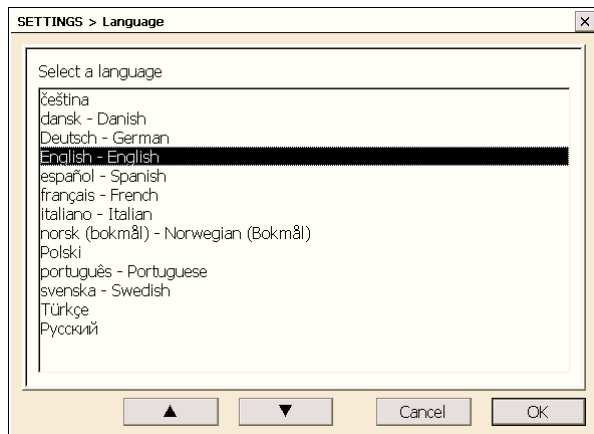
Choose your language and confirm it with **OK**.

4.2 Data Directories

In the *Settings / Data Directories* menu, the data directories from which ComGage Level 2 loads the data or saves data can be configured :
- Directory for test schemes (and measurement data) :

*.tss	Test scheme in the ComGage Level 2 V5 format
*.tsf	Test scheme in the ComGage Professional V4 format
*.rto	Test order in the ComGage Professional V4 format to save the measurement data
*.tod	Test order in the ComGage Professional V4 format to save the measurement data

- Directory for converted measurement data (Excel files, CSV files, …)
- Directory for pictures (*.bmp files)
- Directory for reference information and user setup
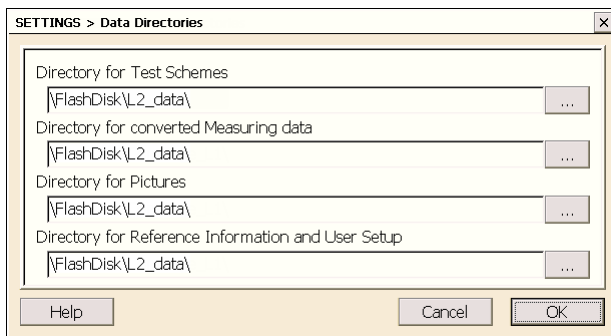
The button opens a separate dialog window to select a directory.

Note :   *You can only type in existing data directories, as ComGage does not create data directories.*
When the data directories are selected, ComGage Level 2 checks whether the data directories exist
and whether write permissions are available. If the data directory does not exist or if there are no write
permissions for the data directory, a corresponding error message of the integrity check will be displayed.

4.3 Date / Time

By clicking on the *Settings / Date & Time* menu, the system time of the system can be adjusted.

Notes :   1. To do this, a configuration window of the Windows CE operating system is called up by ComGage Level 2.
2. This menu is not available on standard Windows.
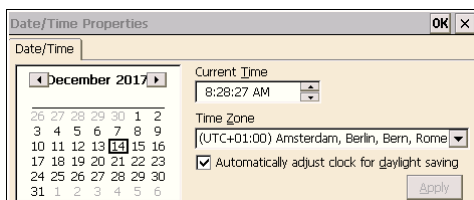
4.4 Connections

Via the **Settings / Connections** menu, the connected IBR interfaces can be detected automatically and the measuring instruments can be configured, if necessary (via **Setup** buttons). ComGage Level 2 opens this window and starts the hardware analysis automatically, when the program is started for the first time.
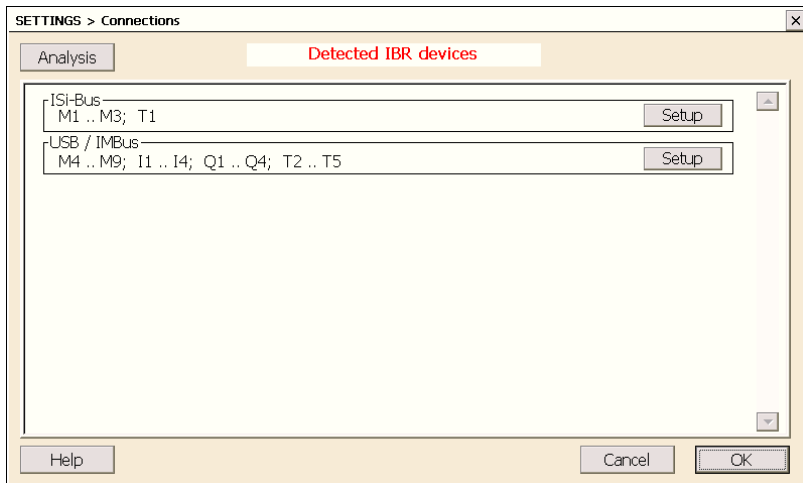
By the button **Analysis** the automatic detection of connected IBR hardware is started. The dialog shows the result of the last hardware scan with the range of measuring inputs (M1…Mx), Digital Inputs (I1...Ix), Digital Outputs (Q1...Qx) and Hand / Foot switches (T1...Tx) of each IBR device. By using the **Setup** button, the measuring inputs of a detected interface can be configured.

IBRit-rf1 :

In the case of IBRit-rf1 radio modules, the menu for the configuration of the modules (e.g. address assignment) can be opened by pressing the **Service** button. ➔ *See IBRit-rf1 Manual*

IMBus :

The **IMBus** *Setup* button displays all connected IMBus modules :
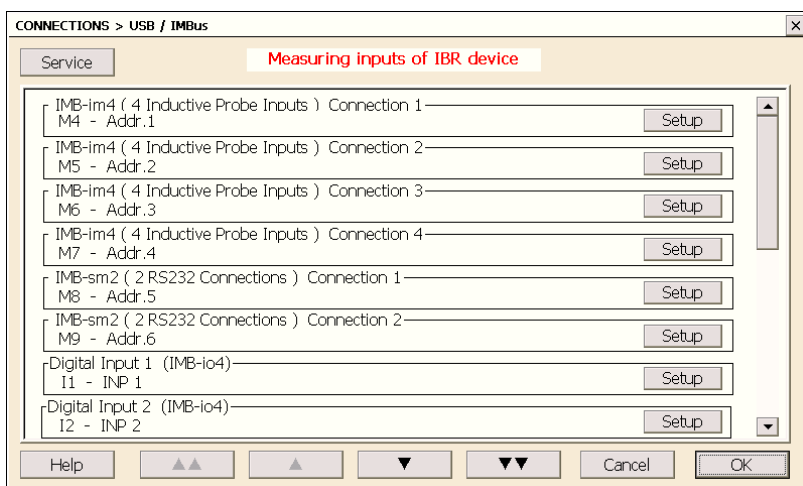
With the four arrow buttons, it is possible to scroll the list of IMBus modules.

Using the **Setup** buttons of the individual measuring inputs, the resolution and measuring direction and more can be chosen in the case of IMBus measuring modules (IMB-im1…8, IMB-dm1…4, IMB-tc1... 4, IMB-ai1…8, IMB-ae1, …). ➔ *See IMBus Manual*
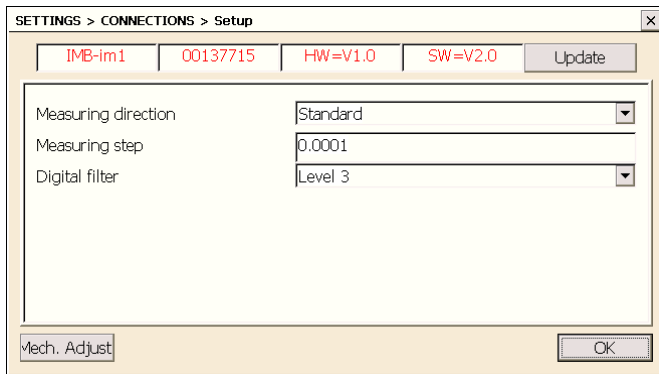
By the **Setup** buttons of the IMB-rf1 modules, the IBRit-rf1 radio module addresses can be assigned to the 8 IMB-rf1 addresses and the IBRit-rf1 radio modules can be configured :
➔ *See IMB-rf1 Manual and IBRit-rf1 Manuals*
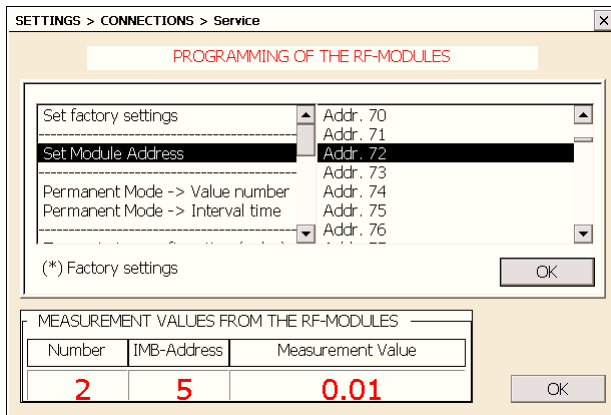
4.5 Onscreen keyboard

Allows the activation / deactivation of the integrated onscreen keyboard.

4.6 Mechanical Adjustment

By clicking on the *Settings / Mechanical Adjustment* menu, the window for the mechanical adjustment of inductive probes in the fixture is opened.
(This is necessary, since inductive probes only work optimally near their electrical zero point.)
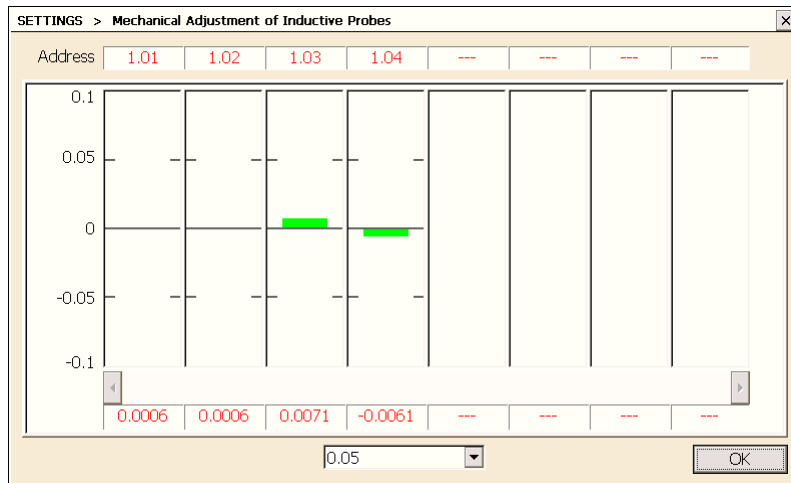
Mechanical adjustment process :

1. Selection of the probe which is to be adjusted. If there are more probes connected than the visible, you can then scroll through the list of connected probes using the scrollbar.

2. Insert the masterpiece or a component into the fixture.

3. Carry out the mechanical adjustment of the probes until all bars are in the green area. The green area of the bars can be adjusted from +/- 0.01 mm to +/- 5 mm using the selection field at the bottom of the window. The default value is +/- 0.05 mm.

    Warning :
    It is absolutely necessary to adjust the green area to +/-0.05 mm in order to mechanically adjust the inductive probes properly.

4. By clicking the *OK* button, you can exit the window.

4.7 Automatic Start

In the *Settings / Automatic Start* menu, a test scheme / order can be chosen, which is to be started automatically when ComGage Level 2 is started.
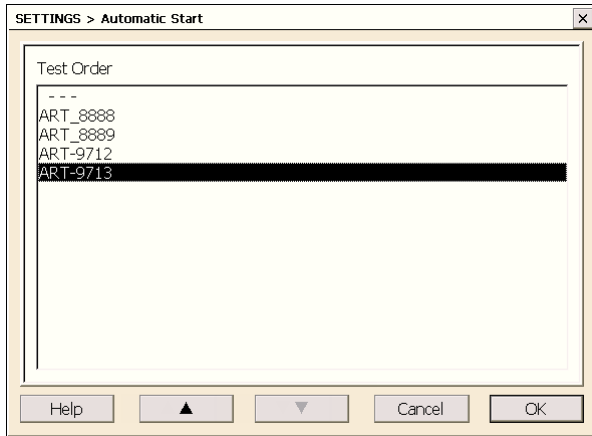
4.8 Password

In the *Settings / Password* menu, a password can be assigned. This password protects the *Settings* und *Test Scheme* menus*.*

To enter the password, the window shown below appears :
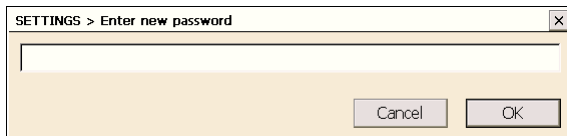
Note :
When starting the software for the first time, no password is activated.

Enter the password and confirm it with **OK**.

To delete the password, the *Settings / Password* must be selected. Then the password entry must be deleted and confirmed with **OK**.

Note :   *The master password "sEndsw" always allows you to close the software in the main menu.*

4.9 Reference Information (operators, machines, batch numbers, etc.)

In the **Settings / Reference Information** menu, the window for programming the reference information and inputting the reference information tables is opened.
All reference information types - except the batch / serial number - are selected from the reference information tables (see below). Only the batch / serial number can be input in an editable field – they are not selected from a reference information table.
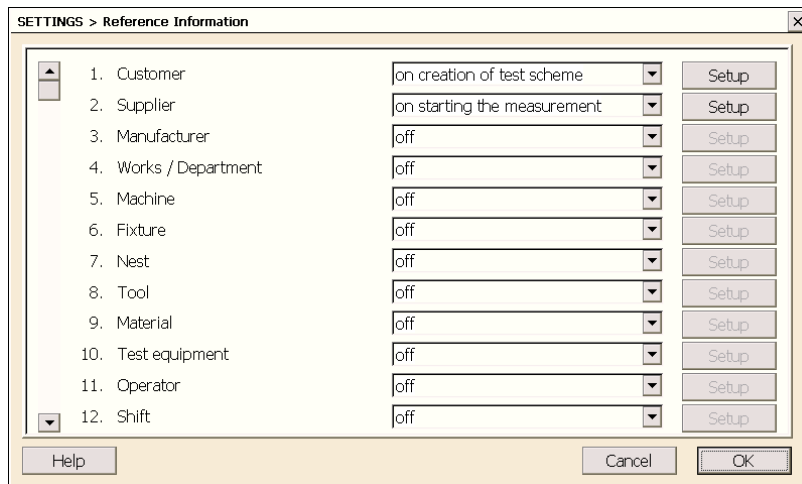
For each data type you can select when the data is requested :

off   - The data type is not used
on creation of test scheme   - The data type is requested when the test scheme is created
                               (menu "Test Scheme > Create/Change")
on starting the measurement - The data type is requested when the measuring mode is started
                               (menu "Measuring > Start")

By clicking the **Setup** button you can programme the table of the selected data type.
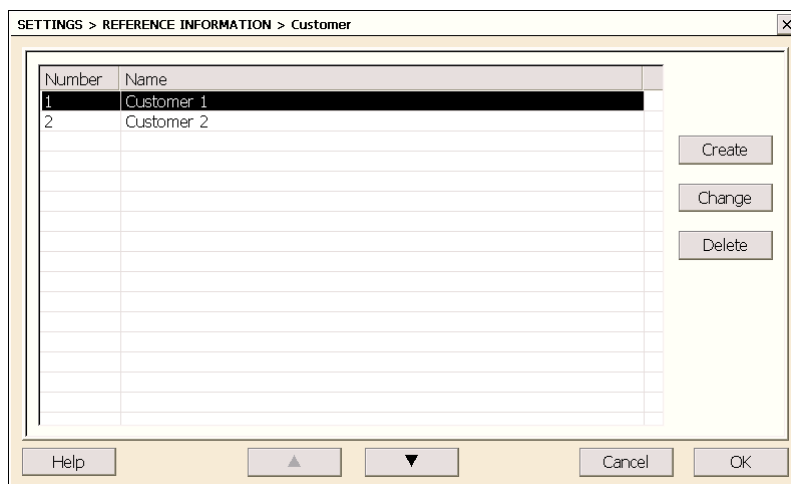
By clicking on the **Create** button on the right side of the table you can create a new data set. To modify an existing data set, you must mark it and click the **Change** button. To delete a specific data set, you must select it and click on the **Delete** button.
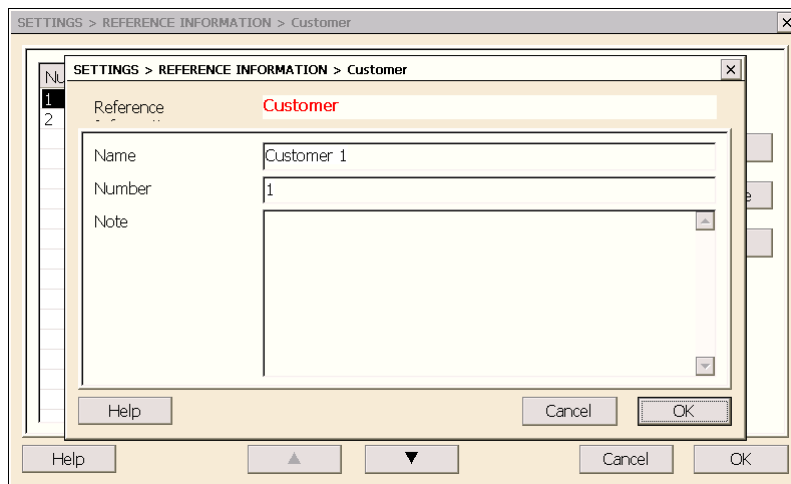
For each data set you can programme the following :

Name   (90 characters)
Number (10 characters)
Note   (650 characters)

After programming one data set you can save the settings and leave the window by clicking the **OK** button at the bottom of the window. The "**Next >**" button allows you to store the settings and directly go on with programming the next data set.

Note :   *All settings stored by clicking the Next > button do not get lost when the Cancel button is clicked.*

Note :   *In ComGage Level 2 you can programme the following reference information data types :*

- Customer	*- Operator*
- Supplier	*- Shift*
- Manufacturer	*- Test place*
- Works / Department	*- Storage place*
- Machine	*- Production instruction*
- Fixture	*- Test instruction*
- Nest	*- Events (Why a measurement value is out of tolerance?)*
- Tool	*- Batch / Serial number*
- Material	*- Action (What has been done for process correction?)*
- Test equipment	

5. Creating / changing test schemes in ComGage Level 2

In a test scheme, a component, its characteristics and the test sequence are defined :

◆ *In the header of the test scheme, the article number as well as the article name are entered.*
◆ *Up to 20 characteristics can be created :*
  ♦ *Characteristic name*
  ♦ *Nominal size and tolerances*
  ♦ *Probe mixing (with mathematical functions, such as sin, cos, tan, Min, Max, …)*
  ♦ *Measurement mode (for static, dynamic [Min, Max, TIR, Mean], … measurements)*
  ♦ *Master values for zero adjustment or automatic gauge calibration (for air gauging)*
  ♦ *Sample size*
  ♦ *Plausibility limits*
  ♦ *Control chart type*
  ♦ *…*
◆ *For the characteristics, a test sequence must be defined :*
  ♦ *Definition which characteristics are measured / calibrated together and in which order*
  ♦ *Assignment of the foot switches, function keys, digital inputs to the functions to be performed (e.g. saving measurement values, deleting measurement values, adjustment, ...)*
  ♦ *Tolerance output to digital outputs, output of the measurement values via COM port, …*
  ♦ *Digital outputs for current state of measuring programme*
  ♦ *Digital outputs for currently displayed measuring / calibration step*

When a test scheme is created, 4 files are written in the "*Directory for Test Schemes*" with the article number as file names :

*.tss   Test scheme in the ComGage Level 2 V5 format
*.tsf   Test scheme in the ComGage Professional V4 format
*.rto   Test order in the ComGage Professional V4 format to save the measurement data
*.tod   Test order in the ComGage Professional V4 format to save the measurement data

The measurement data is saved automatically in a ComGage Professional test order for compatibility reasons and can thus be processed further directly in ComGage Professional.

5.1 File selection for creating, changing, duplicating and deleting test schemes

After the *Test Scheme* menu has been called up, the file selection window appears :
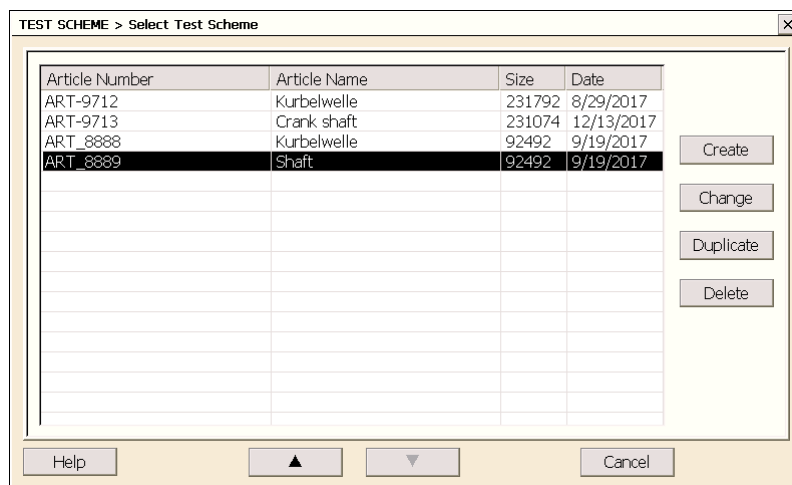
First, a test scheme must be selected. This chosen test scheme can be changed, duplicated or deleted. As an alternative, a new test scheme can be created.

5.2 Selecting the test sequence type when creating a test scheme

When a test scheme is created or duplicated, the Article Number has to be entered and the *test sequence type* has to be selected :

```
TEST SCHEME > CREATE > Input Article Number                        [X]

  Article Number        ART-9713

  Test sequence type    Type 1 : Sequential measurement with column displays

                        Type 2 : Sequential measurement with column displays and
                        advanced calibration functions
                        Type 3 : Auto recognition with bar graphs


  [ Help ]                               [ Cancel ]      [ OK ]
```

Note :
When a test scheme is duplicated, only the characteristics are transferred to the duplicate.
This allows you to choose a different test sequence type for the duplicate.

ComGage Level 2 provides the following test sequence types :

Type 1 : Sequential measurement with column displays

- Measurement of the characteristics in determinable order (sequence)
- Grouping of several characteristics for the measurement
- Calibration of the characteristics in the measuring window

Type 2 : Sequential measurement with column displays and advanced calibration functions

- Measurement of the characteristics in determinable order (sequence)
- Grouping of several characteristics for the measurement
- Calibration of the characteristics in a separate programmable sequence
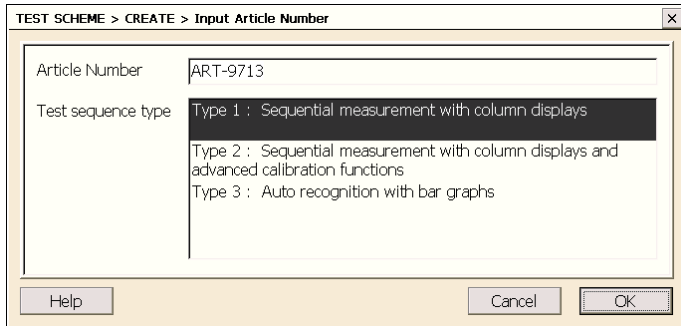- Advanced calibration functions like calibration tolerances, reference checks, forced calibration by part counter / time / …

Type 3 : Auto recognition with bar graphs

- Automatic gage selection by auto recognition when a measuring value changes
- Calibration of the characteristics in the measuring window
- No advanced calibration functions

Note regarding the following chapters
Depending on the selected test sequence type, certain options are not available in the programming windows.
In the corresponding chapters this is indicated by an accompanying table. Options marked with ✓ are available for this test sequence type, options marked with ✗ are not available.
If no option of a programming window is available for a test sequence type, the entire programming window is not selectable.

Example (Measuring sequence) :

```
TEST SCHEME > CHANGE > Programme Test Sequence                        [X]
  Article Number   ART-9717

  Measuring Sequence      Mea. Step : Message Text / Characteristics
  [ Mea. Data Processing ]   MS1 : Measure Diameters 1-3        [ Create ]
                                   C1, C2, C3
  [ Calibration Sequence ]   MS2 : Measure Length L50           [ Change ]
                                   C4
  [ Calibration Settings ]   MS3 : Measure Length L60           [ Delete ]
                                   C5
  [ Control Elements ]
  [ Dig. Out ( Result ) ]
  [ Dig. Out ( State ) ]
  [ Dig. Out ( Step ) ]

  [ Help ]                              [ Cancel ]   [ OK ]
```
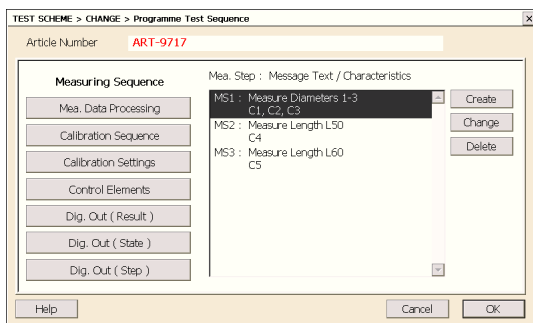
Test sequence type		
Type 1	Type 2	Type 3
✓	✓	✗
✓	✓	✗
✓	✓	✗

The options **Create**, **Change**, **Delete** are available for the programming of test schemes with test sequence type 1 and type 2.
When programming test schemes with test sequence type 3, this window is not displayed.

5.3 Main window for creating test schemes

The test scheme is programmed in 2 steps :

1. Creating the characteristics
2. Programming the test sequence incl. the measuring and calibration order of the characteristics :

Article name *input field*

> Here, the name of the article (e.g. crank shaft, motor block, …) can be entered.

Ref. Info *button*

> This will open a separate dialog where the reference information (see Chapter 4.8) which are requested on creation of a test scheme plus additional test scheme information (Creation Date, Created by, Note) can be entered.

Characteristics *section*

> Here, the 1…20 characteristics can be created.
> New characteristics can be created and existing characteristics can be changed or deleted.
> In the example 5 characteristics were created :
>> 3x Diameter D20
>> 1x Length L50
>> 1x Length L60
> The programming of the characteristics is described in Chapter 5.3.

Test Sequence *section*

> Here, the test sequence can be programmed.
> The programming of the test sequence is described in Chapter 5.4.

5.4 Programming of characteristics

The characteristic is programmed on 4 windows.
In each of the 4 windows, the name of the characteristics can be entered in the top line of the 4 windows.

Window 1 = "*Drawing data*" :

Test sequence type		
Type 1	Type 2	Type 3
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔

Unit
> Here, the unit can be selected.
> In the list, the standard units are shown.
> Special units (**Setup** ➔) can be defined by the *Setup* button. For a "special" unit, a *conversion offset* and a *conversion factor* can be entered (e.g. for the conversion of °F in °C, the factor 5/9 and the offset -160/9 must be entered).

Resolution
> Here, the resolution of the characteristic can be defined which is used for all display elements of measurement values.

Nominal size
> Nominal size of the characteristic

Upper Specification Limit
> Upper specification limit of the characteristic (is entered relative to the nominal size)

Upper Controlling Limit
> Upper controlling limit of the characteristic (is entered relative to the nominal size)
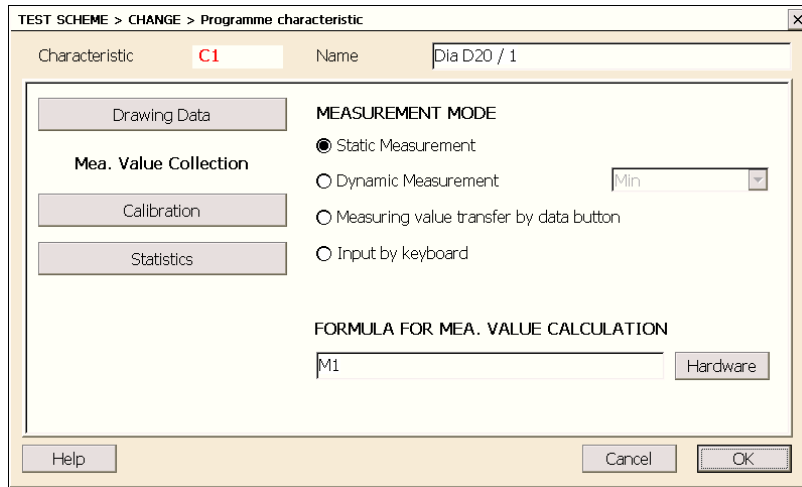
Lower Controlling Limit
> Lower controlling limit of the characteristic (is entered relative to the nominal size)

Lower Specification Limit
> Lower specification limit of the characteristic (is entered relative to the nominal size)

Window 2 = "_Mea. value collection_" :

TEST SCHEME > CHANGE > Programme characteristic		

Characteristic   C1   Name   Dia D20 / 1

Drawing Data

Mea. Value Collection

Calibration

Statistics

MEASUREMENT MODE
- ● Static Measurement
- ○ Dynamic Measurement   [Min ▼]
- ○ Measuring value transfer by data button
- ○ Input by keyboard

FORMULA FOR MEA. VALUE CALCULATION

[M1]   [Hardware]

Help   Cancel   OK

Test sequence type		
Type 1	Type 2	Type 3
✔	✔	✔
✔	✔	✘
✔	✔	✔
✔	✔	✘
✔	✔	✔

Measurement Mode

a) Static Measurement

The component is measured statically. For example, it is inserted in a fixture during the measurement. ComGage continuously measures and calculates the result of the characteristic. The display of measurement values continuously outputs the current measurement value.

b) Dynamic Measurement

The component is moved, e.g. rotated, during the measurement. During this movement of the component, the minimum, maximum, TIR and mean values are searched.

Min	→	Determination of the smallest measurement value
Max	→	Determination of the largest measurement value
TIR	→	Determination of the TIR value (Max-Min)
Mean 1	→	Determination of the area mean value ((Max+Min)/2)
Mean 2	→	Determination of the arithmetic mean value ((X1+...+Xn)/n)

c) Measuring value transfer by data button

Only those measurement values are shown, which are transmitted by data button on the gauge. This mode is especially for hand gauges, on which the measurement value is to be sent by the data button on the hand gauge or, for example, for balances which automatically send their measurement value at the end of measurement.

d) Input by keyboard

ComGage Level 2 opens a touch keyboard via which the measurement value can be entered per touch, mouse or keyboard.

Formula for Measurement Value

In the **Formula for Measurement Value**, the measuring inputs, the results of other characteristics, foot switch inputs, digital inputs, register values, other numeric values and the time can be combined in any way.

In the formulas the following *inputs* can be used :

Address	Input
Mx	Measuring input x
Cx	Current measuring value of characteristic x
Cx_File	Last measuring value from file of characteristic x
Cx_USL	If measuring value of characteristic x is > USL, then Cx_USL = 1
Cx_UCL	If measuring value of characteristic x is > UCL and < USL, then Cx_UCL = 1
Cx_ok	If measuring value of characteristic x is inside the controlling limits, then Cx_ok = 1
Cx_LCL	If measuring value of characteristic x is > SL and < LCL, then Cx_LCL = 1
Cx_LSL	If measuring value of characteristic x is < LSL, then Cx_LSL = 1
Cx_NOM_Val	Nominal value of characteristic x, as programmed in the drawing data
Cx_USL_Val	Upper specification limit of characteristic x, as programmed in the drawing data
Cx_UCL_Val	Upper controlling limit of characteristic x, as programmed in the drawing data
Cx_LCL_Val	Lower controlling limit of characteristic x, as programmed in the drawing data
Cx_LSL_Val	Lower specification limit of characteristic x, as programmed in the drawing data
Cx_MA1_Val	1. Master value of characteristic x, as programmed in the drawing data
Cx_MA2_Val	2. Master value of characteristic x, as programmed in the drawing data
Ix	Digital input x (State "set" = 1 / State "not set" = 0)
Tx	Hand / Foot switch x (State "pressed" = 1 / State "not pressed" = 0)
Fx	Function key F1... F12

In the formulas the following *operators* can be used :

Operator	Function	Example
+	Addition of inputs, characteristics and numbers	M1+M10-34
-	Subtraction of inputs, characteristics and numbers	M1-M2+1.1e-4
*	Multiplication of inputs, characteristics and numbers	M3*0.5+M2*M1
/	Division of inputs, characteristics and numbers	M2/3
^	'x power by y' (e.g. $2^3 = 2*2*2 = 8$)	$M2^{(1/2)}$ = Square root of M2
%	Modulo-operator = carryover of a division (e.g. 5%3 = 2)	M2%2
ABS()	Absolute value	ABS(M1)
SIGN()	Delivers the sign of the parameter	SIGN(-5.23)=-1
ROUND()	Rounds to the next integer	ROUND(5.43)=5 / ROUND(5.53)=6
INT()	Rounds down to the next integer	INT(5.43)=5 / INT(5.53)=5
CEIL()	Rounds up to the next integer	CEIL(5.43)=6 / CEIL(5.53)=6
SIN()	Sine (unit: degree)	SIN(M2)
COS()	Cosine (unit: degree)	COS(M2)
TAN()	Tangent (unit: degree)	TAN(M2*3+M1)
ASIN()	Arc – Sine (unit: degree)	ASIN(M2/50.4)
ACOS()	Arc – Cosine (unit: degree)	ACOS(M2/50.4)
ATAN()	Arc – Tangent (unit: degree)	ATAN(M2/50.4)
PI	Pi (= 3.141592654)	SIN(M2*180/PI)
EXP()	Exponential function (2.7182818^x)	EXP(M1)
LOG()	Natural logarithm	LOG(M1)
TIME(0)	Returns the number of milliseconds since midnight	TIME(0)
MONTH	Current month (1=January, 2=February, ...)	MONTH
DAY	Current day of month (1 ... 31)	DAY
DAYOFWEEK	Current day of week (0=Sunday, 1=Monday, ..., 6=Saturday)	DAYOFWEEK
HOUR	Current time: Hour (0 ... 23)	HOUR
MINUTE	Current time: Minute (0 ... 59)	MINUTE
SECOND	Current time: Second (0 ... 59)	SECOND
Min(;;;) Min()	Min-value of all elements in the list Min-value of all saved measuring values of the characteristic	Min(M1;M2;C3;M4+C5) Min(C3)
Max(;;;) or Max()	Max-value (see Min-function)	Max(M1;M2;C3;M4+C5) or Max(C3)
Avr(;;;) or Avr()	Average (see Min-function)	Avr(M1;M2;C3;M4+C5) or Avr(C3)
Tir(;;;) or Tir()	Max-value minus Min-value (see Min-function)	Tir(M1;M2;C3;M4+C5) or Tir(C3)
SD(;;;) or SD()	Standard deviation (see Min-function)	SD(M1;M2;C3;M4+C5) or SD(C3)

Window 3 = "*Calibration*" :

Test sequence type		
Type 1	Type 2	Type 3
✓	✓	✓
✓	✓	✓
✗	✓	✗
✗	✓	✗

Master Values

Input of the master values for this characteristic.
To perform a *zero adjustment*, entering the *1.* Master value is necessary. To carry out a *gauge calibration* (e.g. on air gauging), entering *two master values* is required.

<u>Note :</u>
When using two masters, the difference between the two master values must be at least > 0.00001.

Reference Check

Here, calibration tolerances can be activated, either related to the last calibration or to the master-calibration. It is possible to activate both options at the same time. An upper and a lower tolerance value are defined in the unit of the characteristic. If the "*Calibrate*" command is processed in the test sequence, the tolerance limits defined here are used to check the calibration (= reference check). If the tolerance values are hurt then an error message is displayed.
This function is used to monitor the measuring fixture (typical errors and faults: probe tip loose / master part dirty / probe defective / …).

<u>Note :</u>
The "Master-Calibration of Characteristics" function must be called in measuring mode for those characteristics in the ComGage test scheme, for which the reference check is activated. The master-calibration must then be carried out prior to the very first regular calibration (see note in section "Configuration of Calibration" on page 24).

Window 4 = "*Statistics*" :

Test sequence type		
Type 1	Type 2	Type 3
✓	✓	✓
✓	✓	✓
✓	✓	✓
✓	✓	✓
✓	✓	✓

Plausibility limits

        If the measurement value is outside the plausibility limits during the data saving process, the operator is then asked whether the measurement value is to be saved or rejected.
If the measurement value is rejected, the measurement can be repeated.
The plausibility limits must be entered as absolute values.
They do not refer to the nominal size of the characteristic.

Sample size

        For the calculation of a Cp / Cpk value.
        ⇨ See Appendix A

        <u>Note :</u>
        In the case of a 100% check, it is not possible to display Cp / Cpk value.

Norm for standard deviation

        Selection of the norm for calculating the standard deviation (ISO9000 / QS9000) and for calculating the Cp / Cpk value.
        ⇨ See Appendix A

Control chart type

   Selection of one of the following control chart types :

- Xq/S - QCC	average [Xq] + standard [S] chart (UCL / LCL are used from "Drawing Data")
- Xq/R - QCC	average [Xq] + range [R] chart (UCL / LCL are used from "Drawing Data")
- Xq/S - Shewhart - QCC	average [Xq] + standard [S] Shewhart chart with input of confidence level
- Xq/R - Shewhart - QCC	average [Xq] + range [R] Shewhart chart with input of confidence level
- Xq/S - Acceptance - QCC	average [Xq] + standard [S] Acceptance chart with input of control probability
- Xq/R - Acceptance - QCC	average [Xq] + range [R] Acceptance chart with input of control probability

5.5 Programming of the test sequence

Test sequence is programmed on 8 windows.

Note : Non-used windows / options of the test sequence are not displayed.

Window 1 = "_Measuring Sequence_" (Test sequence type 1 and 2) :
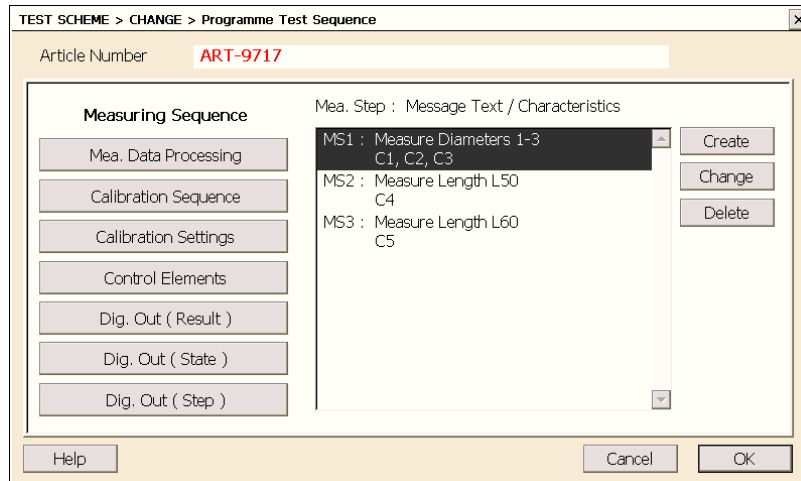
Test sequence type		
Type 1	Type 2	Type 3
✓	✓	✗
✓	✓	✗
✓	✓	✗

In the example, the 3 characteristics C1, C2, C3 = 3x "_Diameter D20"_ are first measured together in a measuring step. Afterwards, the characteristic C4 = _"Length L50"_ is measured and in the end the characteristic C5 = _"Length L60"_.
In Chapter 6.2, the windows of the 3 measuring steps during the measurement are shown and described.

Using the buttons **Create** / **Change** / **Delete**, the measuring steps can be managed. The characteristics for each measuring step must be selected. Blue labelled characteristics are already used in other test steps but can be assigned to the current one.
For each measuring step, a message text for the measuring window can be saved.
The message text can be used to provide the operator an instruction how to carry out the measurement.
When existing, you can select a different template for this measuring step display window by the combo box located at the dialog bottom. The button ⋯ will open a preview window showing the measurement value displays of the selected template.
Information concerning the creation of display window templates can be found in chapter 9.
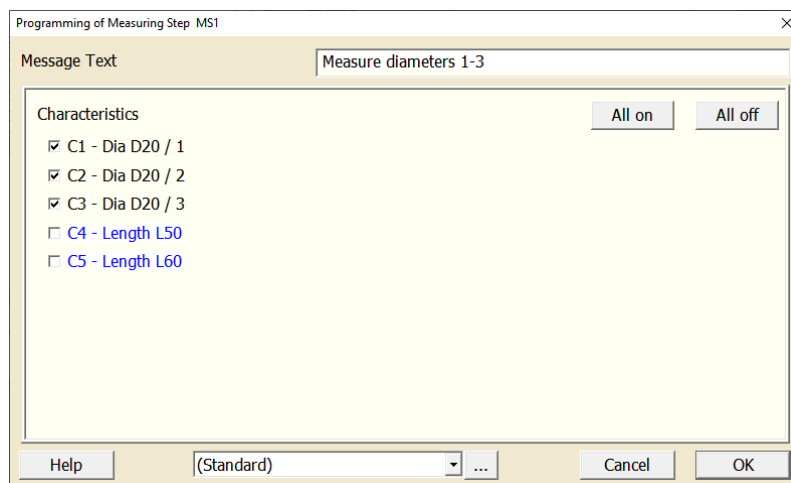

Note :

Characteristics marked blue are already measured in other measuring steps. If they are selected, they will be assigned to the actual measuring step instead of the original one.

Characteristics which cannot be measured in the same measuring step as the already se-lected ones are displayed in grey colour. Static and dynamic characteristics can be measured together in one measuring step. Separate measuring steps are needed for the measurement of characteristics with measuring mode 'Measuring value transfer by data button' or 'Input by keyboard'.

**Window 1 = "*Auto Recognition*" (Test sequence type 3) :**
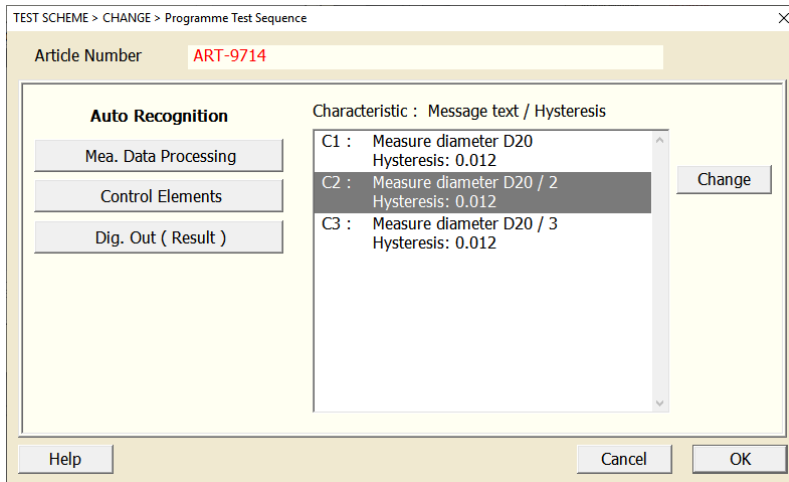
In the example, the 3 characteristics C1 = „*Diameter D20"*, C2 = „*Length L50"* und C3 = „*Length L60"* should be measured by auto recognition (Test Sequence type 3). When using auto recognition, for each characteristic a separate measuring step will be created automatically.

By the button *Change* the selected measuring step can be configured. A message text for the measuring window can be entered and the hysteresis (required measurement value change of current characteristic, to change into this measuring step automatically) can be configured.
When existing, you can select a different template for this measuring step display window by the combo box located at the dialog bottom. The button ⋯ will open a preview window showing the measurement value displays of the selected template.
Information concerning the creation of display window templates can be found in chapter 9.
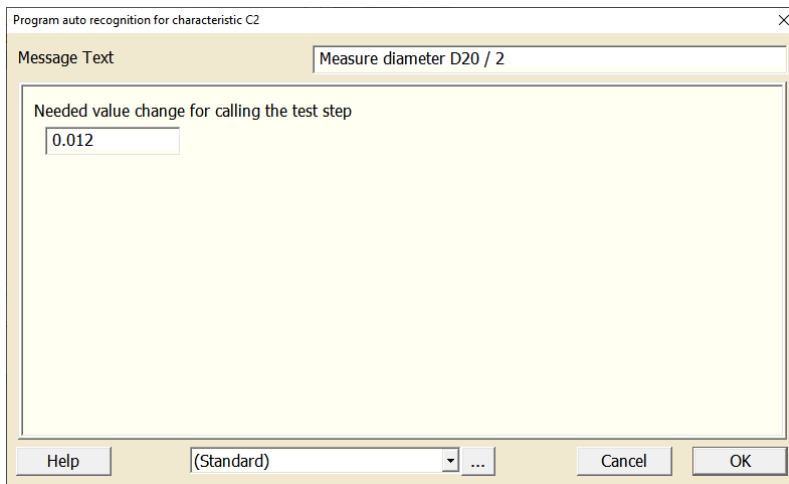
Window 2 = "*Measurement Data Processing*" :
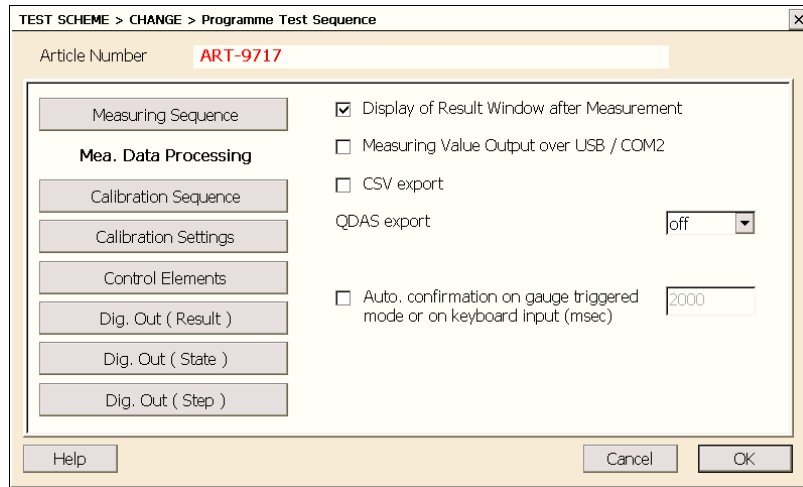
Test sequence type		
Type 1	Type 2	Type 3
✓	✓	✗
✓	✓	✓
✓	✓	✓
✓	✓	✓
✓	✓	✓

Display of Result Window after Measurement

In the result window, the measurement results of all characteristics are shown after all measuring steps have been performed and the operator can confirm or reject all measurement results of the current component.
In Chapter 6.3, the result window during the measurement is shown and described.

Measuring Value Output over USB / COM2

If a component has been tested completely (= all measuring steps have been carried out) and the measurement results have been confirmed inside the result window being activated, the measurement data of the component is then outputted via the COM2 port of Mecc or IMB-pc1 or via USB port of CD43 / CD70.
The measurement data is outputted in the MUX10 format with 9600 Baud,N,8,1.

Characteristic C1 :	01A+1234.5678<cr>
Characteristic C2 :	02A+1234.5678<cr>
…	
Characteristic C20 :	20A+1234.5678<cr>

CSV export

If a component has been tested completely (= all measuring steps have been carried out) and the measurement results have been confirmed inside the result window being activated, the measurement data of the component is then attached to a CSV file as a new line.
The file name of the CSV file is the name of the test order and is saved in the "*Directory for converted measurement data*".

QDAS export

If a component has been tested completely (= all measuring steps have been carried out) and the measurement results have been confirmed inside the result window being activated, the measurement data of the component and configured reference information will be exported to a DFQ file. You can select between the options "*off*", "*Single File*", "*File per Day*" or "*File per Month*".
The file name of the DFQ file is the name of the test order plus day/month if selected and is saved in the "*Directory for converted measurement data*".

Auto. confirmation on gauge triggered mode or on keyboard input (msec)

If this option is active, the values of gauge triggered characteristics and characteristics entered by keyboard, are confirmed automatically after the specified time and ComGage changes to the next test step.
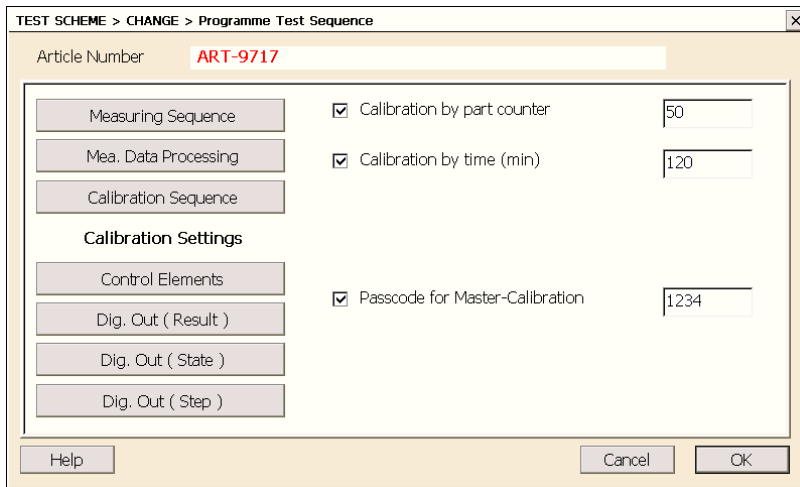
Window 3 = "*Calibration Sequence*" :
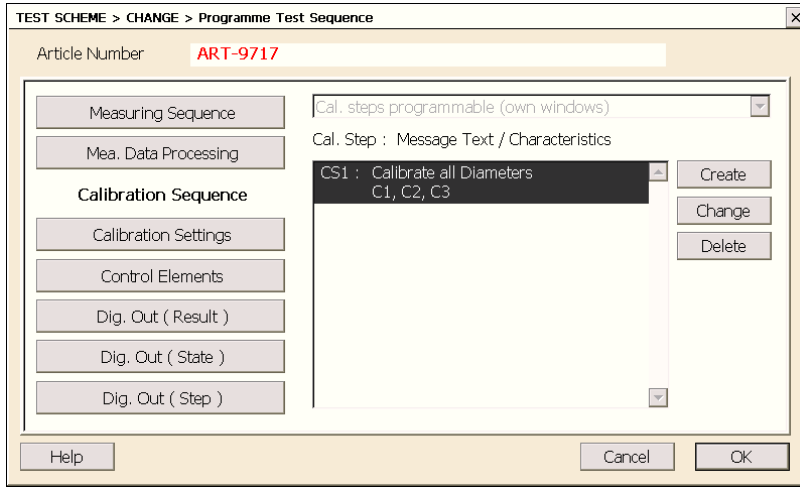
Test sequence type		
Type 1	Type 2	Type 3
✘	✓	✘
✘	✓	✘
✘	✓	✘

However, the calibration is performed in a separate calibration sequence with several calibration steps with separate calibration windows (see Chapter 6.4). Because of a separate calibration sequence, a calibration order other than the measuring order can be defined. For each calibration step, a separate message text (= instruction for the operator) can be saved.

Window 4 = "*Calibration Settings*" :

Test sequence type		
Type 1	Type 2	Type 3
✘	✓	✘
✘	✓	✘
✘	✓	✘

If calibration by part counter or by time is activated (either one or both), the calibration sequence is called up after the measurement of e.g. 50 parts, or automatically every 120 minutes, for example, then the operator is forced to perform a calibration.

For protection of the Master-Calibration a passcode can be entered.

Window 5 = "*Control Elements*" :
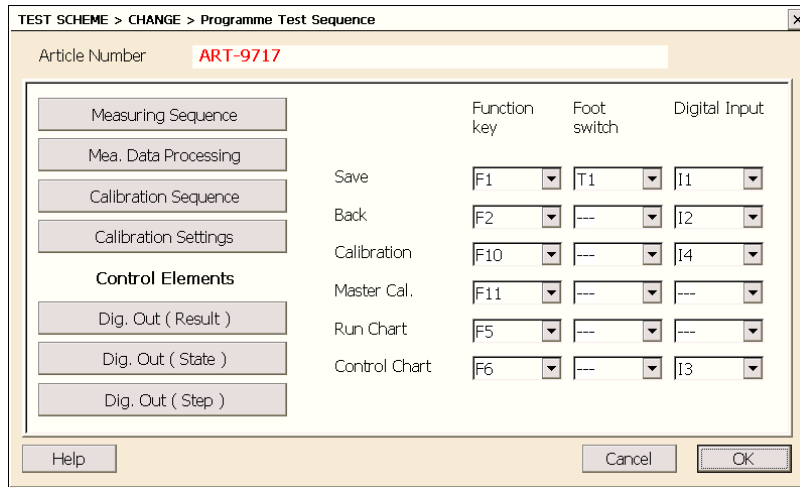
Test sequence type		
Type 1	Type 2	Type 3
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✘
✔	✔	✘
✔	✔	✘

In the measuring windows, there are **Save**, **Back**, … buttons. These buttons can be controlled via the touch screen and are described in Chapter 6.2.
To execute these functions, function keys, hand / foot switches and digital inputs can also be assigned in this window.

> ***Note :***
> *The assigned function keys, had / foot switches and digital inputs are also assigned for controlling the run and control chart window (see chapter 6.6).*
>
> **Next >**   *same assignment as for* **Save**
> **< Back**   *same assignment as for* **Back**
> **Measure**   *same assignment as for* **Run Chart** / **Control Chart**
>
> *The button for ending the measurement mode (**Exit**)is generally assigned to the function keys <Alt>+<F10>.*

Window 6 = "*Digital Outputs (Result)*" :
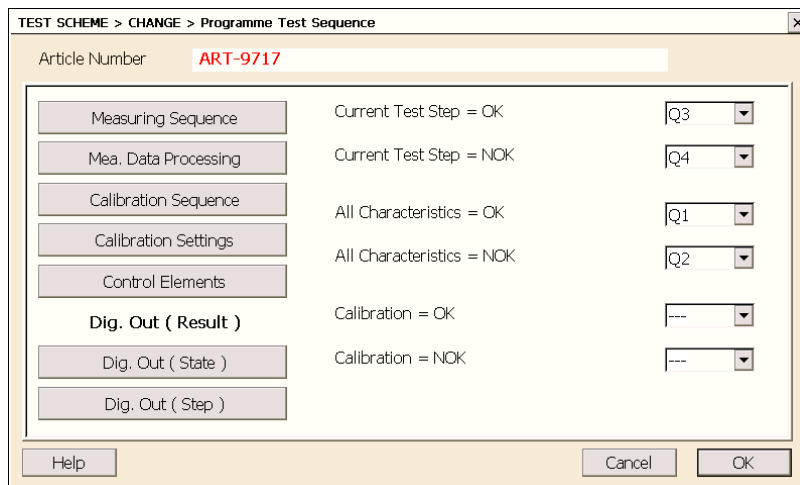
Test sequence type		
Type 1	Type 2	Type 3
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔
✔	✔	✔

In the example, the digital outputs are set = 1 if the following conditions are met :

Digital output Q1 = 1 if the characteristics of the last part are within the tolerance limits
Digital output Q2 = 1 if at least one of the characteristics of the last part is out of the tolerance limits
Digital output Q3 = 1 if the characteristics in the current measuring step are within the tolerance limits
Digital output Q4 = 1 if at least one of the characteristics of the current measuring step is out of the tolerance limit

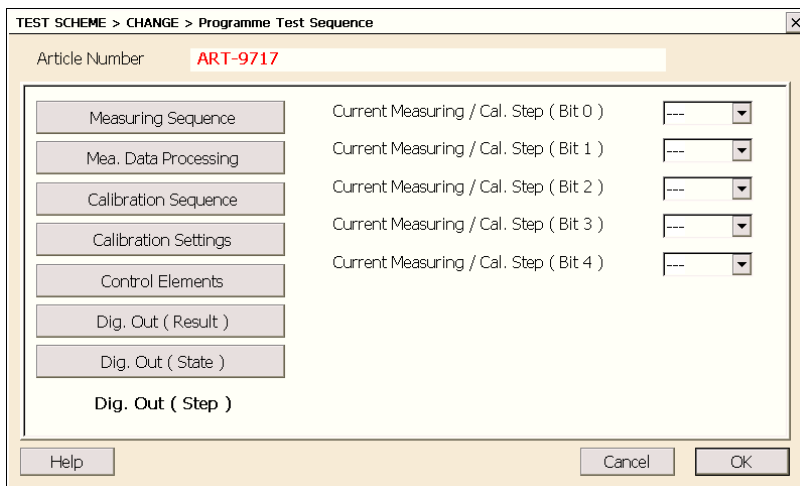### Window 7 = "*Digital Outputs (State)*" :
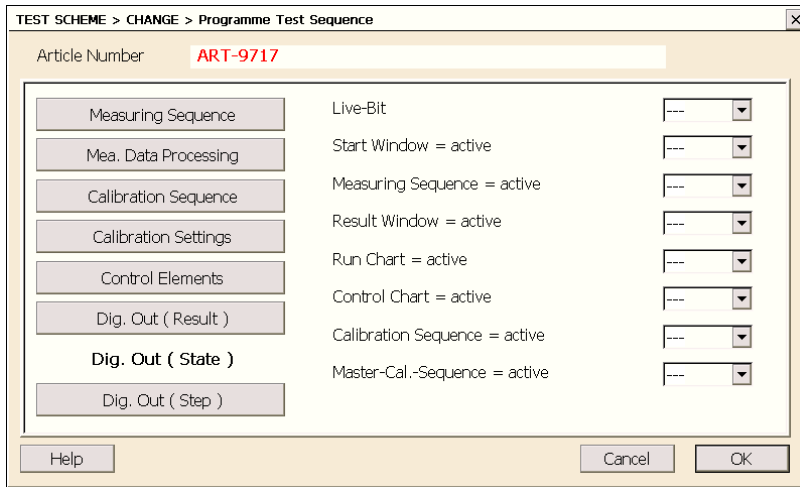
Test sequence type		
Type 1	Type 2	Type 3
✓	✓	✗
✓	✓	✗
✓	✓	✗
✓	✓	✗
✓	✓	✗
✓	✓	✗
✓	✓	✗
✓	✓	✗

In this window digital outputs can be assigned to the current state of the measuring programme.

If for example one output is assigned to "*Measuring Sequence = active*", then this output is 1 when a measuring step is executed. If the calibration step, the result window, ... is shown, this output is 0.

Additionally you can use the "*Live-Bit*" which changes its state from 0 to 1 every second when the measuring programme is up and running.

Window 8 = "*Digital Outputs (Step)*" :

Test sequence type		
Type 1	Type 2	Type 3
✓	✓	✗
✓	✓	✗
✓	✓	✗
✓	✓	✗
✓	✓	✗

In this window digital outputs can be assigned to the actually processed measuring step / calibration step. The combination of all digital output steps reflects the entire measuring process and state to an external system which may also control the entire measuring process by setting digital inputs.

6. Measuring with ComGage Level 2

In the measurement mode, ComGage Level 2 only works with the test order generated automatically in menu *Test Scheme / Create or Change* or by ComGage Professional, i.e. with the following 2 files :

        .rto   Test order in the ComGage Professional V4 format to save the measurement data
        .tod   Test order in the ComGage Professional V4 format to save the measurement data

The measurement data is saved automatically in a ComGage Professional test order for compatibility reasons and can thus be processed further directly in ComGage Professional.

6.1 File selection for starting the measurement

After the *Measuring* menu has been called up, the file selection window appears :
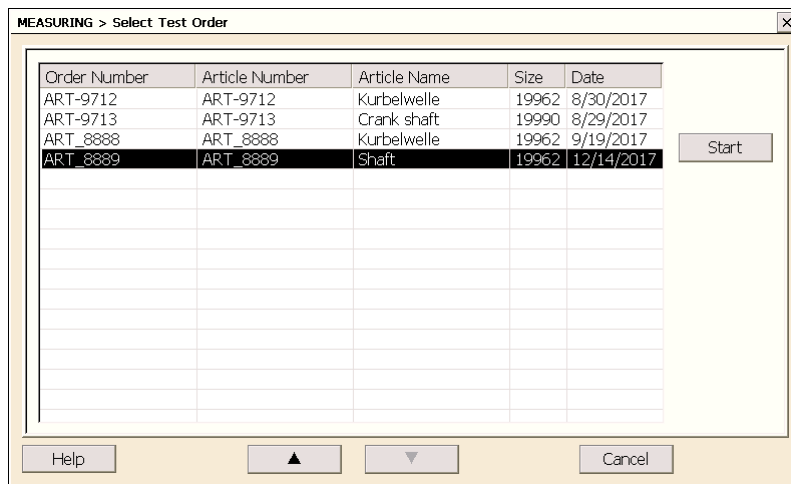
First, a test order must be selected and then the *Start* button pressed.

6.2 Measuring window

There are three different types of measuring windows :

- Type 1 is used for the combined collection of 1…20 static or dynamic characteristics
- Type 2 is used for the collection of one characteristic which is sent by data button of the gauge
- Type 3 is used for the collection of one characteristic via keyboard input

In the case of type 2 and type 3, only one characteristic at a time can be sent. This means that a new measuring step is created by ComGage Level 2 for each characteristic.

In the header of the measuring window, the message text (= instruction for the operator), test order number, article name and article number are displayed. (See also Chapter 5.4 / Window 1)

In the footer, the following buttons are available :

|	
Save >	Saves the measurement values of the current measuring step and switches to the next measuring step. In the case of dynamic characteristics, pressing the button once will start the dynamic measurement and pressing it again will stop the dynamic measurement. The software saves the measurement value and switches to the next measuring step.
< Back	Repeats the previous measuring step und rejects the measurement values of the previous measuring step.
Calibrate	The software switches to the calibration sequence. ➔ See Chapter 6.4
Run Chart	Display of run chart and value table of the collected measurement values. ➔ See Chapter 6.6
Control Chart	Display of control chart, histogram and SPC values of the collected measurement values. ➔ See Chapter 6.6
Exit	Closes the measurement mode.

Measuring window for the combined collection of 1…20 static or dynamic characteristics :
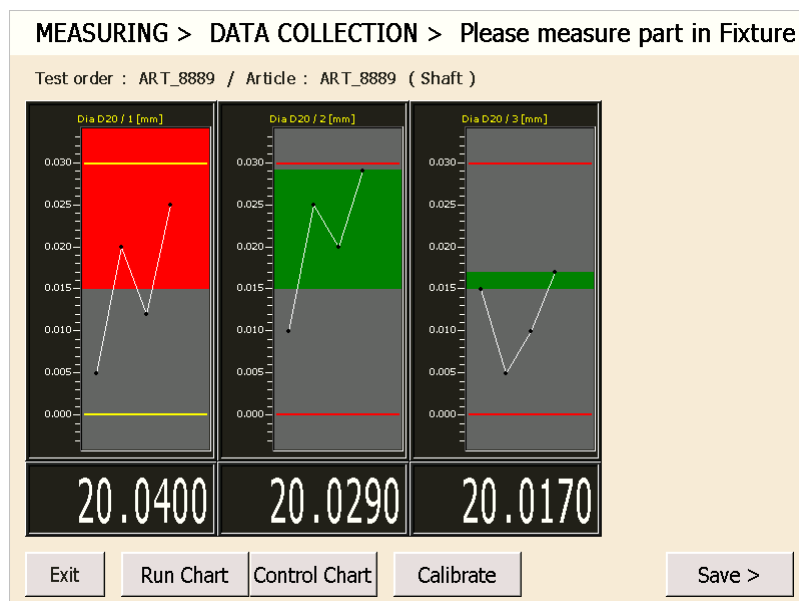
Measuring window for collection of one characteristic which is sent by data button of the gauge :
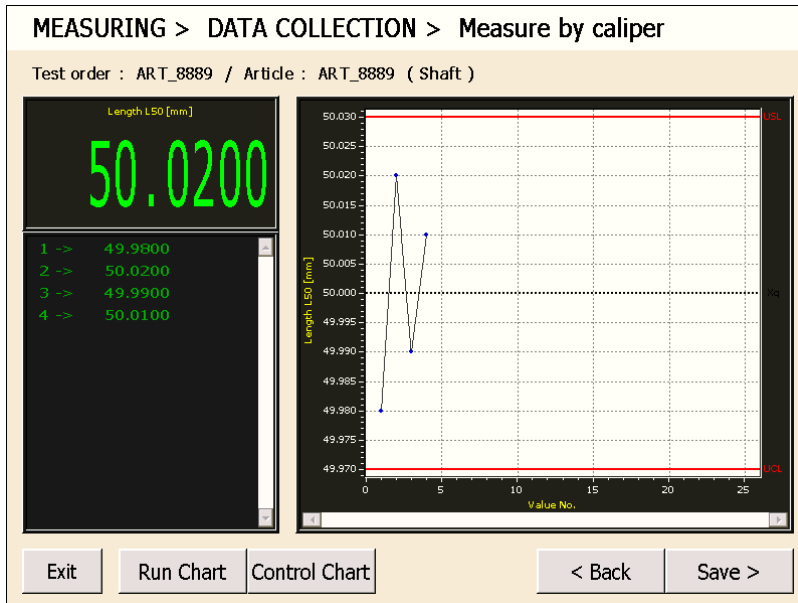
Measuring window for collection of one characteristic via keyboard input :
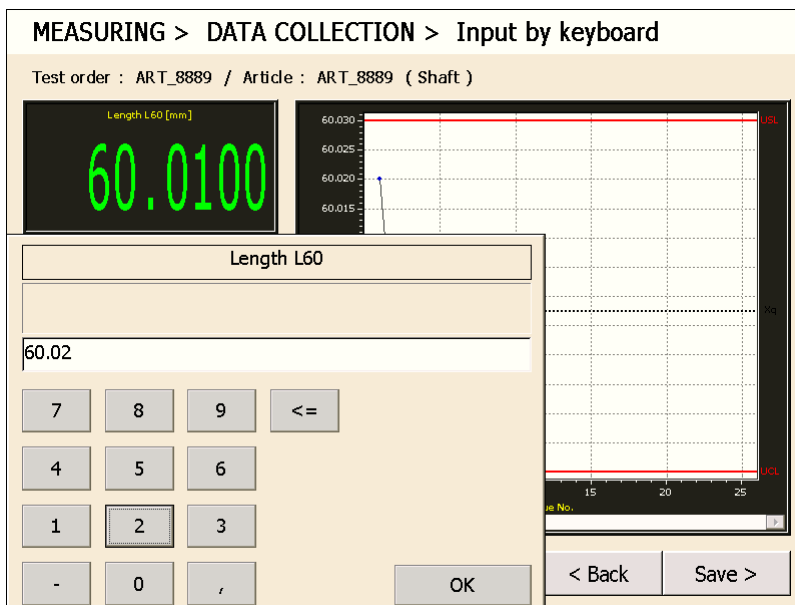
6.3 Result window

In the result window, the measurement results of all characteristics are shown after all measuring steps have been carried out and the operator can confirm or reject all measurement results of the current component.

In the footer, the following buttons are available :

Confirm   The collected measurement results of the part are saved in the database = test order and, if activated, written in the CSV/DFQ file and, if activated, sent via the COM2 port / USB port.

Reject   The collected measurement results of the part are rejected and the measurement of the next part starts.

< Back   Repeats the previous measuring step and rejects the measurement values of the previous measuring step.

Run Chart   Display of run chart and value table of the collected measurement values.
➔ See Chapter 6.6

Control Chart   Display of control chart, histogram and SPC values of the collected measurement values. ➔ See Chapter 6.6

**Exit**   Closes the measurement mode.
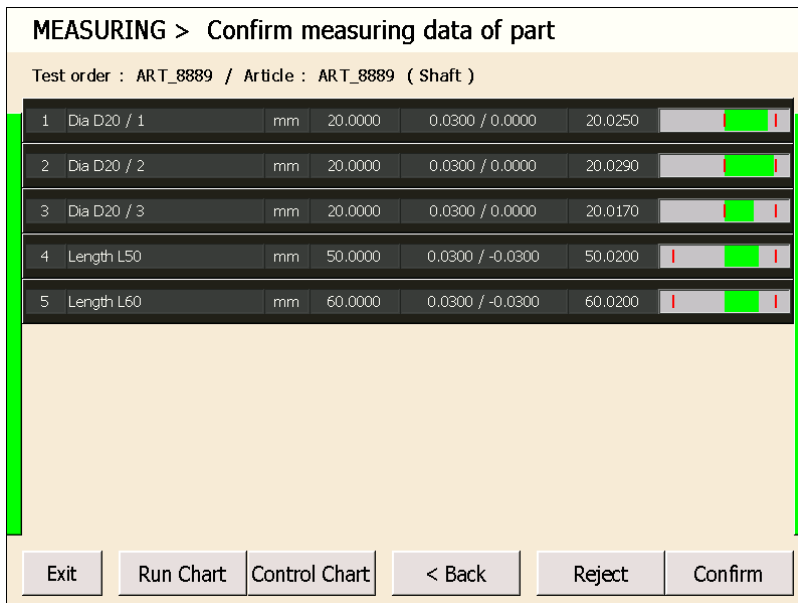
6.4 Calibration window

If a separate calibration sequence is programmed, there are special calibration windows for the individual calibration steps with the message text (= instruction for the operator) saved in the test scheme. (Only static and dynamic characteristics are calibrated.)

In the footer, the following buttons are available :

Calibrate	Performs the calibration of the characteristics in the current calibration step and switches to the next calibration step.
Master-Calibrate	Calls up the separate sequence for master-calibration. ➔ See Chapter 6.5
Exit	Closes the measurement mode.
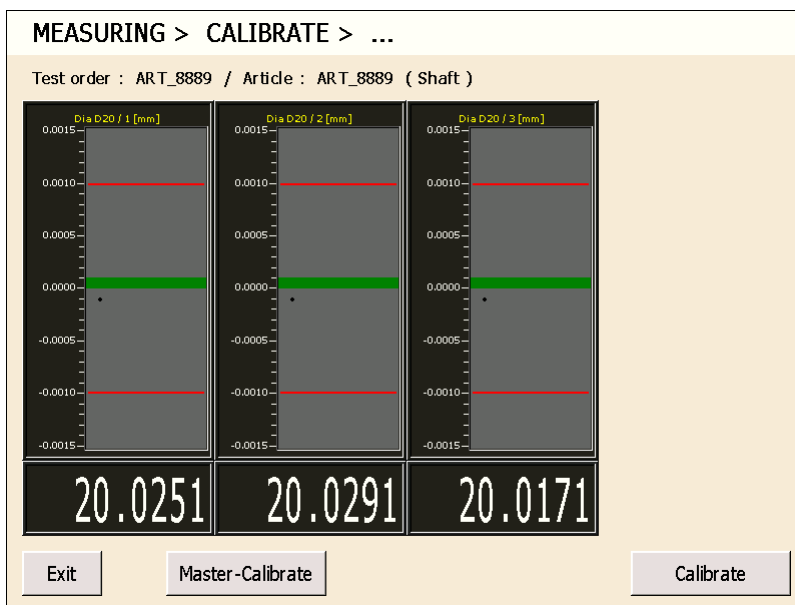
In the case of an error, an error message is displayed if reference check (See Chapter 5.3 / Window 3) has been activated, and the software also remains in the current calibration step to repeat the calibration.
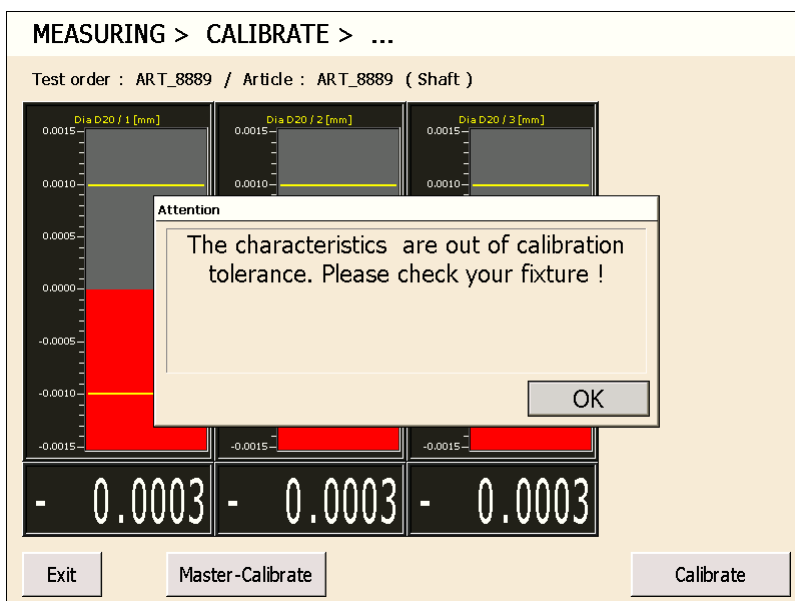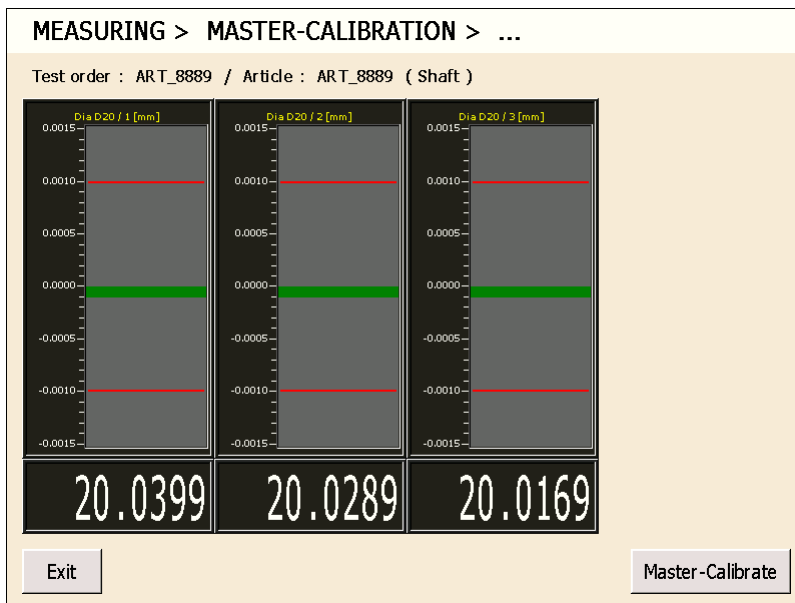
6.5 Master-Calibration window

From the calibration sequence, a separate master-calibrate sequence can be called up to perform the master-calibration after the fixture has been taken into operation / maintained.
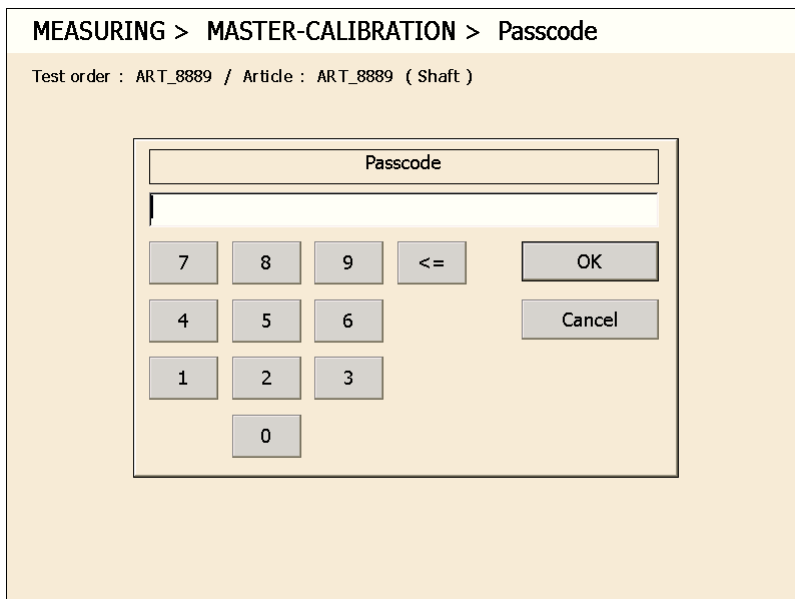
In the footer, the following buttons are available :

Master-Calibrate   Performs the master-calibration of the characteristics in the current master-calibration step and switches to the next master-calibration step.

Exit   Closes the measurement mode.

To protect the master-calibration, a password (passcode) can be activated in the test scheme :

6.6 Run Chart / Control Chart

For each characteristic, the collected measurement values in the test order can be displayed by means of a run chart and a value table or a control chart with histogram and SPC values.
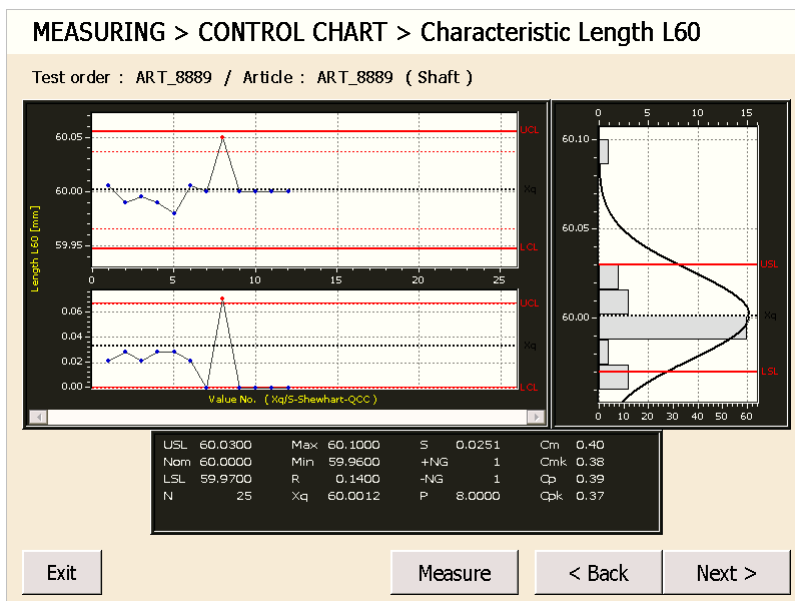
In the footer, the following buttons are available :

Next >	Switches to the next characteristic.
< Back	Switches to the previous characteristic.
Measure	Returns to the measuring windows.
Exit	Closes the measurement mode.

Displayed run chart :
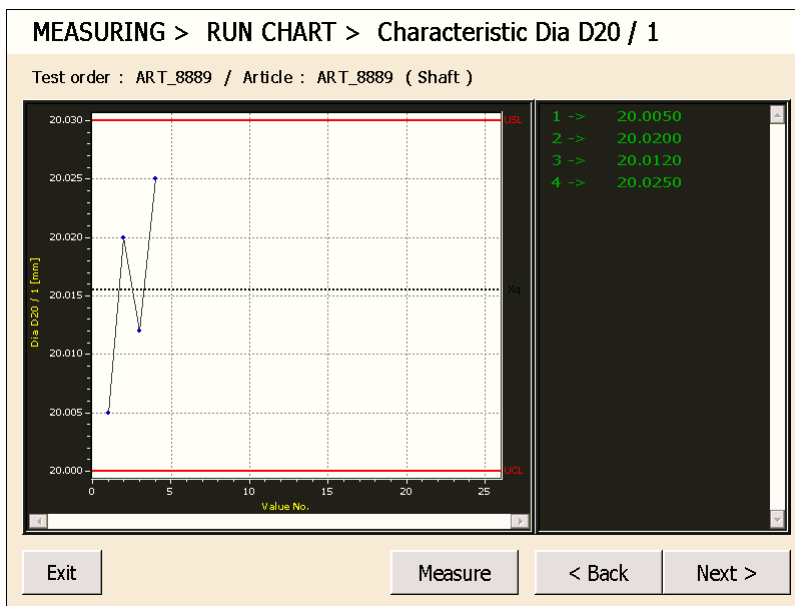
Displayed control chart (as configured in the characteristic's statistics settings) :

## 7. Processing measurement data with ComGage Level 2

The collected measurement data can be analysed, printed, saved as Excel file and deleted with ComGage Level 2.

In this menu, ComGage Level 2 only works with the test order generated automatically in menu **Test Scheme / Create or Change** or by ComGage Professional, i.e. with the following 2 files :

***.rto**	Test order in the ComGage Professional V4 format to save the measurement data
***.tod**	Test order in the ComGage Professional V4 format to save the measurement data

7.1 File selection

After the **Measurement Data** menu has been called up, the window for the file selection is shown :
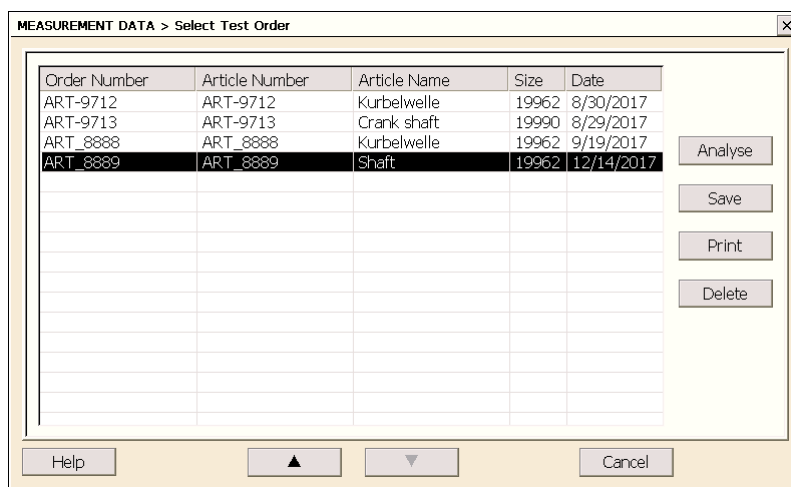
First, a test order must be selected.

Then, one of the 4 buttons must be pressed. ➔ See Chapter 7.2 … 7.4

7.2 Analyse

After the *Analyse* button has been pressed, the measurement data is represented graphically as a run / control chart, as a histogram and as statistical data.

In the header, the characteristic to be visualised or the displayed chart type (run chart or a specific control chart) can be chosen.
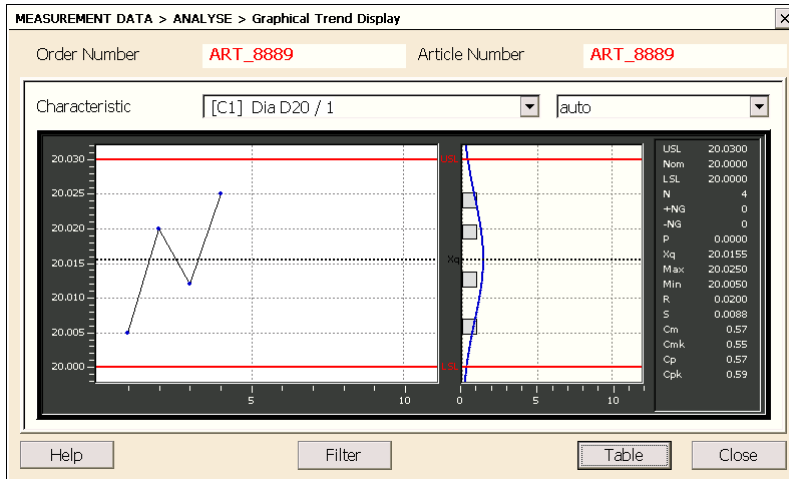
Via the *Table* button, the measurement values and collected reference information are displayed as value table. (Here, too, the characteristic can be chosen in the header.)
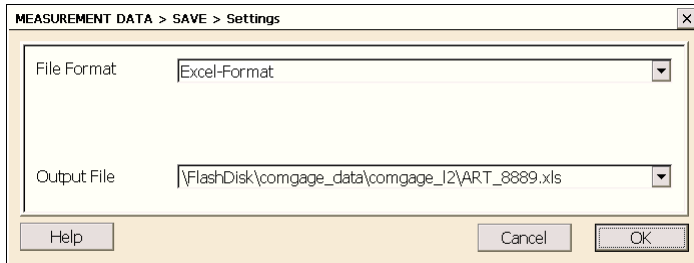

By clicking on the *Edit* button, the selected measurement value can be changed. (Password = *sval*)
By clicking on the *Delete* button, the selected measurement value can be deleted. (Password = *sval*)

7.3 Save

After the *Save* button has been pressed, the measurement data in the "*Directory for converted measurement data*" is saved as an Excel file or ComGage Test Order.


Note :   In the "Output File" field, the output directory and file name can still be modified.

7.4 Print

After the *Print* button has been pressed, the measurement data is sent to a printer in tabular format.
To do this, the printer can be selected, among other things.

Notes :   a) Under Windows CE, USB printers are shown under the port name "LPT1".
   b) We recommend checking that Paper Size = A4 has been chosen.
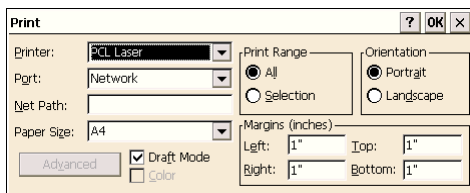
7.5 Delete

After clicking the *Delete* button, in the following window can be selected if only the measurement data shall be deleted or the complete test order :
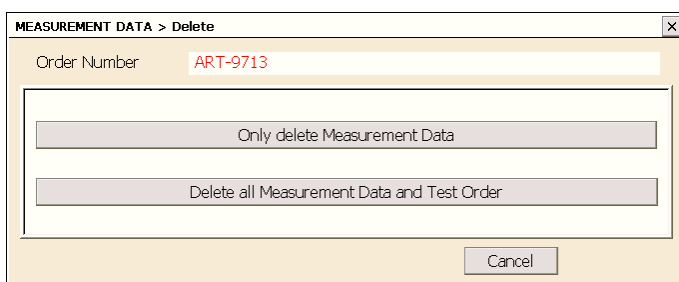
8. Exchange of data with ComGage Professional

Using ComGage Professional (IBR_TSH module), test schemes (*.tsf) with free screen design can be created for ComGage Level 2, requiring the following setting to be made in the window for test scheme creation inside ComGage Professional :
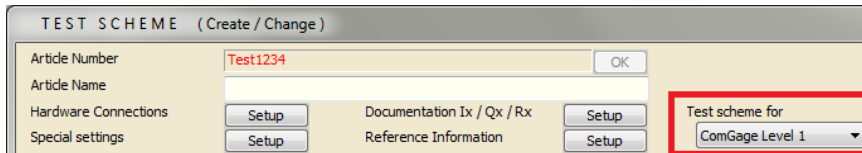
With ComGage Professional (IBR_TOH module), test orders (*.rto) can be created on the basis of these test schemes (*.tsf), which can then be used for the collection of measurement values in ComGage Level 2.

Since no test schemes (*.tsf) are needed in the measurement mode in ComGage Level 2, a separate test order (*.rto) can also be created for each batch, for example, on the basis of the same test scheme in ComGage Professional and used for measurement in ComGage Level 2.

Note :   *To be able to end the measurement in ComGage Level 2, a text field has to be added when programming a test scheme with ComGage Professional for ComGage Level 2. This text field has to be activated as button and has to simulate the function key "Exit measurement mode".*
This option is available from ComGage V4.35.
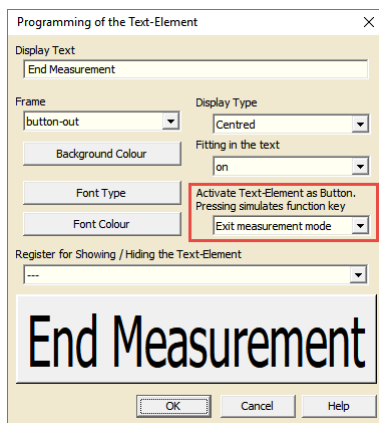
The test orders (*.rto / *.tod), in turn, can be processed further in ComGage Professional.
Thus, a QDAS export of the collected measurement data can be carried out, for example, via the IBR_TOH module.

9. Creation of display window templates in ComGage Professional

Using ComGage Professional (IBR_TSH module), display window templates for measuring steps (*.dwc file) can be created. The display window template can be selected for a specific measuring step when programming the test sequence.
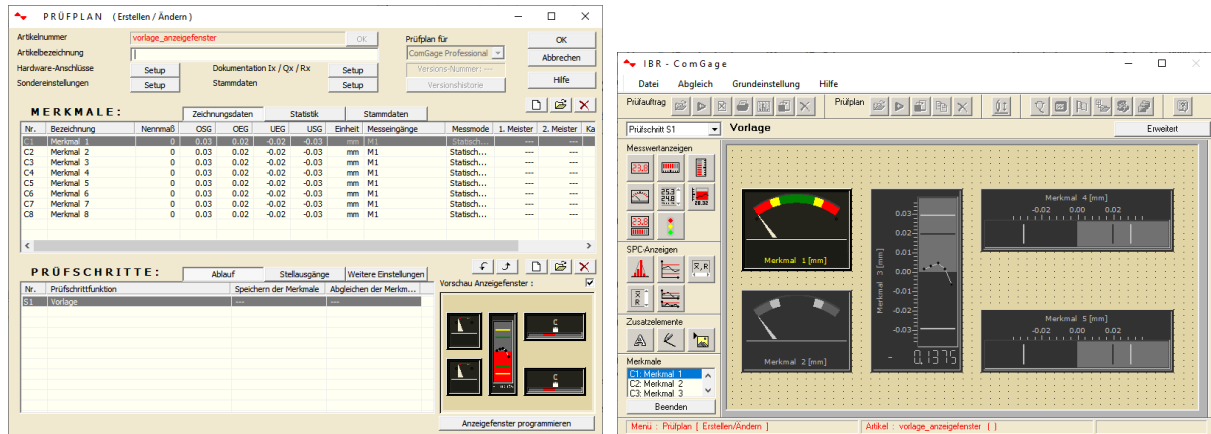
To create a display window template for a measuring step display window, proceed as follows :

1. Create a test scheme with 20 characteristics. The characteristic attributes and the formula for measurement value inputs to compute the characteristic value are not relevant.

2. Create a new test step. The test step does not need to contain any test step functions.

3. Change to programming of the display window of the recently created test step.

4. By the menu *Resolution*, you can change the resolution of the display window to the resolution of the target device for which you intend to create the display window template.

5. For designing a display window, a raster of 50 lines x 40 columns is used. Since the buttons for controlling the measuring sequence and the measuring step caption will be added automatically by ComGage Level 1 / Level 2, the first 6 and last 4 rows of the designed display window must be left empty.

6. Now you can add measurement value displays. For each measurement value display one of the characteristic C1 .. C20 must be assigned. In the measuring step the selected characteristics will be assigned to the measurement value displays the following way: The measurement value displays assigned to C1 will be assigned to the 1st selected characteristic of the display window template, the measurement value displays assigned to C2 will be assigned to the 2nd selected characteristic of the measuring step and so on.

7. If a measuring step contains less characteristics as the display window template is designed for, not assignable measurement value displays will be removed from the display window of the measuring step.

8. If a measuring step uses more characteristics than available in the display window template, not all characteristics of the measuring step will get a measurement value display assigned.

9. The selected background colour of the display window template will be used also in the display window of the measuring step.

10. The created display window template can be saved into a *.dwc file by pressing the <S> key. Already existing display window templates can be loaded by the <L> key for editing.

The display window templates (*.dwc files) need to be copied into the directory for test schemes. Afterwards, they can be selected in the measuring step configuration window.

Appendix A

Terms and Formulas used by the ComGage Level 2 SPC calculations

Average

The average value indicates the value around which the measuring results fluctuate. (corresponds with the maximum turning point of the bell-shaped curve)

Standard deviation

The standard deviation indicates with which absolute value the measuring results fluctuate around the average value. (corresponds with the width of the bell-shaped curve)

In the area of +/- one standard deviation around the average value are located on a normally distributed production process from statistical view: 68.26 % of all manufactured components.
In the area of +/- two standard deviations around the average value are located on a normally distributed production process from statistical view: 95.4 % of all manufactured components.
In the area of +/- three standard deviations around the average value are located on a normally distributed production process from statistical view: 99.73 % of all manufactured components.

Calculation of the estimated standard deviation σ:

Note :   *The standard deviation is estimated for Cp & Cpk values, because on measuring only samples of components there are not all measurement values of the manufactured components available for statistical calculations.*

Method "Sigma = Sges" :

$$\sigma = s_{ges} = \sqrt{\dfrac{\sum\limits_{i=1}^{n*k}(x_i - x_q)^2}{n*k-1}}$$

x_i : Measuring value i
x_q : Average of all measuring values
n : Sample size
k : Number of samples

Method "Sigma = Rq / Dn" :

$$r_j = \max\ j - \min\ j;\ range\ of\ sample\ j$$

$$\sigma = \dfrac{\sum\limits_{i=1}^{k} r_j}{k*d_n}$$

d_n : Table of constants, see DGQ – SPC2, page: 128

Method "Sigma = Sq / An" :

$$s_j = \sqrt{\dfrac{\sum\limits_{i=1}^{n}(x_{i,j} - x_{q,j})^2}{n-1}};\ Standard\ deviation\ of\ sample\ j$$

$$\sigma = \dfrac{\sum\limits_{i=1}^{k} s_j}{k*a_n}$$

a_n : Table of constants, see DGQ – SPC2, page: 128

Method "Sigma = sqr(…)" :

$$s_j = \sqrt{\frac{\sum_{i=1}^{n}(x_{i,j} - x_{q,j})^2}{n-1}} \; ; Standard\ deviation of\ sample\ j$$

$$\sigma = \sqrt{\frac{\sum_{j=1}^{k}s_j^2}{k}} = \sqrt{\frac{\sum_{j=1}^{k}\sum_{i=1}^{n}(x_{i,j} - x_{q,j})^2}{k*(n-1)}} = .\sqrt{\frac{\sum_{j=1}^{k}sum2,j - \frac{sum1,j * sum1,j}{n}}{k*(n-1)}}$$

$$sum1,j = \sum_{i=1}^{n}x_{i,j}$$

$$sum2,j = \sum_{i=1}^{n}x_{i,j} * x_{i,j}$$

$x_{i,j}$: Measuring value i of sample j
$x_{q,j}$: Average of sample j
n : Sample size
k : Number of samples

Cp - Value

The Cp - Value is calculated as shown below :

$$C_p = \frac{USL - LSL}{6*\sigma}$$

If the Cp - Value = 1, then from statistical view 99.73 % of the manufactured components are within the tolerance limits.
If the Cp - Value < 1, then from statistical view less than 99.73 % of the manufactured components are within the tolerance limits.
If the Cp - Value > 1, then from statistical view at least 99.73 % of the manufactured components are within the tolerance limits.

Cpk - Value

The Cpk - Value is calculated as shown below :

$$C_{pk} = MIN(\frac{USL - Xq}{3*\sigma} ; \frac{Xq - LSL}{3*\sigma})$$

The Cpk value is > 1.33 for a capable process.
With a Cpk value between 1.00 and 1.33, the process must be constantly monitored.

If Cpk << Cp and Cp > 1.00, then the process centring must be improved.