BT-Calibration User Manual

BT-Calibration is a calibration program for use with BTG's BT-5350/5400 brightness transmitters. This user manual describes the main functions of the program in overviews and step-by-step instructions.

BT-Calibration includes an example calibration database. This example database has been used in the figures and examples included in this user manual. The example database has been created manually however and does not represent a real calibration case.

Supported operating systems	Supported instruments
Windows 2000	BT-5350
Windows XP	BT-5400

Main Topics:

1 User Interface Overview

This section guides you through the basic elements of the BT-Calibration user interface. The overview provides a basic understanding of the user interface that will help you use subsequent sections of this manual.

Numbers within parentheses in the body text refer to callouts in the picture(s) within the same section.

Topics

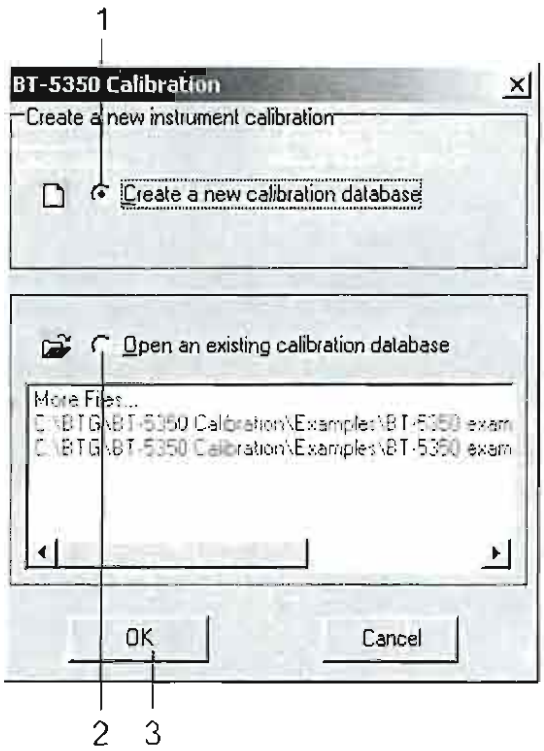
1.1 Startup Dialog

The BT-Calibration program initially requests whether you wish to create a new calibration database or continue updating an existing calibration database.

To create a new database, click **Create a new calibration database** (1) and then click **OK** (3). The Read Data Dialog (See section 1.9 on page 18) opens.

To open an existing database, click **Open an existing calibration database** (2). Then select a database from the list or use the file browsing dialog shown when you double-click the **More Files...** row. Click **OK** (3) when a file has been selected.

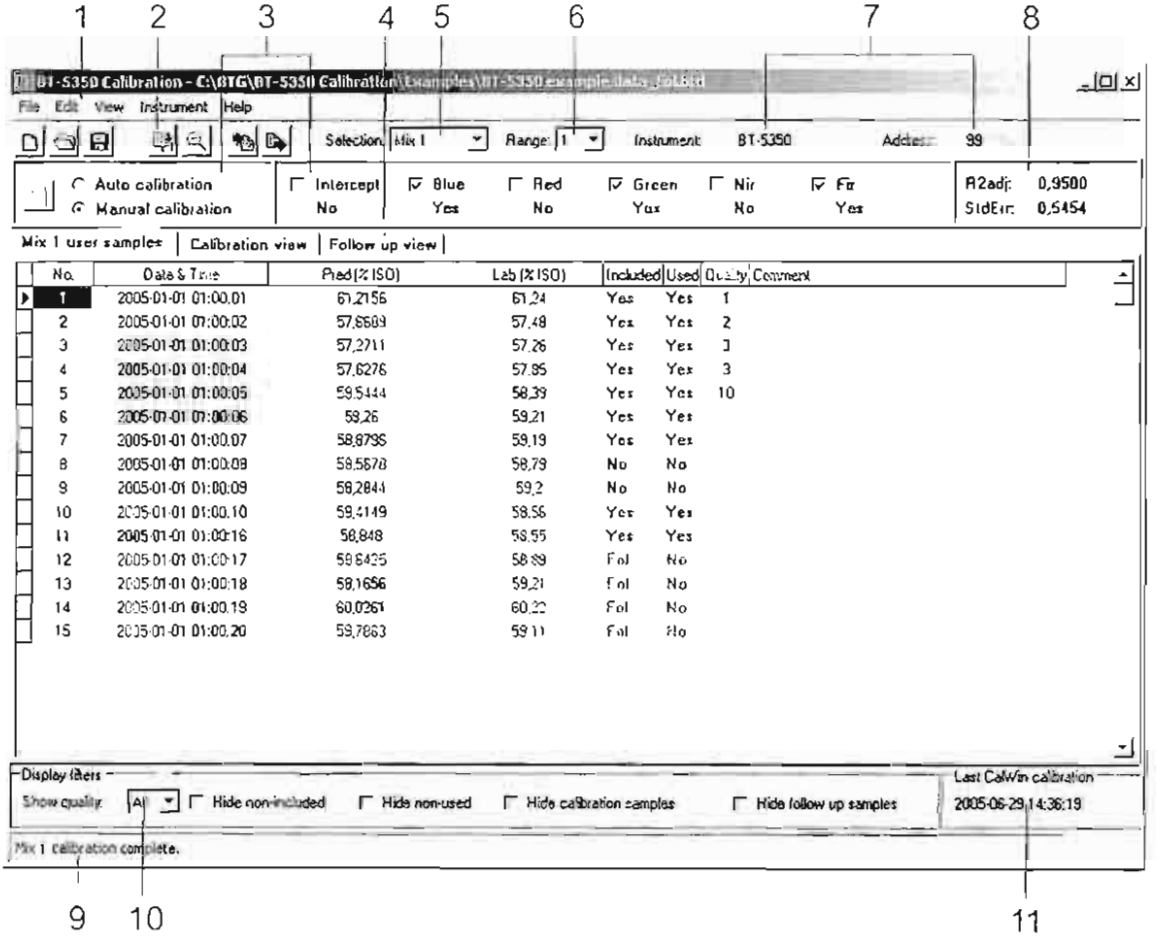
Startup file selection dialog



1.2 BT-Calibration Main Window

The BT-Calibration main window is displayed with the data from the selected database. The key elements of the window are explained in the table below.

BT-Calibration main window

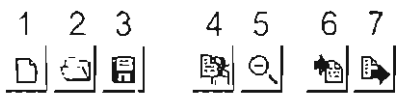


Element	Description
1	Menu Bar (See section 1.4 on page 7)
2	Toolbar Buttons (See section 1.3 on page 6)
3	Calibration Panels (See section 1.5 on page 9)
4	Tabs for the different sample data views (User Samples View, Calibration View, and Follow-up View)
5	Selection of mix 1-5. The number of each mix represent the corresponding output signal number of the transmitter.
6	Selection of range 1-4
7	Information about the current instrument (instrument type and instrument address)
8	The correlation and standard deviation of the calibration.
9	Status line displaying information messages
10	Display filters. When enabled, samples not matching the filter criteria may be hidden. See section 1.11: *Display Filters*.
11	Date and time setting on the PC when the last calibration was performed

1.3 Toolbar Buttons

The BT-Calibration toolbar, shown in the figure below, consists of seven toolbar buttons for quick access to the most commonly used functions in the program. Most of the button functions are also available from the Menu Bar (See section 1.4 on page 7).

Toolbar buttons



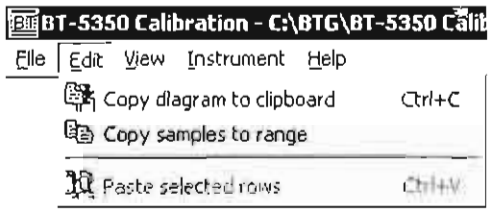
The toolbar buttons have the following functions:

Button	Button name	Description
1	New database	Creates a new calibration database
2	Open database	Opens an existing calibration database
3	Save database	Saves the current calibration database
4	Copy to clipboard	Copies a diagram to the Windows clipboard.
5	Unzoom	Unzooms a zoomed diagram
6	Read from instrument	Reads new sample data from an instrument
7	Send to instrument	Sends a new calibration to an instrument

1.4 Menu Bar

The BT-Calibration menu bar consist of five menus, from which most of the functions in the program can be reached. A short description of all menu commands is included in the table below.

BT-Calibration menu bar



File Menu	
Command	**Description**
New	Creates a new calibration database
Open	Opens an existing calibration database
Save	Saves the current calibration database
Save As	Saves the current calibration database with a different name
Exit	Exits the BT-Calibration program
Edit Menu	
Command	**Description**
Copy diagram to clipboard	Copies a diagram to the Windows clipboard buffer, from where it then can be pasted into another document or program that has the functionality for pasting images. The command can be used with the diagrams in the Calibration View and the Follow-up View.
Copy samples to range	Copies all samples with a specific quality to another range. See section 3.3: *Copy samples between ranges* for detailed step-by-step instructions on how to copy samples between ranges.
Paste selected rows	Pastes the content of the Windows clipboard into the *Lab value* or *Comment* cell(s) of the selected row(s). See section 3.4: *Paste sample data* for detailed step-by-step instructions on how to use the paste function.

View Menu	
Command	**Description**
Selection	Lets you select the mix (output signal) to calibrate from a submenu
Range	Lets you select the range to calibrate from a submenu
Display	Lets you select which view to be displayed in BT-Calibration from a submenu
Unit	Lets you specify the unit of the selected mix (output signal) (%ISO, %, PPM, PE, or none), from a submenu
Instrument Menu	
Command	**Description**
Read from instrument	Reads new sample data from an instrument
Send to instrument	Sends a new calibration to an instrument
Calibrate	Performs a new calibration
Help Menu	
Command	**Description**
Manual	Opens the BT-Calibration online manual
Manual for print	Opens a printable PDF-version of BT-Calibration manual
About	Opens the BT-Calibration information window

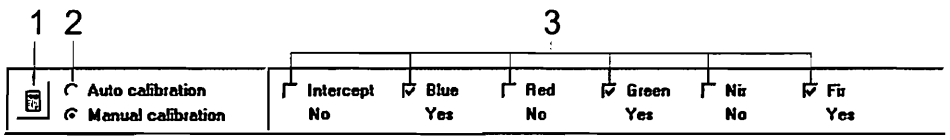
1.5 Calibration Panels

In the BT-Calibration user interface, there are two panels for management of the calibration settings.

In the left panel there are two option buttons (2) for selection between Auto or Manual calibration mode. These modes are described further on in this section. There is also a button (1), which is used to execute a new calibration (the **Calibrate** button).

The right panel consist of six check boxes (3); one for each variable that can be included in the calibration calculation. The available variables are *intercept* and each of the five BT color signals (blue, red, green, Nir, and Fir/UV). Depending on the selected calibration mode the check boxes are used to either specify variables to be included in the next calibration, or to display which *variables were used in the most recent calibration.* After a calibration has been performed the word *Yes* or *No* will appear below each check box to indicate whether or not the variable was significant in the calibration calculation.

Calibration panels



Auto calibration mode

Auto calibration mode is the standard calibration mode and is recommended for most users. When BT-Calibration is set to Auto mode, all six check boxes in the right calibration panel are greyed out and cannot be changed.

Before the calibration is performed all check boxes are automatically selected. During the calibration process, BT-Calibration will try to find the most optimal combination of variables (colors and intercept) to include in the calibration calculation. This process is further described in section 2: *Calibration Methods for BT-5350/5400*. When the calibration is completed, the check boxes for all significant variables, used in the calibration, are still selected and indicated with *Yes*, while the check boxes for all non-significant variables are cleared and indicated with *no*.

The calibration settings for the latest calibration will be displayed in the right panel until you once again press the **Auto calibration** option button, which will reset the panel, or until you switch to manual mode and manually change the settings.

At least ten samples are required to be able to perform a calibration in Auto mode.

Manual calibration mode

In manual calibration mode you have the possibility to manually specify which variables (colors and intercept) to be included in the calibration. All check boxes in the right panel can be selected or cleared freely.

During the calibration process, BT-Calibration will only use the selected variables in the calibration calculation. When the calibration is completed, the indicator text under each check box indicates whether or not the variable was significant for the calibration. If any included variable is indicated as not significant, it is highly recommended that it is removed and a new calibration is performed.

If more than one included variable is indicated as not significant, an asterisk is added to the indication of the least significant variable. Only one variable at a time should be removed between two calibrations.

Manual calibration mode should be used if less than 10 samples are available or if there are special demands for the calibration that are not fulfilled in Auto mode, e.g. a known color that must be included in a particular calibration.

1.6 User Samples View

The first of three sample data views is the User Samples View. The User Samples view is displayed when you select the leftmost tab, labeled "Mix X user samples" (where X is the currently selected mix). This view is the default view at startup of BT-Calibration, and displays sample data in a plain table. It is also the main view for editing.

The sample data displayed in the User Samples view is specific for the current selection of mix and range. Each column is described in the table below.

User Samples View columns

No.	Date & Time	Pred (% ISO)	Lab (% ISO)	Included	Used	Quality	Comment
1	2005-01-01 01:00:01	61,2156	61,24	Yes	Yes	1	
2	2005-01-01 01:00:02	57,6889	57,48	Yes	Yes	2	
3	2005-01-01 01:00:03	57,2711	57,26	Yes	Yes	3	
4	2005-01-01 01:00:04	57,6276	57,85	Yes	Yes	3	
5	2005-01-01 01:00:05	58,5444	58,39	Yes	Yes	10	
6	2005-01-01 01:00:06	59,26	59,2	Yes	Yes		
7	2005-01-01 01:00:07	58,8796	59,19	Yes	Yes		
8	2005-01-01 01:00:08	58,5678	58,79	No	No		
9	2005-01-01 01:00:09	58,2844	58,2	No	No		

Column	Description	May be edited	Value range
No.	Sample number	No	
Date & Time	The date and time the sample was taken according to the instrument settings.	No	
Pred	The calculated (predicted) sample value.	No	
Lab	The sample lab value.	Yes	
Included	Indicates whether the sample is to be included in the calibration or not. A Sample marked with *Fol* indicates that the sample is a follow-up sample, and is not included until changed to *Yes*	Yes	Yes, No, or Fol
Used	Indicates whether or not the sample was included in the last performed calibration. Note that the last calibration may not have been sent to the instrument.	No	
Quality	A value for grouping samples in a range into different quality groups. The quality value is common for all mixes.	Yes	1-10 or empty
Comment	A free text comment attached to a sample. Comments are common for all mixes.	Yes	Free text, max 45 characters

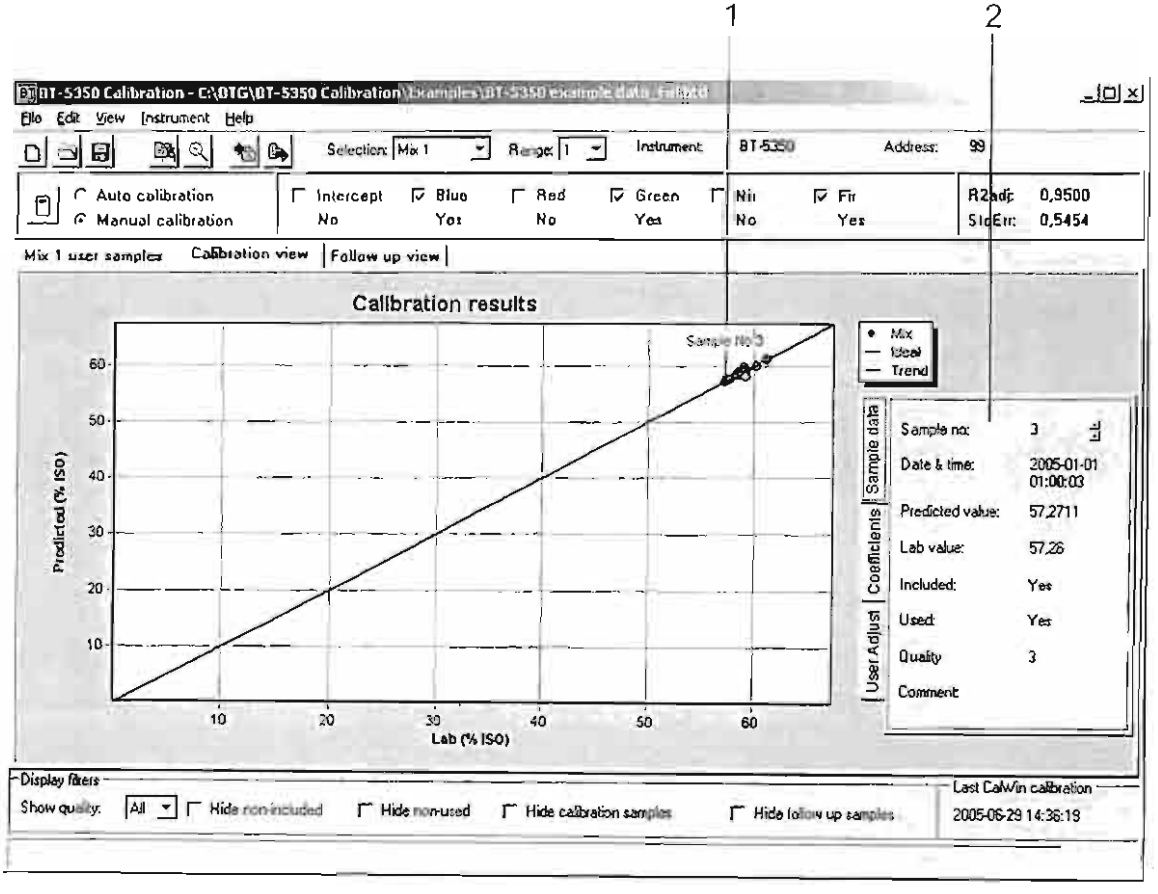
1.7 Calibration View

The second of the three sample data views is the Calibration View. Its main purpose is to display predicted sample values for a specific range, in relation to the corresponding lab values. Primarily for samples present when the calibration was made.

Each sample is shown as a blue, green, or red dot in the diagram. Blue dots represent samples that are marked as included, as well as used in the last calibration, green dots represent follow-up samples, while red dots represent all other cases. When clicking on a sample dot, the sample number is displayed in the diagram (1) and the corresponding sample data is shown in the information box to the right (2).

Sample data cannot be edited from this view, with the exception of the *Included* value. To change this value, right-click on a sample and select a value from the pop-up menu.

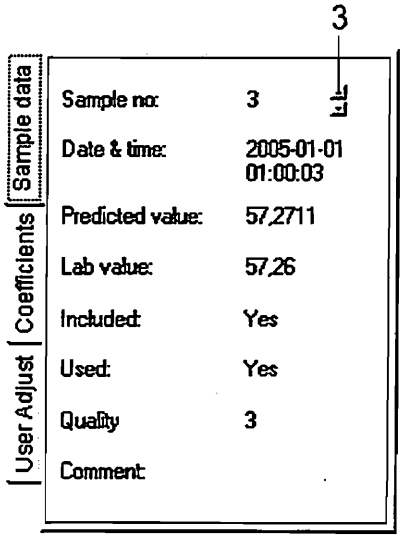
Calibration View



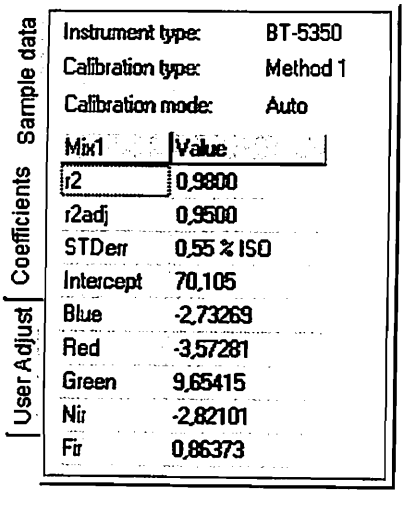
Calibration View Information Box

The information box, at the right hand of the calibration view, shows properties for the current calibration, and also offers the possibility to customize some of the calibration properties. The calibration properties are shown in three separate tabs:

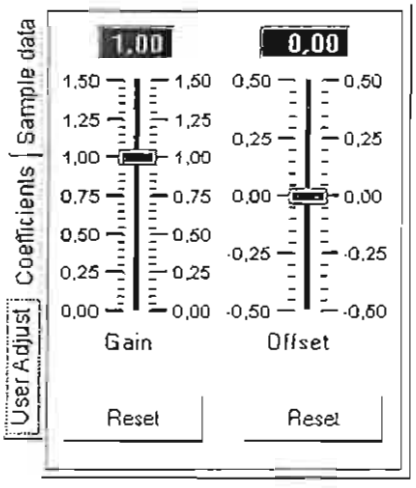
- The **Sample data** tab shows sample data for the selected sample. The data shown is the same as displayed in the table of the User Samples View (see section 1.6 on page 11). It is possible to step through the samples using the arrow button control (3).



- The **Coefficients** tab shows correlation coefficients (r2, r2adj), Standard deviation (STDerr), and calibration variables. These variables are further described in section 2: *Calibration Methods for BT-5350/5400.*



- In the **User Adjust** tab, there are two sliders that can be used to set user defined values for the gain and offset of the calibration trend curve. More information on when user defined gain and offset values are required can be found in section 2: *Calibration Methods for BT-5350/5400.*

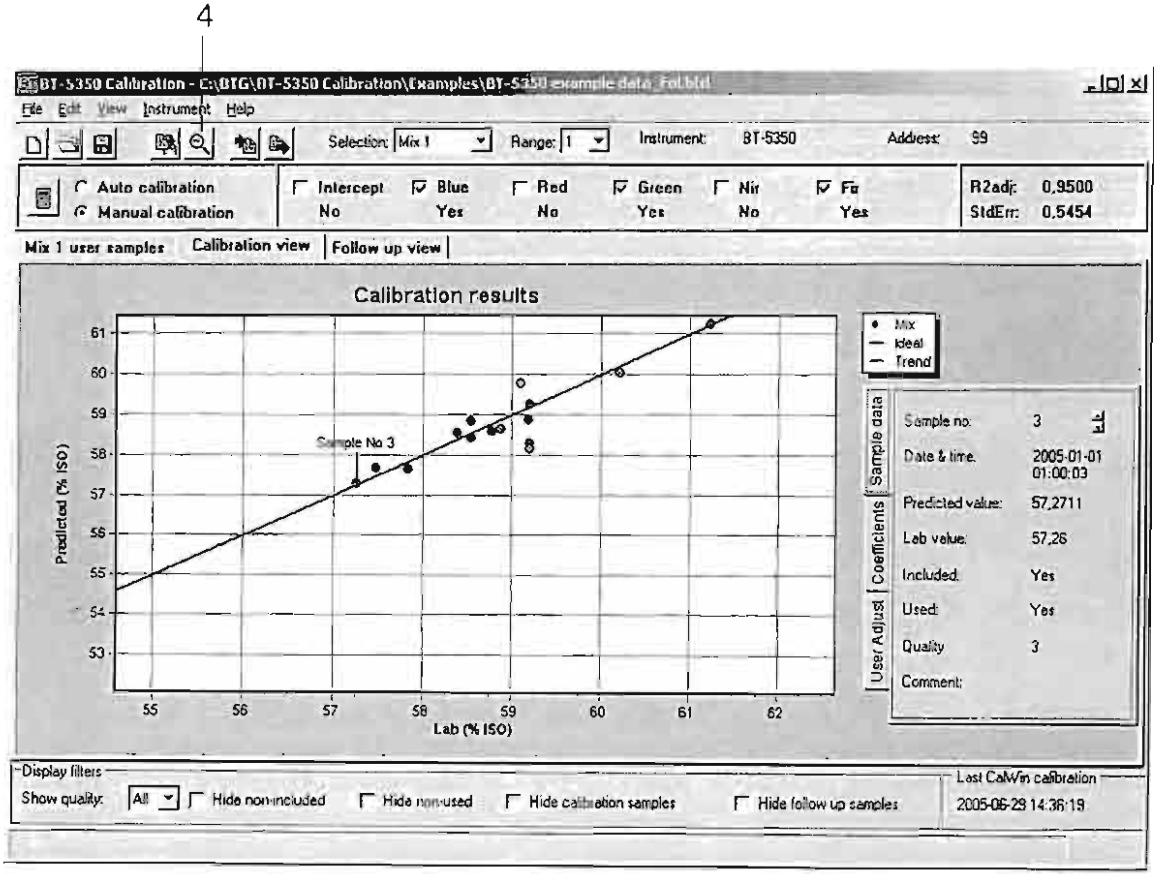


Zoom and Scrolling in Calibration View

A zoom function is available to more closely view part of a diagram.
To zoom in an area of the diagram, use the left mouse button and draw a rectangle from the top left corner to the bottom right corner of the area you wish to enlarge. The contents of the rectangle will be displayed as the new diagram and the axis values will be modified. To zoom out, click on the zoom-out button in the BT-Calibration toolbar (4).

To scroll a diagram, press and hold the right mouse button, then move the mouse in desired direction.

Zoomed diagram

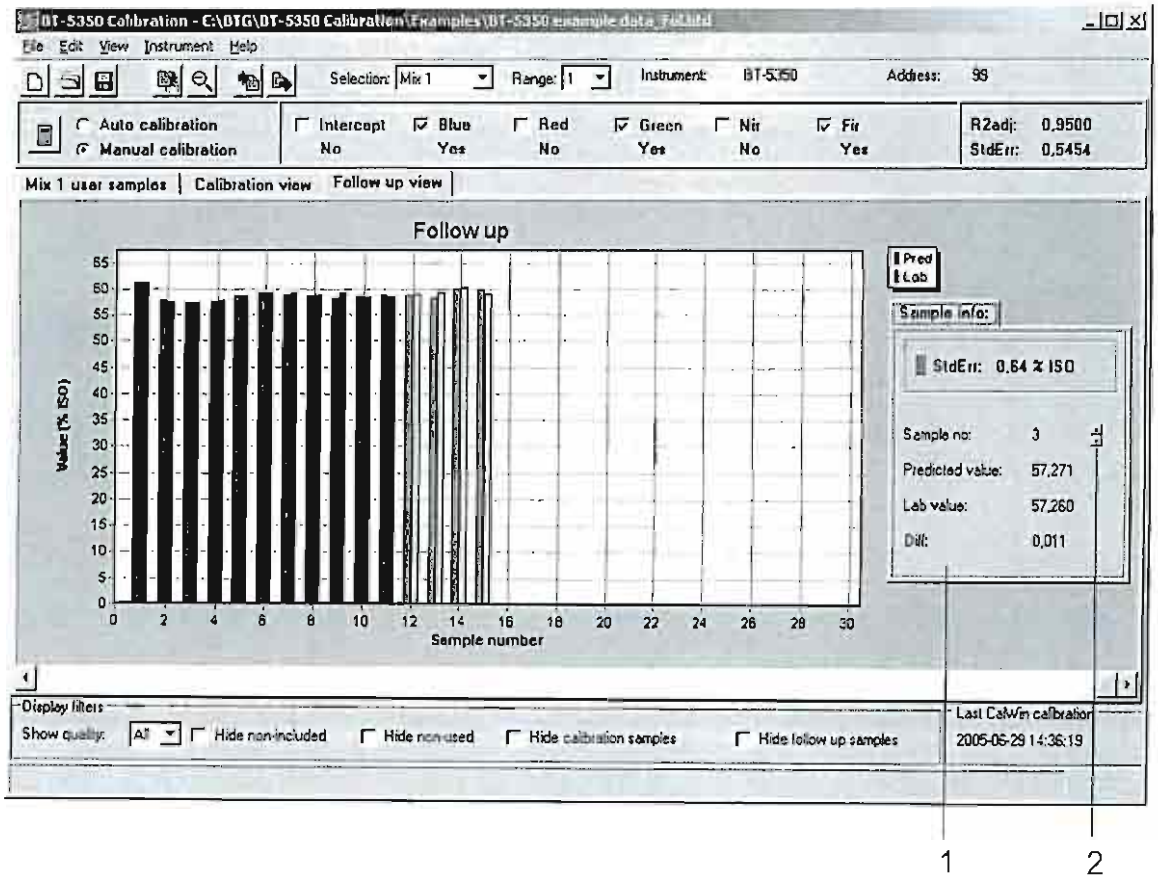


1.8 Follow-up View

The third sample data view is the Follow-up View. The Follow-up View displays a bar chart where the predicted value (red and green bars) for each sample is presented in pairs with the corresponding lab value (blue and grey bars). This view is read-only and is primarily used to follow up on a calibration by viewing the samples taken after the calibration was made. The follow-up sample bars are distinguished from other samples by separate colors, normal sample bars are red and blue while follow-up sample bars are green and grey.

Click on a bar to show the corresponding sample data in the information box (1) to the right. It is possible to step through the samples using the arrow button control (2). The information box also shows the standard error of the follow-up samples.

Follow-up View

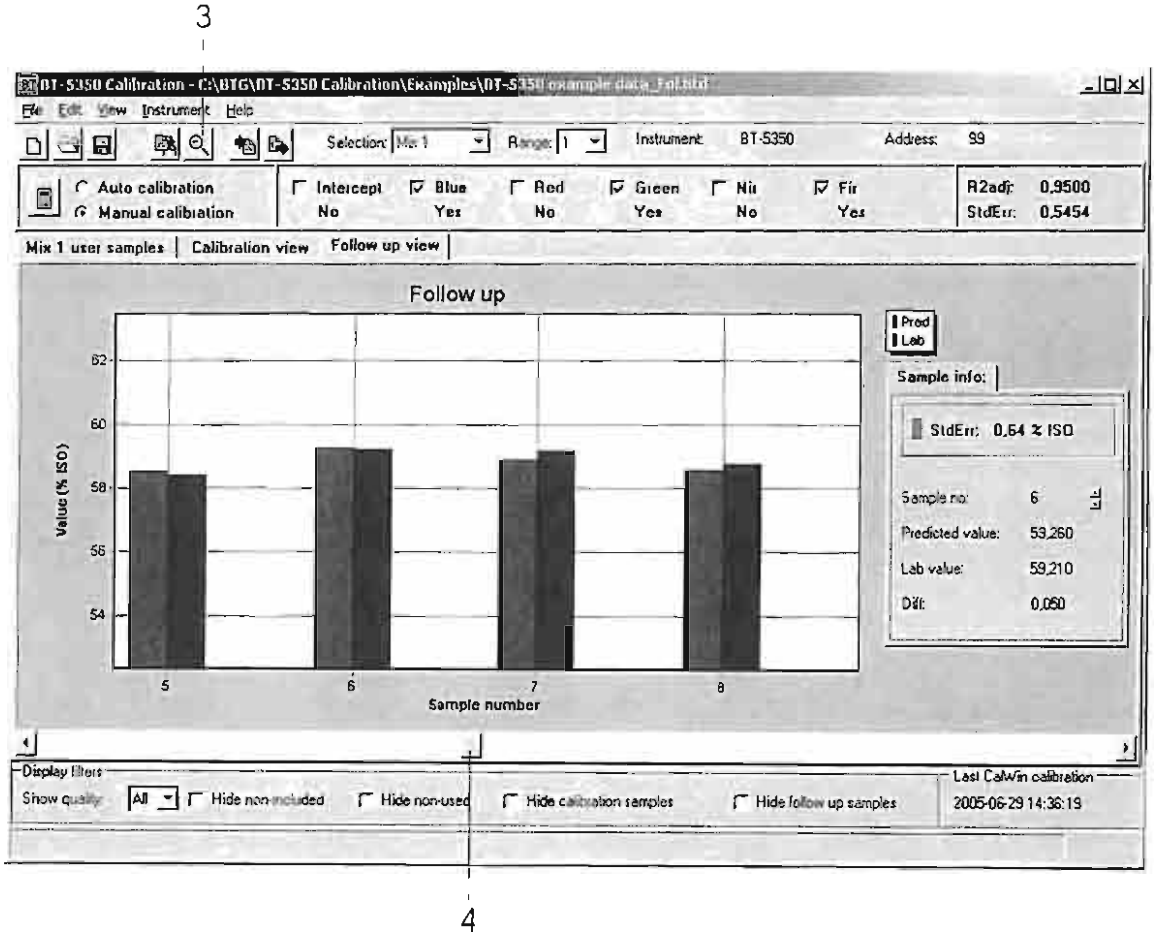


Zoom and Scrolling in Follow-up View

A zoom function is available to more closely view part of a diagram.
To zoom in an area of the diagram, use the left mouse button and draw a rectangle from the top left corner to the bottom right corner of the area you wish to enlarge. The contents of the rectangle will be displayed as the new diagram and the axis values will be modified. To zoom out, click on the zoom-out button in the BT-Calibration toolbar (3).

The bar chart in the Follow-up view can display up to 30 samples at the same time when zoomed out. If more samples are included, the bar chart can be scrolled horizontally, using the scroll bar (4). A zoomed bar chart can also be scrolled both horizontally and vertically by pressing and holding the right mouse button, and then moving the mouse in desired direction.

Zoomed diagram



1.9 Read Data Dialog

The Read Data Dialog is used when sample data is to be read from an instrument to BT-Calibration. The dialog appears when **Create a new calibration database** is selected in the Startup Dialog (see section 1.1 on page 3). It can also be opened manually from the program by clicking **Read from instrument** on the **File** menu, or by clicking the **Read from instrument** button in the toolbar.

Before sample data can be read, there are some information that has to be specified in the Setup area (1) of the Read Data dialog:

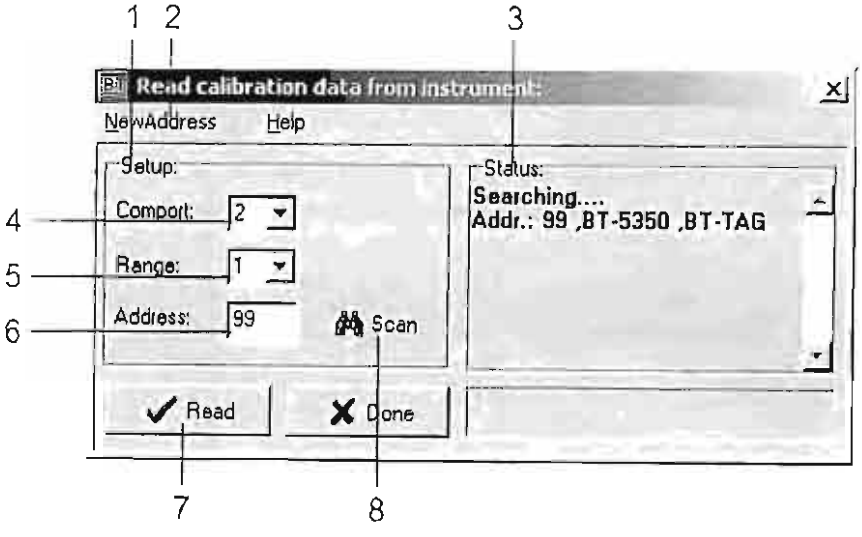
- In the **Comport** box (4), the COM port used by the PC for communication with the instrument must be specified. Only the COM ports available when BT-Calibration was started can be selected from the box.
- In the **Range** box (5), the desired range(s) for the calibration must be specified.
- In the **Address** box (6), the address of the instrument to read sample data from must be specified.

If the instrument address is unknown, it is possible to search for connected instruments by clicking **Scan** (8). All connected instruments will be presented, together with their instrument addresses, in the Status area (3). Double-click on an instrument address in the Status area to copy it to the address field (6).

It is also possible to change the instrument address of a connected instrument from the Read Data dialog. To do this, first enter the current address of a connected instrument in the address box. Then click the **NewAddress** menu (2) and choose **Set**. In the dialog that appears, enter the new instrument address and click **OK**.

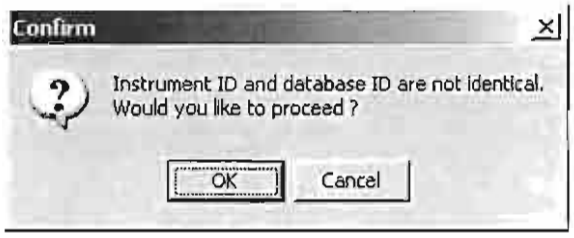
When all information has been specified in the Setup area, click the **Read** button (7) to start reading samples from the instrument.

Read data dialog



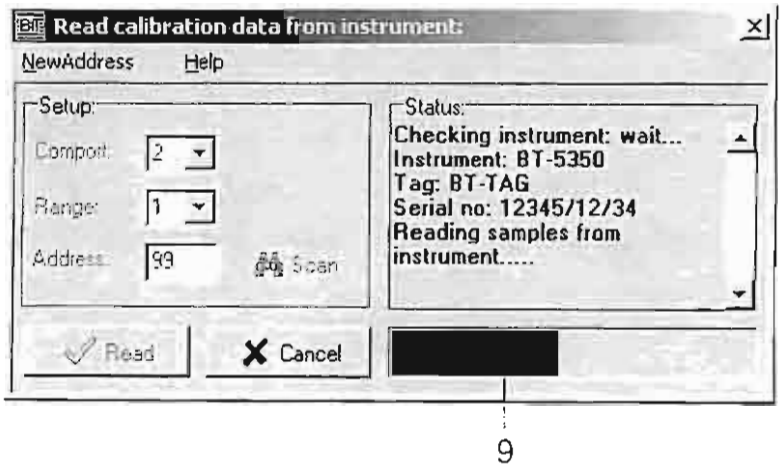
If additional samples are to be read to an existing database, the serial number of the chosen instrument is compared to the serial number of the instrument used when the database was created, before BT-Calibration starts reading sample data. If the serial numbers do not match, the following warning message is displayed. Clicking **OK** will make BT-Calibration ignore the mismatch and proceed reading sample data. Clicking **Cancel** will abort the read data process and enable you to open another database or choose another instrument.

Serial number mismatch



While BT-Calibration reads sample data from the instrument, a status bar (9) indicates the progress of the reading process. It is possible to abort the read process by clicking Cancel. This will discard all retrieved sample data.

BT-Calibration reads sample data from an instrument

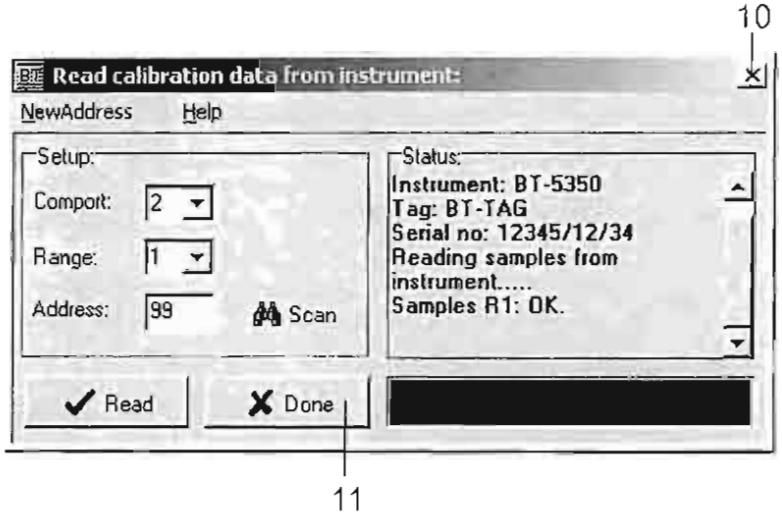


When all samples have been successfully retrieved, "Samples Rx: OK" will be displayed in the status area, where x is the selected range number.

To use the retrieved sample data and return to the BT-Calibration main window, click the **Done** button (11).

It is also possible to return to the BT-Calibration main window without keeping the retrieved sample data. This is done by clicking the **X** button (10) in the upper right corner of the Read Data dialog.

Finished reading sample data



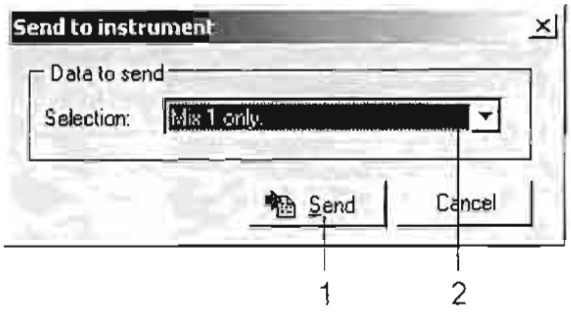
If any errors occur before or during the read process, an error message will appear in the Status area. See section 4: *Trouble Shooting* for more information.

If the read process fails or if the retrieved samples are discarded intentionally or otherwise, a standard Windows alarm sound will indicate that no sample data was saved to BT-Calibration.

1.10 Send Data Dialog

The Send Data Dialog is used when a calibration is to be sent from BT-Calibration to an instrument. To open the dialog, click **Send to instrument** on the **File** menu or click the **Send to instrument** button in the speed button row. In the dialog that appears, choose the mix (2) to send calibration data for, and then click **Send** (1). The current database will be saved automatically.

Choose selection



Before a calibration can be sent, some settings must be made in the Setup area (3) of the Send Data dialog:

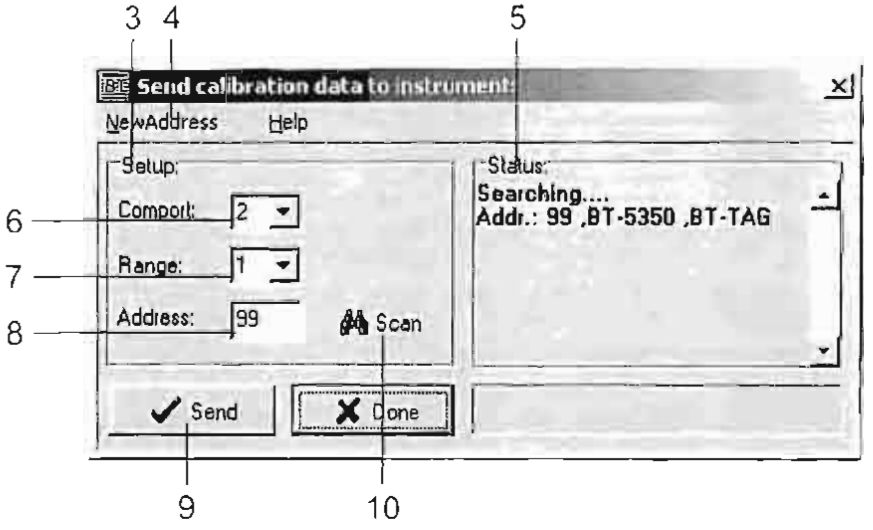
- In the **Comport** box (6), the COM port used by the PC for communication with the instrument must be specified. Only the COM ports available when BT-Calibration was started can be selected from the box.
- In the **Range** box (7), the desired range(s) for the calibration must be specified.
- In the **Address** box (8), the address of the instrument to send a calibration to must be specified.

If the instrument address is unknown, it is possible to search for connected instruments by clicking **Scan** (10). All connected instruments will be presented, together with their instrument addresses, in the Status area (5). Double-click on an instrument address in the Status area to copy it to the address field (8).

It is also possible to change the instrument address of a connected instrument from the Send Data dialog. To do this, first enter the current address of a connected instrument in the address box. Then click the **NewAddress** menu (4) and choose **Set**. In the dialog that appears, enter the new instrument address and click **OK**.

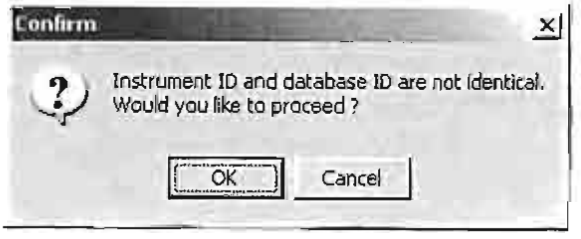
When all information has been specified in the Setup area, click the **Send** button (9) to start sending the calibration to the instrument. BT-Calibration will automatically force the selected instrument channel (Aout*) to Mix calibration mode.

Send data dialog



Before BT-Calibration starts sending calibration data, the serial number of the selected instrument is compared to the serial number of the instrument used when the database was created. If the serial numbers do not match, the warning message shown in the figure below is displayed. Clicking **OK** will make BT-Calibration ignore the mismatch and proceed sending calibration data. Clicking Cancel will abort the send data process and give you the possibility to open another database or choose another instrument.

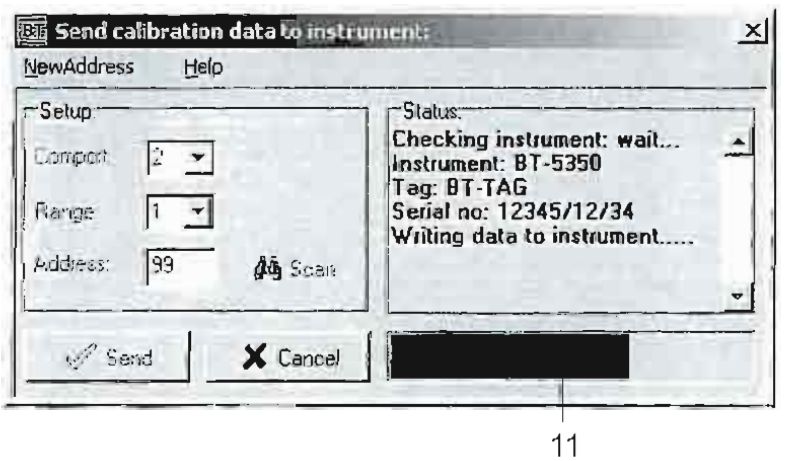
Serial number mismatch



While BT-Calibration sends the calibration data to the instrument, a status bar (11) indicates the progress of the send process. The status bar only indicates progress if a calibration has been made for the selected range. If All ranges has been selected in the **Range** box, but a calibration does not exist for some ranges, the status bar will stop before reaching 100%. The existing calibrations are, however, sent to the instrument anyway.

It is possible to abort the send process by clicking **Cancel**.

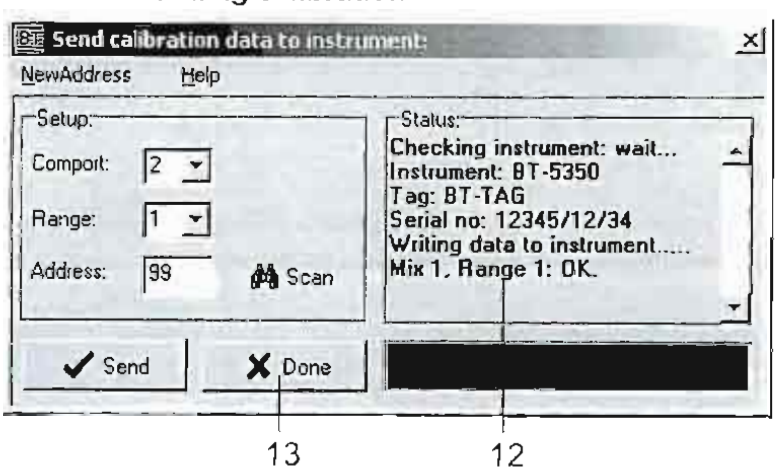
BT-Calibration sends calibration to an instrument



When the calibration has been successfully sent, it is indicated in the status area (12).

To close the Send Data dialog and return to the BT-Calibration main window, click the **Done** button (13).

Finished sending calibration



If any errors occur before or during the send process, an error message will appear in the Status area. See section 4: *Trouble Shooting* for more information.

If the send process fails or is cancelled by the user, a standard Windows alarm sound will indicate that no calibration data was sent to the instrument.

1.11 Display Filters

While using BT-Calibration, it is often useful to display only a subset of the samples in the database. This can be done by using display filters. Applying a filter sets a condition which each sample has to meet, otherwise the sample is not displayed. Note that samples are never removed from the database using filters. The filtering function is simply a display function.

BT-Calibration has five different filters. These can be used separately or in combination. Note that some filters are mutually exclusive. If these are enabled at the same time an empty set of samples will be displayed.

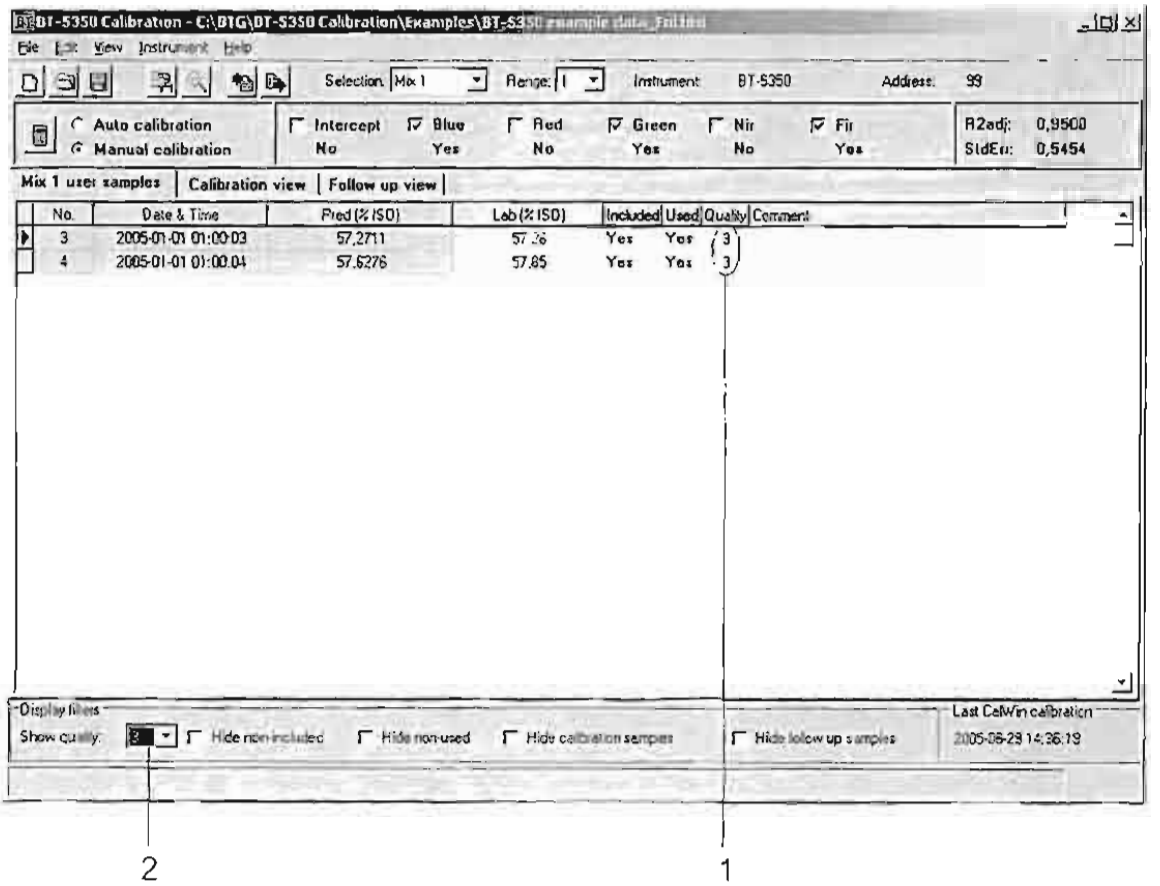
Opening a database will automatically reset all filters. The same applies when other sample set changes are made, for example when changing to a different range. Filters are not reset when switching between different mixes as these are parts of the same set of samples.

Filter Index

1.11.1 "Show quality" filter

The "Show quality" filter is used to display samples of a certain quality (1) only. The preferred quality value is selected from the leftmost menu control in the *Display filters* section of the BT-Calibration main window (2). The filter is disabled by selecting *All* as preferred quality.

Result of using the "Show quality" filter

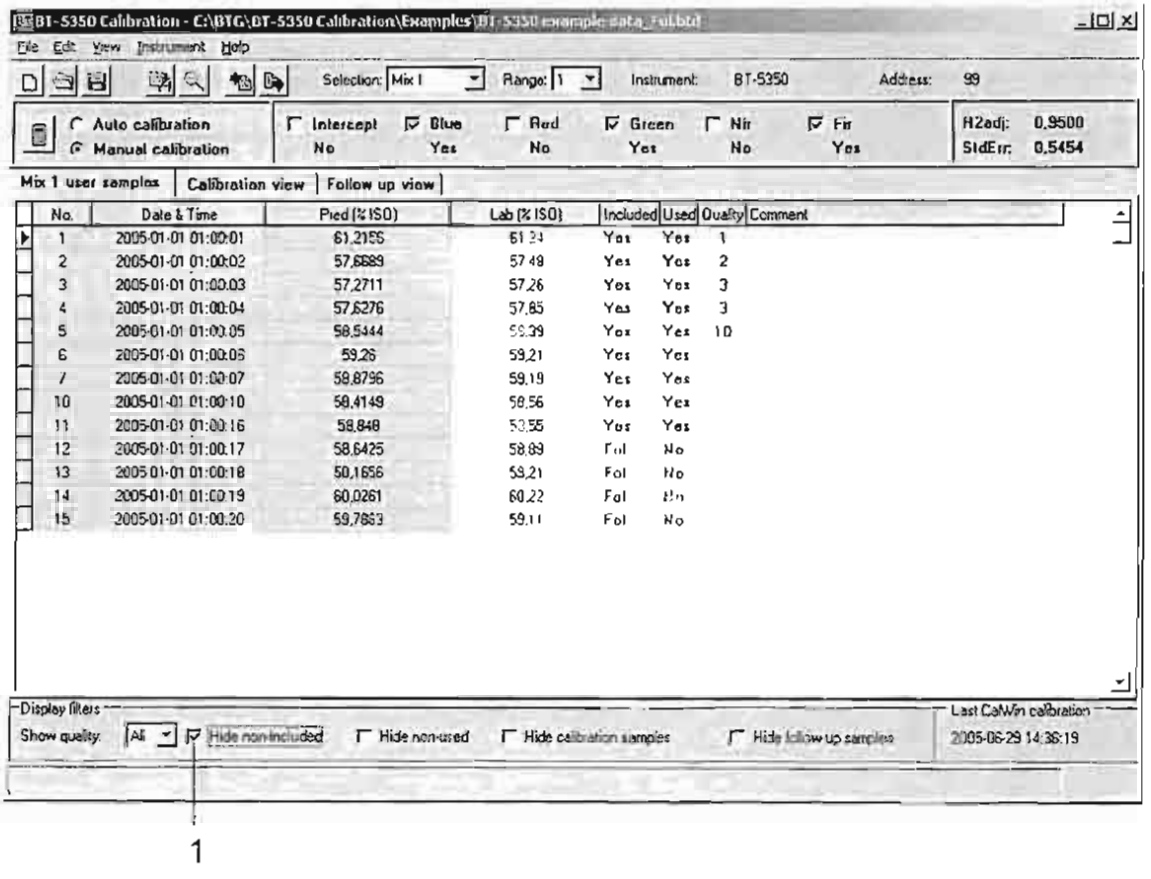


1.11.2 "Hide non-included" filter

The "Hide non-included" filter hides all samples marked to not be included in the next calibration, with the exception of follow-up samples. This makes the filter most useful in combination with other filters.

The filter criteria is that all samples with *No* as value in the *Included* column for the current mix selection are hidden. The filter is activated by marking the check box (1).

Result of using the "Hide non-included" filter

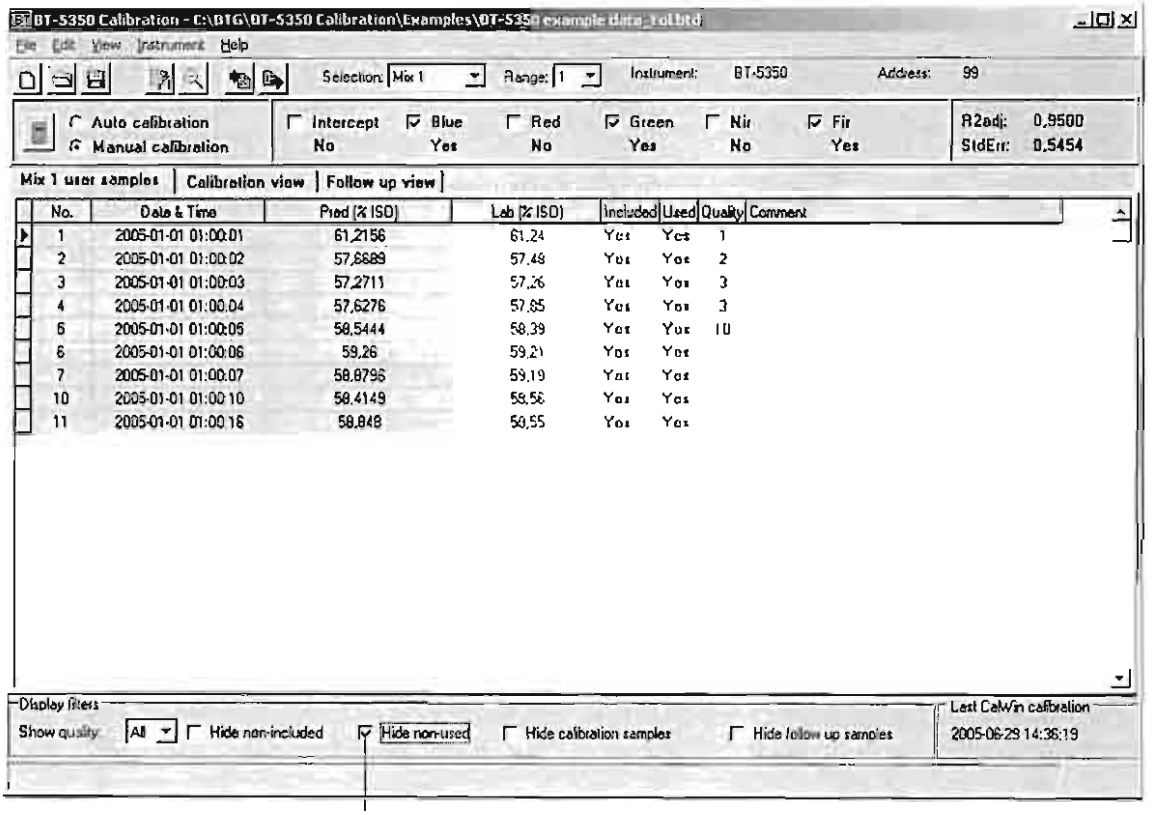


1.11.3 "Hide non-used" filter

The "Hide non-used" filter is used to display only the samples that were included in the last calibration.

The filter criteria is that all samples with *No* as value in the *Used* column for the currently selected mix are hidden. The filter is activated by marking the check box (1).

Result of using the "Hide non-used" filter

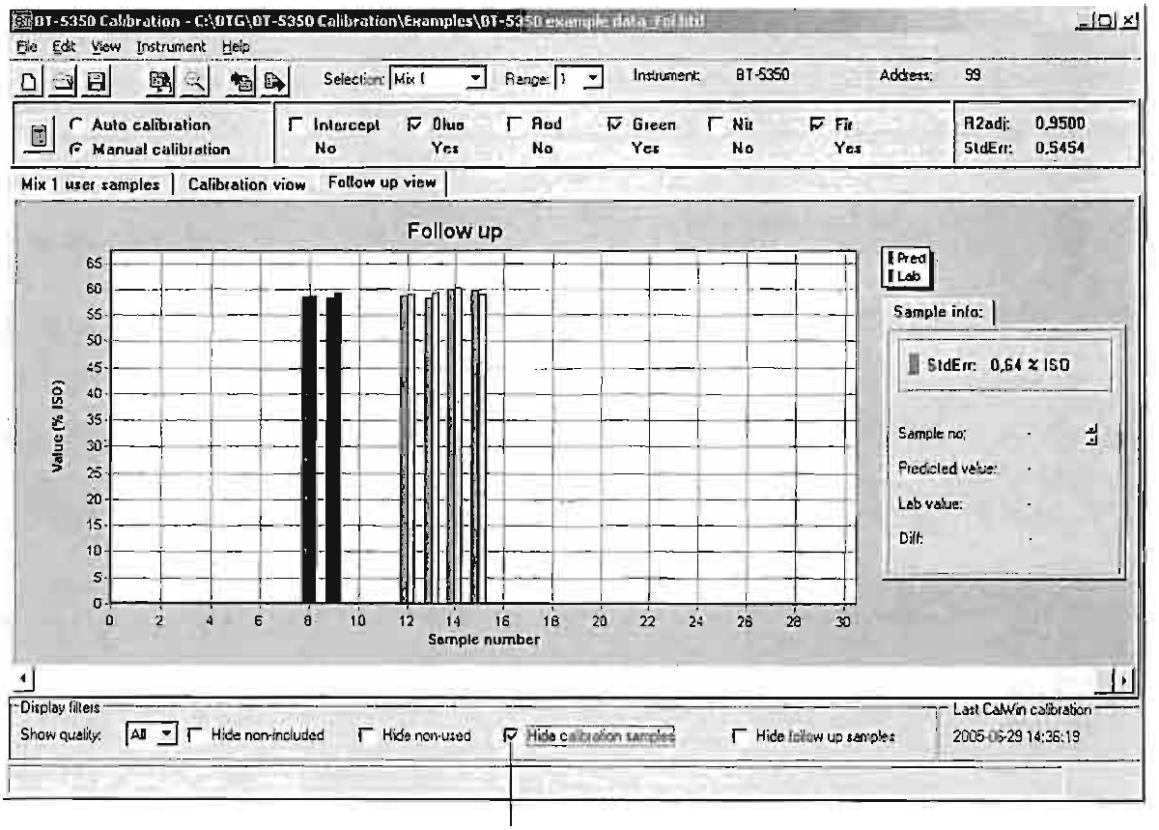


1.11.4 "Hide calibration samples" filter

The "Hide calibration samples" filter hides all samples that were included in the last calibration and is therefore most useful in the Follow-up View.

The filter criteria is that all samples with *Yes* as value in the *Used* column for the currently selected mix are hidden. The filter is activated by marking the check box (1)

Result of using the "Hide calibration samples" filter

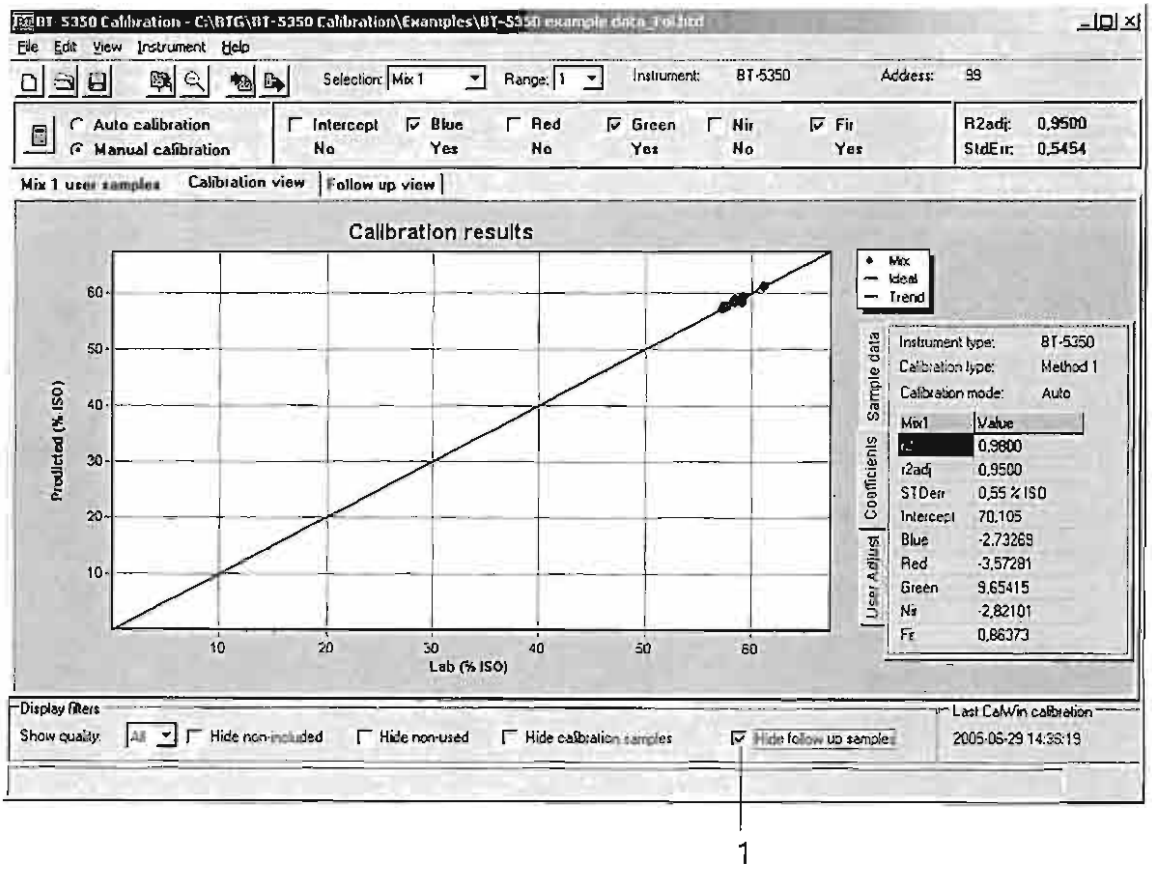


1.11.5 "Hide follow-up samples" filter

The "Hide follow-up samples" filter hides all follow-up samples that have been loaded to BT-Calibration since the last calibration was performed. Therefore it is most useful in Calibration View, since the user can remove all follow-up samples and focus on those that were present when the calibration was performed.

The filter criteria is that all samples with *Fol* as value in the *Included* column for the current mix selection are hidden. The filter is activated by marking the check box (1)

Result of using the "Hide follow-up samples" filter



2 Calibration Methods for BT-5350/5400

The BT-5350/5400 sensor may take advantage of an automated mix calibration method, aiming at providing accurate and robust calibration models with minimum effort from the user. This chapter summarizes the employed method implemented in the BT-Calibration program.

Topics

2.1 Introduction

Complexity levels

The algorithm chooses an appropriate model complexity level depending on a number of factors. Certain criteria must be fulfilled before a higher complexity level is chosen, in order to achieve a robust calibration model.

Calibration samples

As in all indirect measurements one is dependant on the quality of the provided reference data, i.e. the accuracy of the sampling and the laboratory consistency determination, and also the synchronization between the sampling and the instrument reading. All estimates of model performance, e.g. standard error, will also require that the calibration samples are fully representative for future samples.

Natural guidelines for successful sampling are as follows

- Accurately determined reference values (see above).
- Large variability, i.e. low and high consistency samples.
- When applicable, samples should cover variations in composition (content of fibres, fines and fillers).
- Use many calibration samples, e.g. at least 10 samples are needed for at all exploiting the full potential of the calibration algorithm.
- Samples should be representative of future measurements.

Abbreviations:

MLR	Multiple Linear Regression
STDerr	Standard Deviation Error

2.2 Guidelines for the UV-channel in BT-5400 UV

The UV-channel in the BT-5400 UV measures fluorescence, which may appear from FWA present in the pulp. An optical filter is used in front of the detector transmitting only the part of the emitted UV-light which is reflected in the visible wavelength region. Thus, the part of the UV-light which is reflected as UV is removed. Subsequently, pulps without FWA will have a measured signal at zero, or very close to zero, for the UV channel.

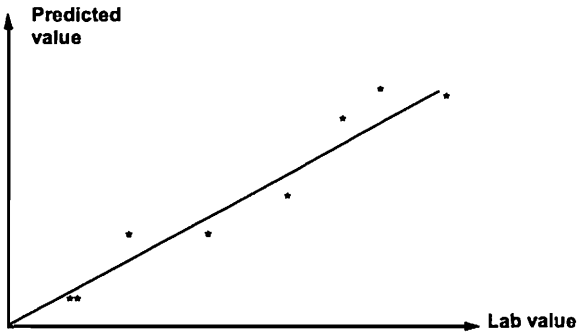
Since the UV-channel measures only the fluorescence component of the reflectance, it must be calibrated using a different reference than the other channels; a fluorescent paper. For the 'high' reference, this paper is put on the probe tip with the common reference cup then put on top of it, and for the 'low' reference the dark side of the reference is used. The value to be used for the 'high' reference thus is the fluorescence component of the brightness of the standard fluorescent paper, typically approximately 10 % ISO, and the value for the 'low' reference is zero, corresponding to no fluorescence.

For tuning of the calibration it is recommended that process samples are taken covering the intended span of operation, with respect to the brightness parameters of interest. Depending on application this may be one or more of the following three:

1. Brightness according to laboratory standard with UV-filter, i.e. without the fluorescence component.
2. Brightness according to laboratory standard without UV-filter, i.e. including the fluorescence component.
3. The difference between 1 and 2, i.e. the fluorescence component only. If more than one of them are to be used, then they should be varied independently in order to achieve a robust calibration.

In BT-Calibration the channels to be included in the calibration procedure can be set, provided that manual calibration mode is used. For all parameters without influence of fluorescence, such as brightness according to the laboratory method with UV-filter, L*a*b* and ERIC, the UV-channel should be de-activated in order to avoid overfitting. Subsequently, for calibrating parameters with influence of fluorescence, such as brightness according to the laboratory method without UV-filter, or the fluorescence component itself, the UV-channel naturally must be activated. Furthermore, for calibrating the brightness according to the laboratory method without UV-filter, in addition to the UV-channel also at least one of the RGB LED's must be activated, presumably the blue one.

2.3 Calibration Method 1: MLR Calibration



Formula: Pred = b0 + b1*Blue + b2*Red + b3*Green + b4*Nir + b5*Fir

Due to the nature of MLR it's not possible to show the relationship between the variables in a simple plot. Therefore the above plot shows the output from the MLR calibration.

Calibration

The constants b0-b5, are adjusted in a least-square sense to obtain a proper relationship between the reference values and the predicted values.

Lab = MLR(Blue, Red, Green, Nir, Fir/UV) which gives b0-b5.

In auto mode:

Every variable are tested if they are statistically significant and automatically stepwise removed if proved not. The optimization is fulfilled when the remaining variables are significant.

In manual mode:

The user selected variables are used in the MLR calculation. The variables are analyzed if they are statistically significant and marked No if not.

The optimization is controlled by the user.

Criteria

1. In auto mode the number of samples must be 10 or more.
2. In manual mode the number of samples needed depends on the number of activated variables (Intercept, Blue, Red, Green,.....).

Considerations:

There may be difficulties when the calibration points are clustered together. In this case there may be negative correlation. In this case a warning is given to disable bad samples in order to produce a positive correlation factor, r^2.

The formula used for the prediction error ('standard error') is corrected for the number of degrees of freedom according to equation 1 below:

Equation 1

$$STDerr = \sqrt{\frac{\sum_{i=1}^{n} (y_i - \hat{y}_i)^2}{n - p}}$$

y = Reference value

$\hat{y}$ = Predicted value

n = Number of calibration samples

p = Number of parameters in the model

2.4 Estimates of Model Performance

The standard error (STDerr) of the chosen method is presented. It is a good estimate of the expected uncertainty of future predictions. Also shown is the correlation coefficient r^2 according to equation 2, which reflects the degree of variance explained by the model.

Equation 2

$$r^2 = 1 - \frac{\sum_{i=1}^{n} (y_i - \hat{y}_i)^2}{\sum_{i=1}^{n} (y_i - \bar{y})^2}$$

A correlation coefficient adjusted for degrees of freedom, r^2adj is also shown. The corresponding expression is shown in equation 3

Equation 3

$$r^2_{adj} = 1 - \frac{\left(\sum_{i=1}^{n} (y_i - \hat{y}_i)^2\right)/(n-p)}{\left(\sum_{i=1}^{n} (y_i - \bar{y})^2\right)/(n-1)}$$

where *p* is the number of parameters in the model. Compared with the classical r^2 this is arguably a better measure of the goodness of fit of the calibration. Note that r^2, r^2adj and STDerr are not affected by user offset and user Gain.

There may be cases where too little information is provided to calculate coefficient r^2 or r^2adj. This is indicated by "Na" (Not applicable). Add more samples until the number of samples is greater than the number of parameters.

There may be cases where the calculation model fails and gives negative values for coefficient r^2 or r^2adj. This is indicated by "Neg". Some samples may be bad. Try to disable suspect samples.

The formula used for the follow-up prediction error ('standard error') is shown in equation 4 below:

Equation 4

$$STDerr = \sqrt{\frac{\sum_{i=1}^{n} (y_i - \hat{y}_i)^2}{n-p}}$$

y = Reference value

$\hat{y}$ = Predicted value

n = Number of calibration samples

p = Number of parameters in the model

2.5 Verification in MS Excel

The calibration model is presented as a plot of the predicted values versus the reference values. The model parameter estimate is however optimized with respect to the reference values, which correspond statistically to an assumption that there are errors in the reference values but not in the raw signals.

In order to verify the calculation of the r^2 value, the x- and y-axis should be switched and the reference values plotted versus the predicted values. A zero intercept should be used in the regression line.

This is because the offset is deemed insignificant even though a method utilizing the offset in the model determination has been chosen, thus a 'free' regression line will still pass the origin of coordinates. The correlation coefficient r^2 will be the same, while r^2adj is not calculated in Excel.

The standard error calculation (STDerr) can be verified using the corresponding expression in the appropriate calibration method equation.

3 Step-By-Step Instructions

Topics

3.1 Make a calibration for the first time

This chapter will guide you through the steps required to perform a calibration for the first time.

Before you start using BT-Calibration you will need to take a number of lab samples using the instrument. For an a calibration in Auto mode at least ten samples are required, while in Manual mode at least one sample per included variable is required. You will not be able to make a calibration of your instrument without these lab samples.

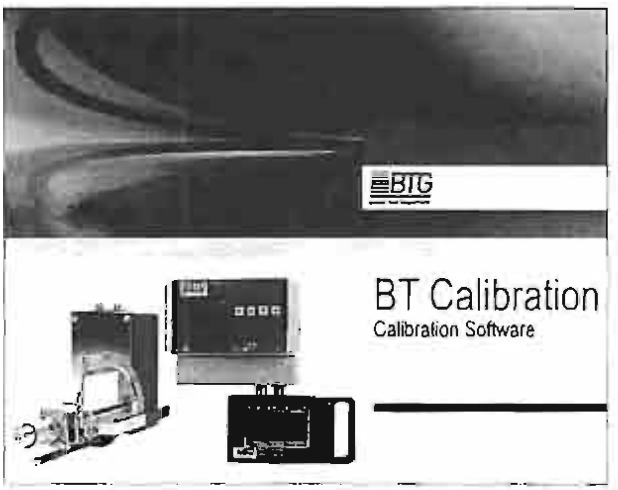
Numbers within parentheses in the body text refer to callouts in the picture(s) within the same section.

Index:

3.1.1 Create a new calibration database

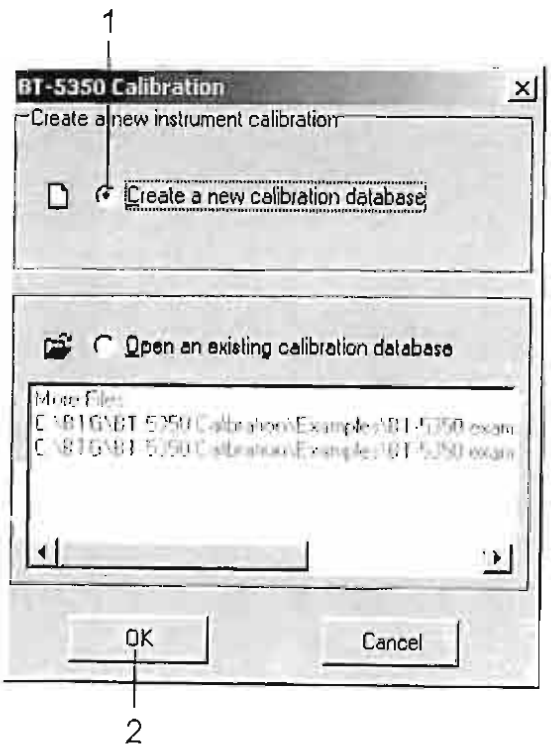
1. Start BT-Calibration by selecting "Program" "BT-Calibration" from the Windows Start menu.

BT-Calibration start-up screen



The program will first ask you to select whether to create a new calibration database or continue to update an existing calibration database.

2. Click **Create a new calibration database** (1), and then click **OK** (2).

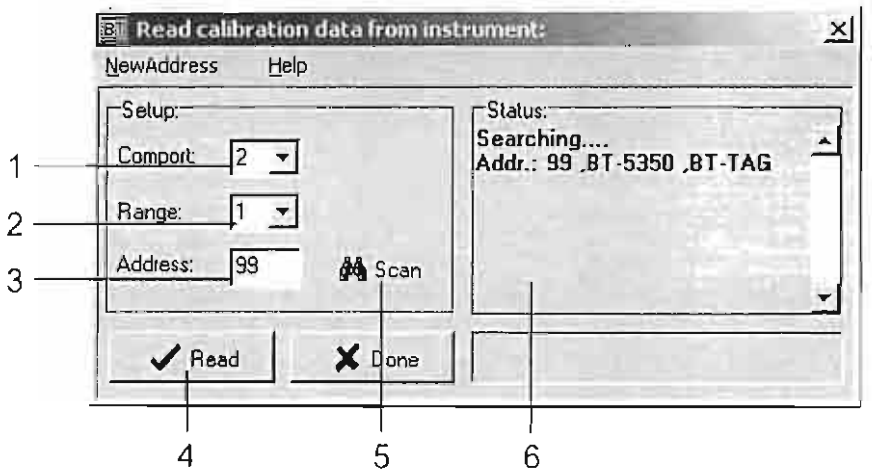


3.1.2 Read samples from the instrument

1. Select the COM port your instrument is connected to (1), the desired calibration range (2), and the instrument address (3).

If you don't know the instrument address, you can search for connected instruments by clicking **Scan** (5). All connected instruments will be listed, together with their addresses, in the Status area (6). Double-click on an instrument address in the Status area to copy it to the address field (3).

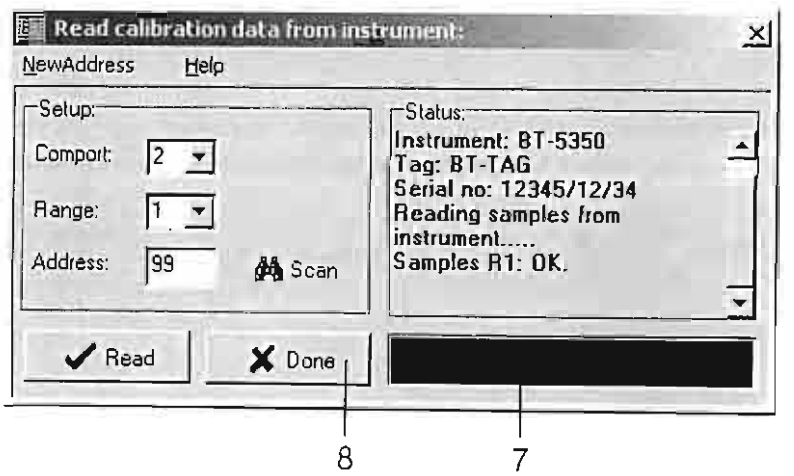
2. Click **Read** (4).



BT-Calibration starts retrieving samples from the instrument. A status bar (7) indicates the progress of the reading process. When all samples have been successfully retrieved, the status area will display "Samples Rx: OK", where x is the selected range number.

Note! If an error message is displayed in the status area, consult section 4: *Trouble Shooting.*

3. Click **Done** (8) to proceed to the BT-Calibration main window.

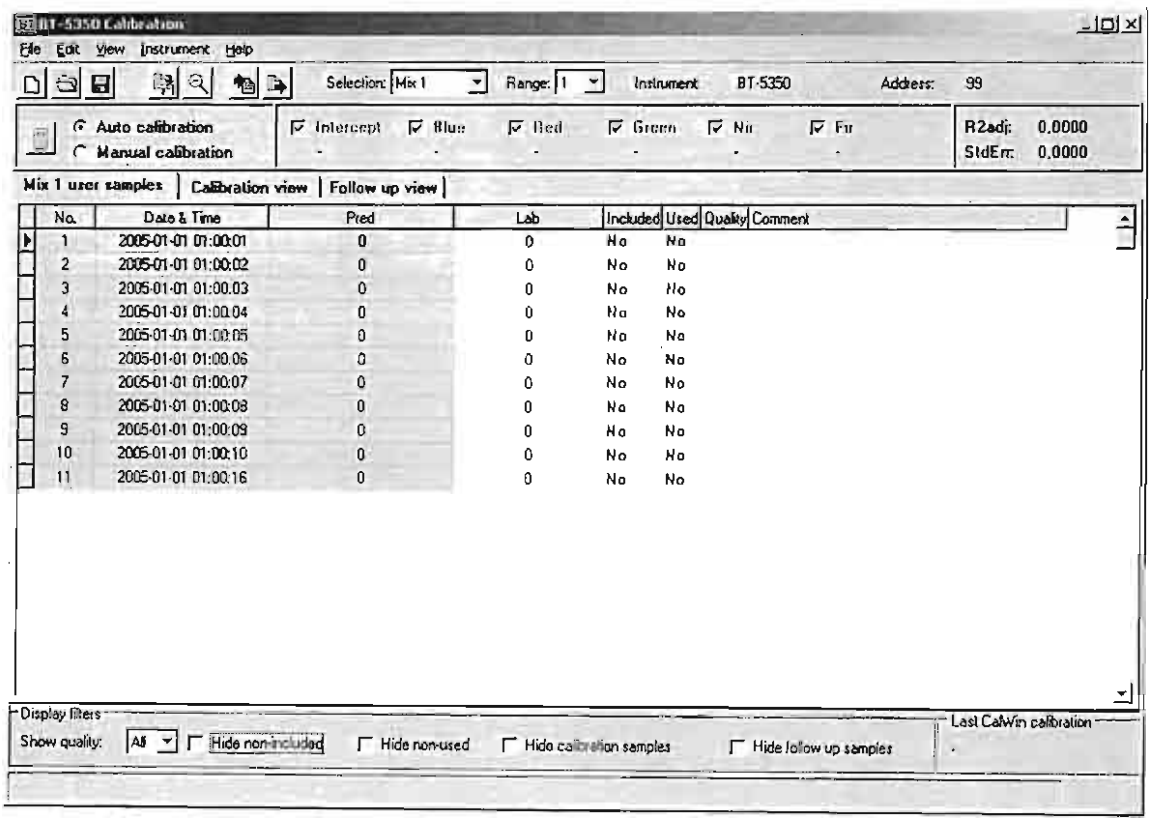


3.1.3 BT-Calibration started

The samples are now retrieved by BT-Calibration, and the sample data for calibration of mix 1 (output signal 1) are displayed in the BT-Calibration main window. These samples may be used in your calibration.

Note! The samples will only have the *Pred* value "0" until the lab values are entered and the calibration button is pressed. This is further described in the subsequent steps of this chapter.

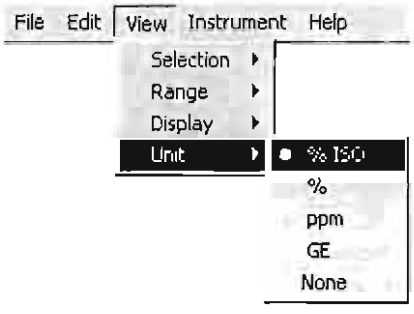
BT-Calibration main window with new samples



3.1.4 Set unit for mix 1

Before proceeding, the unit of the physical quantity that corresponds to output signal 1 in the transmitter must be specified for mix 1 in BT-Calibration. In this example, mix 1 is calibrated for brightness (ISO-value).

1. On the **View** menu, point to **Unit** and select **% ISO** from the sub-menu.

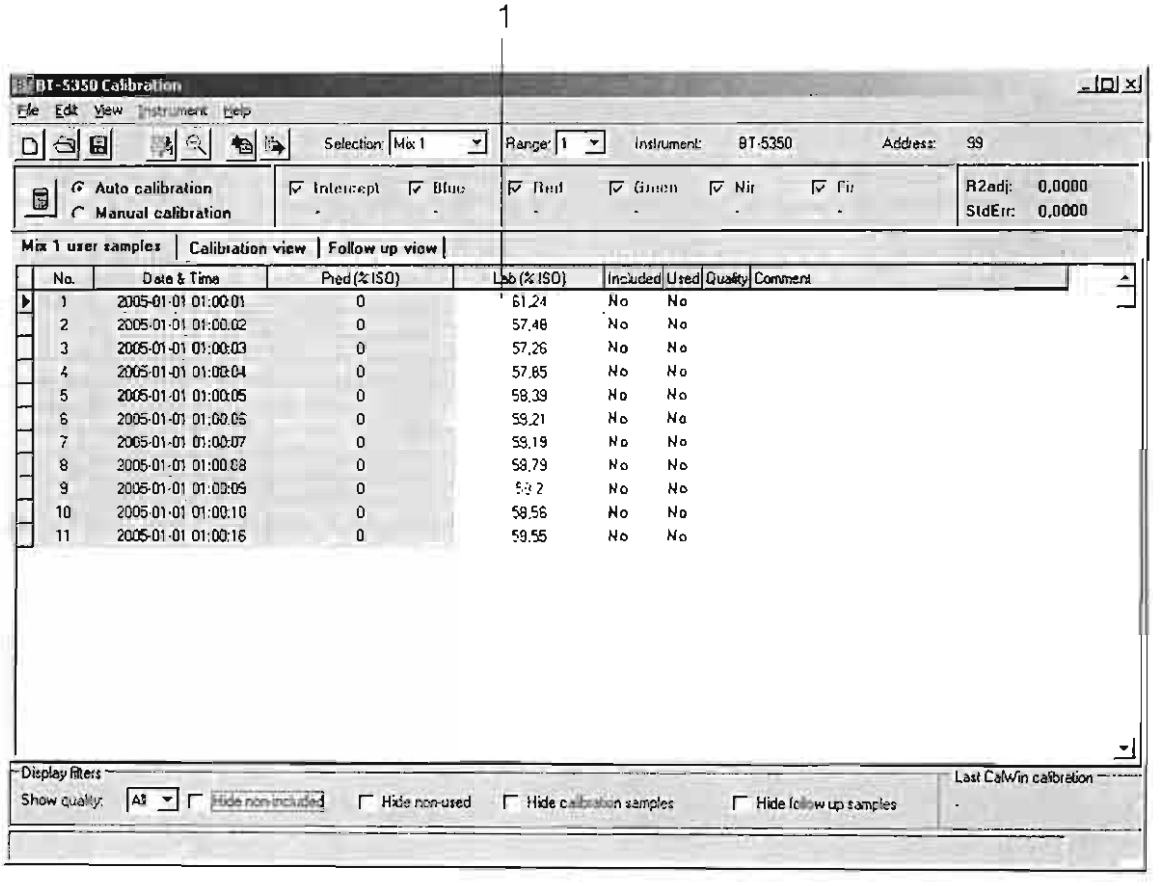


The headers of the *Pred* and *Lab* columns will now display the selected unit.

	No.	Date & Time	Pred (% ISO)	Lab (% ISO)	Included
▶	1	2005-01-01 01:00:01	0	0	No
	2	2005-01-01 01:00:02	0	0	No
	3	2005-01-01 01:00:03	0	0	No

3.1.5 Insert lab values

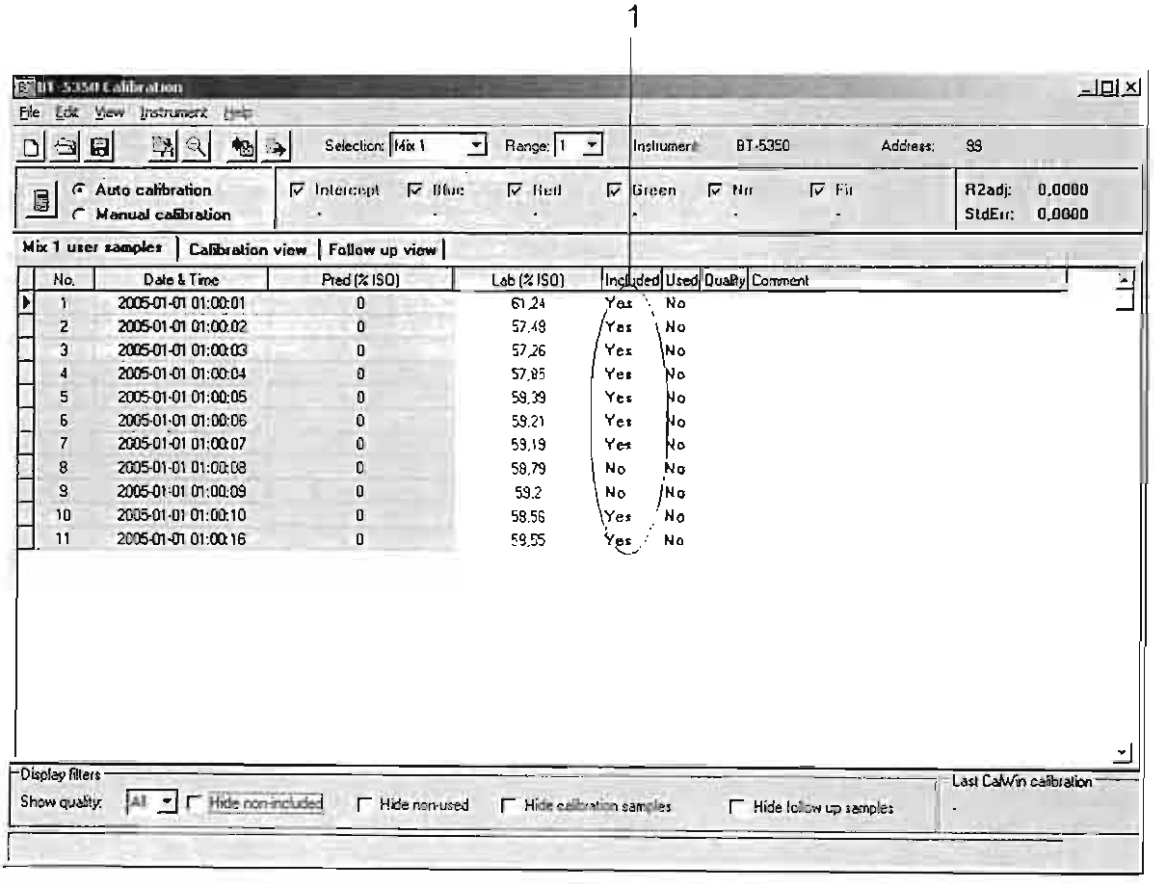
1. Click on the *Lab* cell for the first sample (1) and enter the lab value. Repeat the procedure for each sample.



3.1.6 Select lab samples to be included in calibration

1. In the *Included* column (1), double-click the value cell of each sample that you want to include in your calibration for mix 1.

Included samples will be displayed with the value *Yes* in the *Included* column. A second double-click will toggle the value back to *No*.

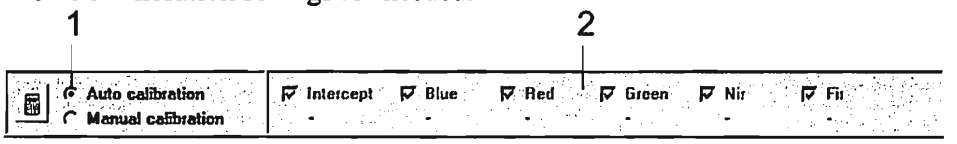


3.1.7 Configure calibration settings

The calibration can be performed in either Auto calibration mode or Manual calibration mode. The two modes are further described in section 1.5: *Calibration Panels*.

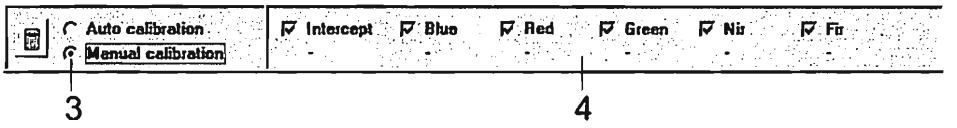
Auto calibration mode

BT-Calibration is by default set to Auto calibration mode when a new calibration database is created. This is indicated by the selected option button (1) in the left calibration panel, and by the greyed check boxes in the right calibration panel (2). If Auto calibration mode is to be used, no further configuration of the calibration settings are needed.



Manual calibration mode

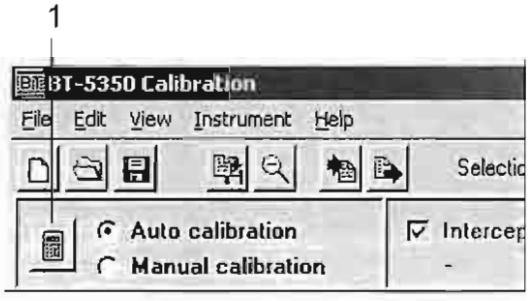
1. Select the **Manual calibration** option button (3) to switch to manual calibration mode.
   The check boxes in the right calibration panel (4) can now be manually selected or cleared. All check boxes are by default selected.



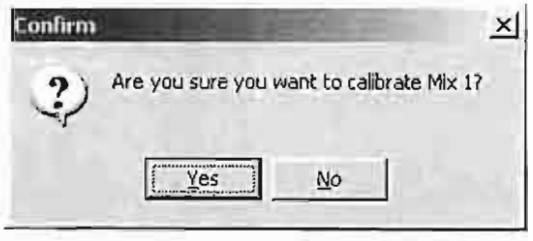
2. Clear the check boxes for the variables you do not want included in the calibration calculation.

3.1.8 Calibrate mix 1

1. Click on the **Calibrate** button (1).



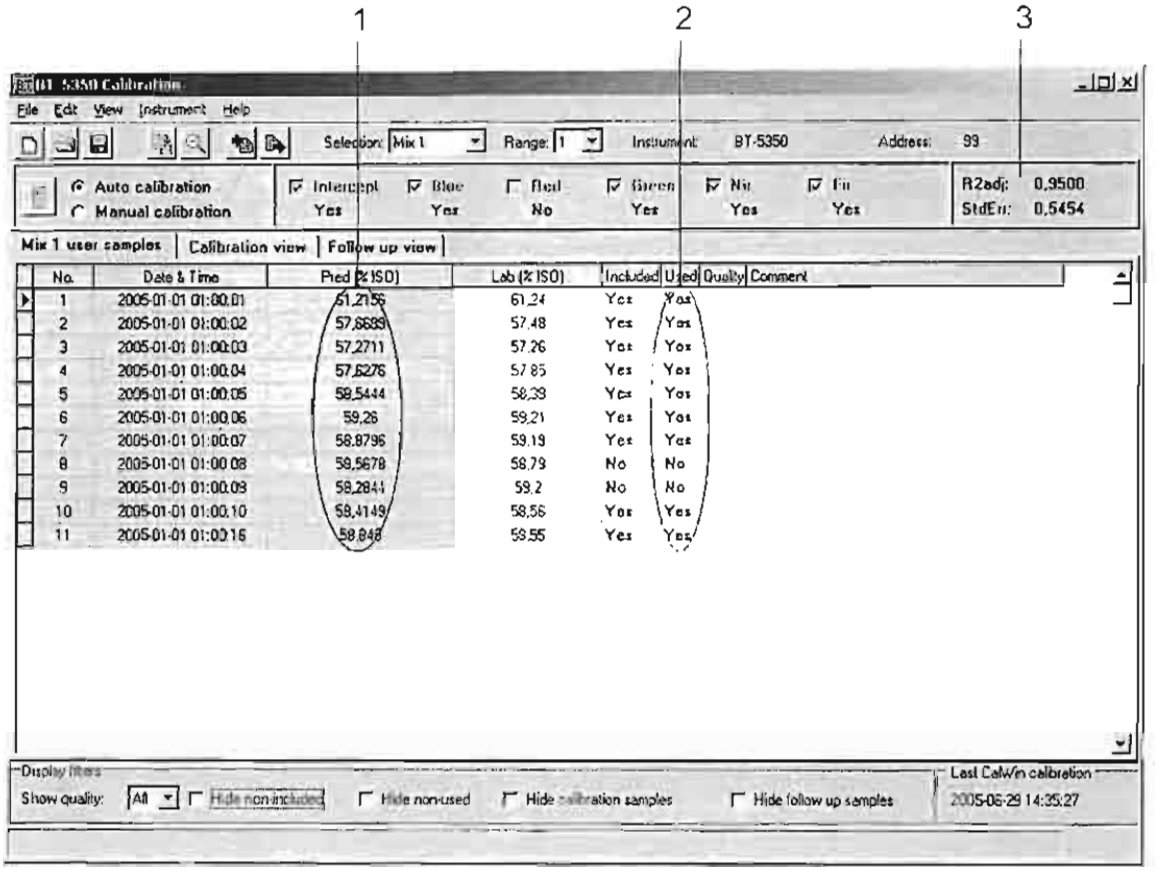
2. Confirm the calibration of mix 1 by clicking **Yes** in the confirmation dialog.



Note! This operation does not send new calibration values to the instrument (see section 3.1.13: *Prepare to send calibration to the instrument*). It only calculates the new calibration.

3.1.9 Verify calibration for Mix 1 (User Samples View)

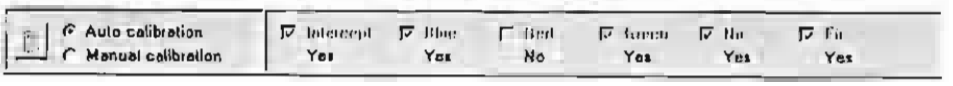
The *Pred* column (1) and *Used* column (2) are updated. The *Used* column shows which samples were used in the latest calibration. The correlation and standard deviation (3) of the calibration are also displayed in the BT-Calibration main window.



The calibration panel is also updated. The result depends on the used calibration mode:

Auto calibration mode

If Auto calibration mode was used, the check boxes is still greyed out but the boxes for the variables that were not significant for the calibration, and thereby not used in the calibration calculation, have been cleared and indicated with *No*.

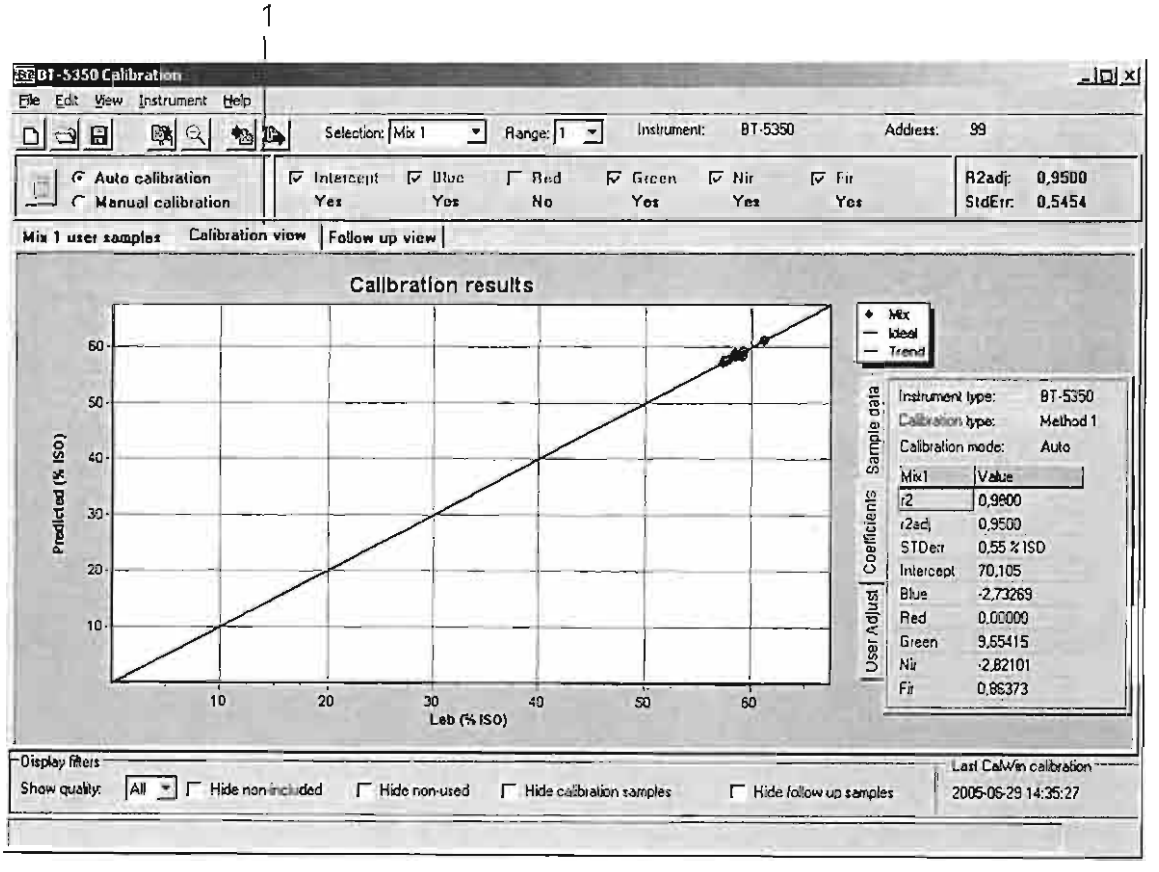


Manual calibration mode

If Manual calibration mode was used, the check boxes selected before the calibration is still selected. Below each check box there is an indication of whether or not the variable was significant for the calibration. If a selected variable is marked as not significant (*No*), it is highly recommended that you remove it and redo the calibration.

3.1.10 Verify calibration for Mix 1 (Calibration View)

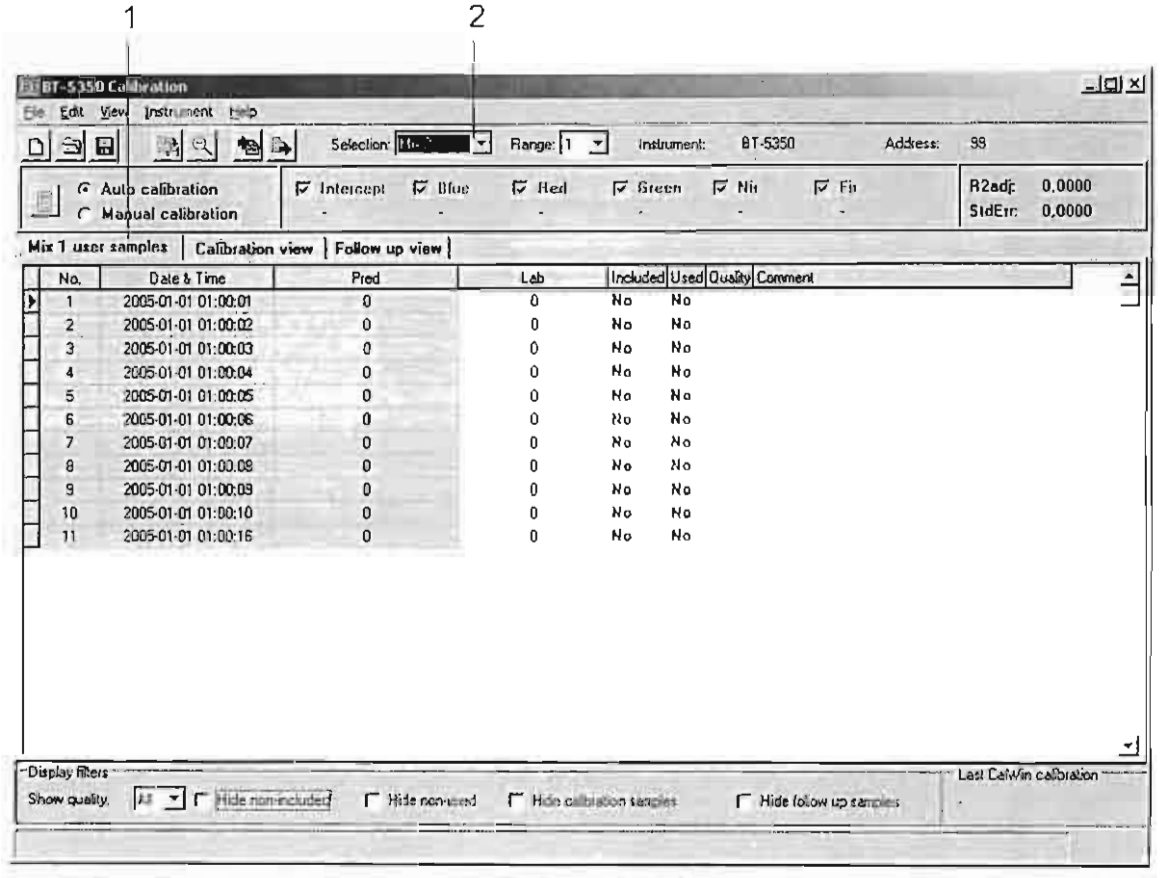
1. Click the **Calibration view** tab (1) to change to Calibration View.
2. Check that the values of the samples used in the calibration (blue dots) seem to be correct.



3. If necessary, exclude any unwanted samples from the calibration by right-clicking on the dots and select **No** from the shortcut menu. Then redo the calibration according to section 3.1.8: *Calibrate mix 1*.

3.1.11 Calibrate other mixes

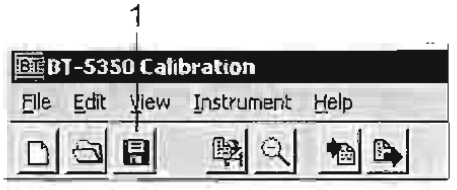
1. Change your selection to desired mix (1).
2. Click the **User samples** tab (2) to change to User Samples View.



3. Follow the same procedure as described for Mix 1 to calibrate other mixes.

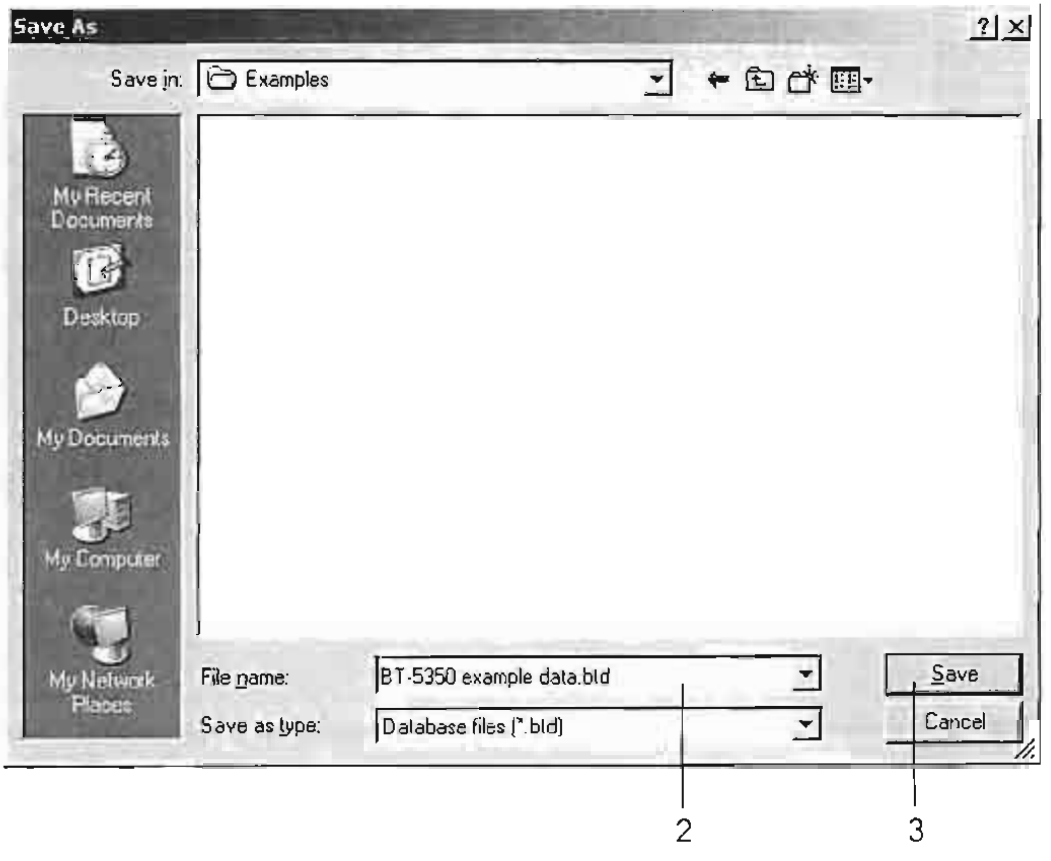
3.1.12 Save Calibration

1. In the toolbar, click the **Save** button (1).



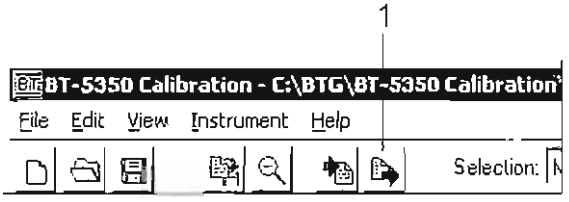
2. Select a name for your calibration database (2) and click **Save** (3).

Hint: Select a file name that makes it easy to identify the calibration database, for example, the description of the installation point, and the date the calibration was sent to the instrument.

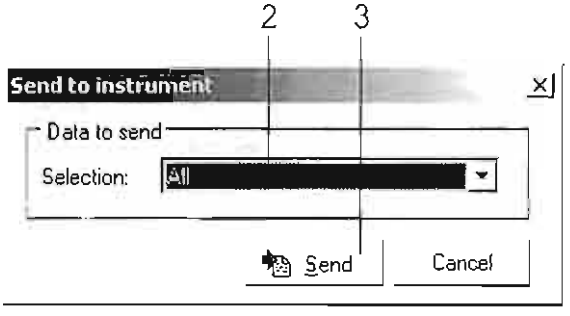


3.1.13 Prepare to send calibration to the instrument

1. In the toolbar, click the **Send to instrument** button (1).



2. In the dialog box that appears, select the desired mix(es) to send calibration for (2), and click the **Send** button (3).

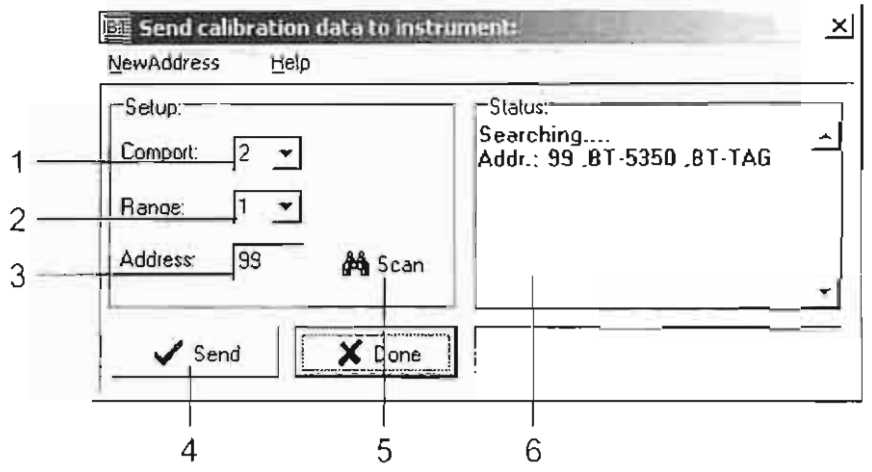


3.1.14 Send the calibration to the instrument

1. Check that correct COM port (1), range (2), and instrument address (3) are specified in the send data dialog.

If you don't know the instrument address, you can search for connected instruments by clicking **Scan** (5). All connected instruments will be listed, together with their addresses, in the Status area (6). Double-click on an instrument address in the Status area to copy it to the address field (3).

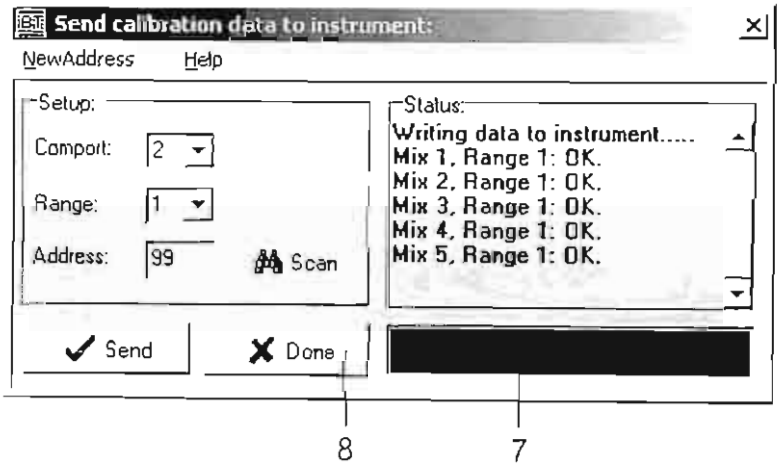
2. Click **Send** (4).



BT-Calibration starts sending the calibration to the instrument. A status bar (7) indicates the progress of the sending process. When the calibration has been successfully sent, it is indicated in the status area.

Note! If an error message is displayed in the status area, consult section 4: *Trouble Shooting*.

3. Click **Done** (8) to go back to the BT-Calibration main window.



3.1.15 Finished!

You have now created your first calibration database.

3.2 Open and follow up an existing calibration

Following up an existing calibration means that you take new calibration samples and load them into BT-Calibration. In the program you verify the existing calibration by comparing the predicted values for the new samples with their lab values. If the difference is acceptable, the calibration is ok. Otherwise the calibration has to be redone with the new samples included.

This chapter will guide you through the steps required to follow up an existing calibration.

Before you start BT-Calibration to follow up an existing calibration, you must have taken new lab samples since your last calibration (see section 3.1: *Make a calibration for the first time*).

Numbers within parentheses in the body text refer to callouts in the picture(s) within the same section.

Index:

3.2.1 Open an existing calibration database

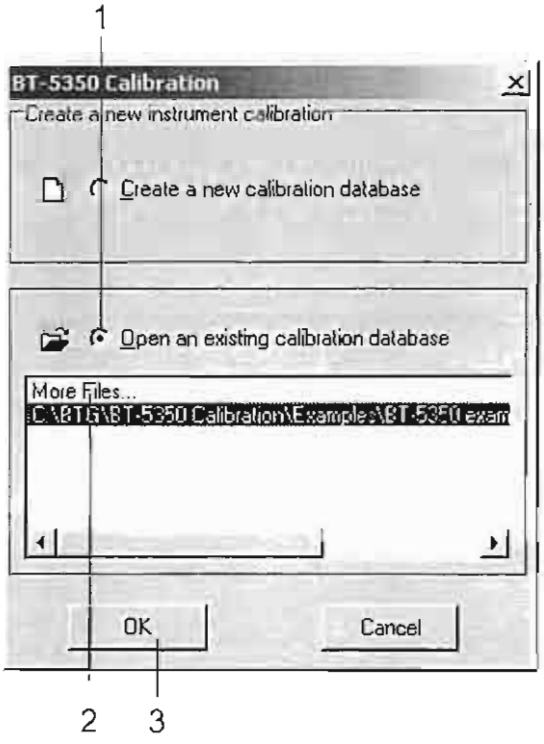
1. Start BT-Calibration by selecting "Program" "BT-Calibration" from the Windows Start menu.

BT-Calibration start-up screen

The program will first ask you to select whether to create a new calibration database or continue to update an existing calibration database.

2. Click **Open an existing calibration database** (1).
3. Select a database from the list or use the file browsing dialog shown when you double-click the **More Files...** row (2).

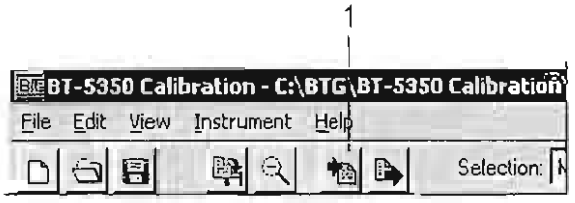
4. Click **OK** (3) when a file has been selected.



It is also possible to start BT-Calibration and open a calibration database by double-clicking on the database file (.btd) from Windows Explorer, provided that multiple subsequent spaces does not exist in the file name or file path.

3.2.2 Read samples from the instrument

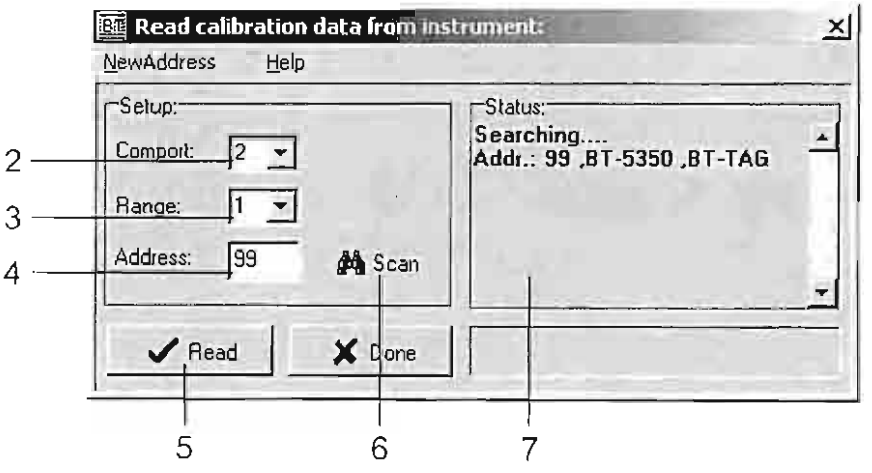
1. In the toolbar, click the **Read from instrument** button (1).



2. Select the COM port your instrument is connected to (2), the desired calibration range (3), and the instrument address (4).

If you don't know the instrument address, you can search for connected instruments by clicking **Scan** (6). All connected instruments will be listed, together with their addresses, in the Status area (7). Double-click on an instrument address in the Status area to copy it to the address field (4).

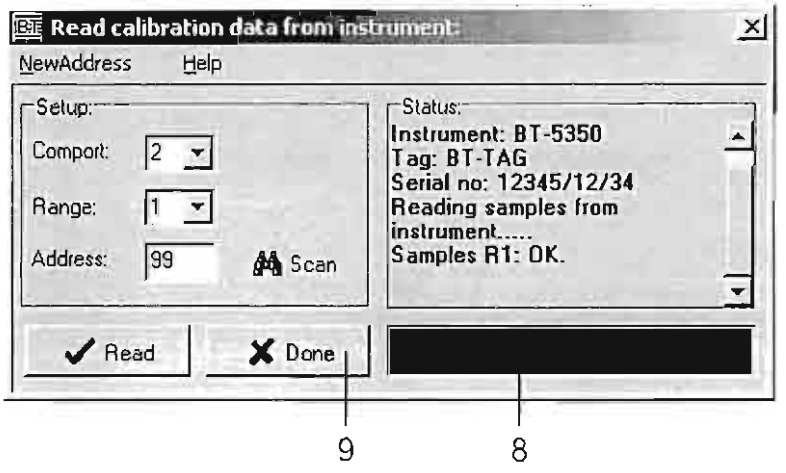
3. Click **Read** (5).



BT-Calibration starts retrieving samples from the instrument. A status bar (8) indicates the progress of the reading process. When all samples have been successfully retrieved, the status area shows "Samples Rx: OK", where x is the selected range number.

Note! If an error message is displayed in the status area, consult section 4: *Trouble Shooting*.

4. Click **Done** (9) to proceed to the BT-Calibration main window.

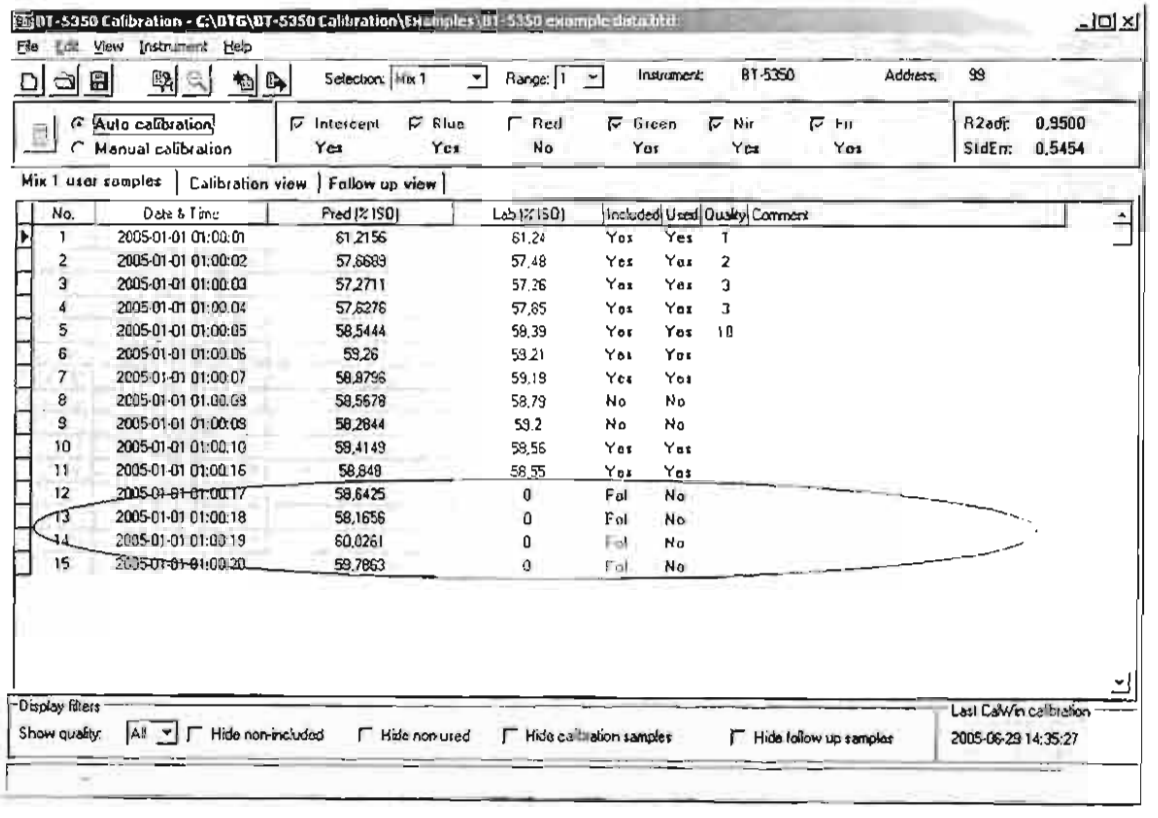


3.2.3 New Samples

The new samples (No. 12 - 15 in this example, see the figure below) are added to the existing calibration database. The new samples have *Fol* as value in the *Included* column, which indicate that they are follow-up samples. Only samples added to a calibration database that has been calibrated at least once are marked as follow-up samples.

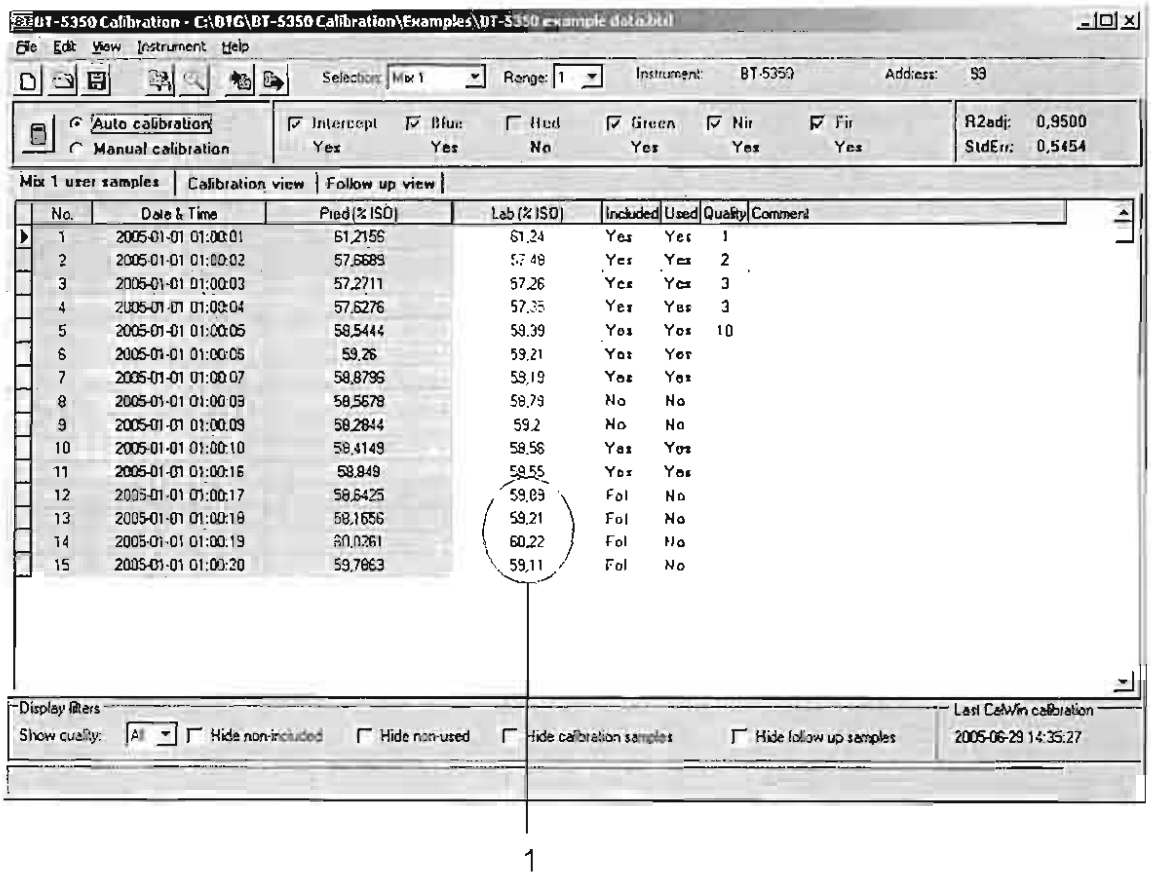
Note! Only values for mix 1 are shown in the current selection.

BT-Calibration main window with new samples



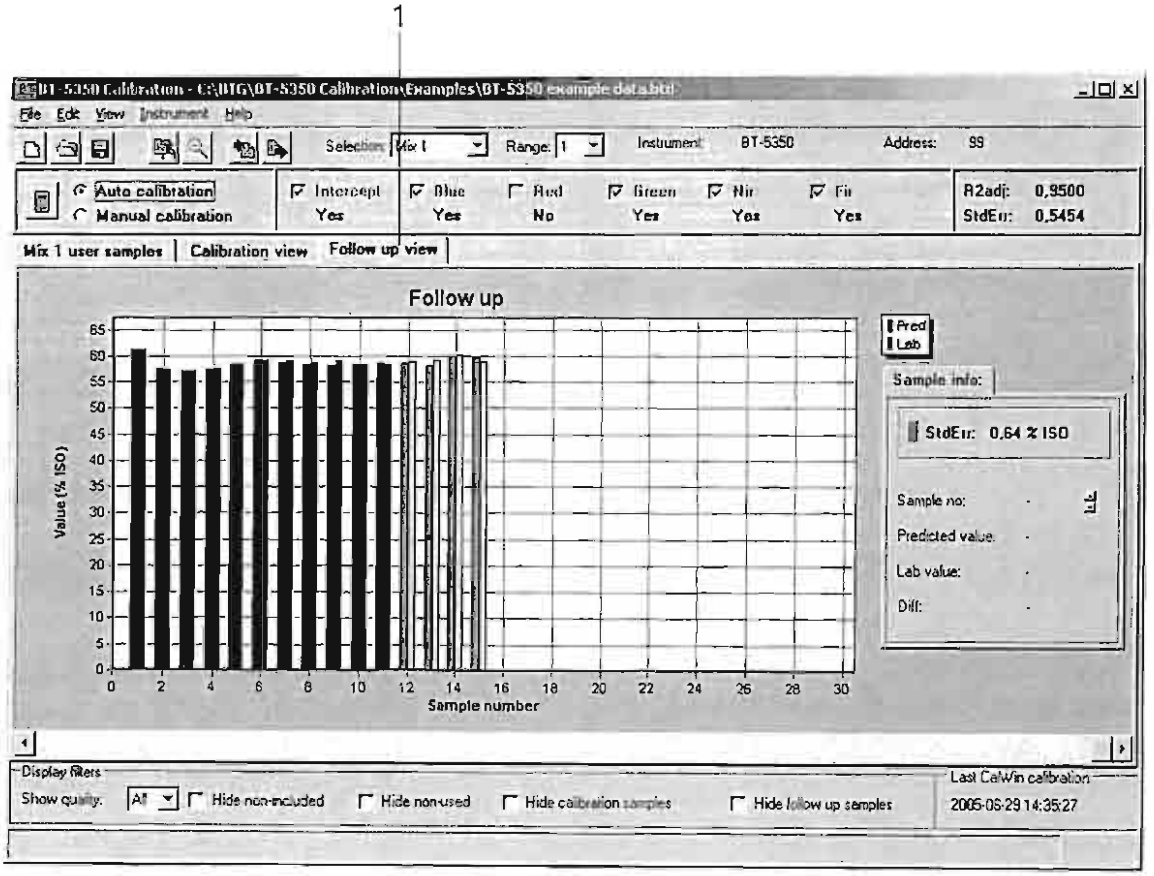
3.2.4 Insert lab values

1. Click on the *lab value* cell for each of the follow-up samples (1) and enter the lab values for mix 1.



3.2.5 Verify calibration for mix 1 (Follow-up View)

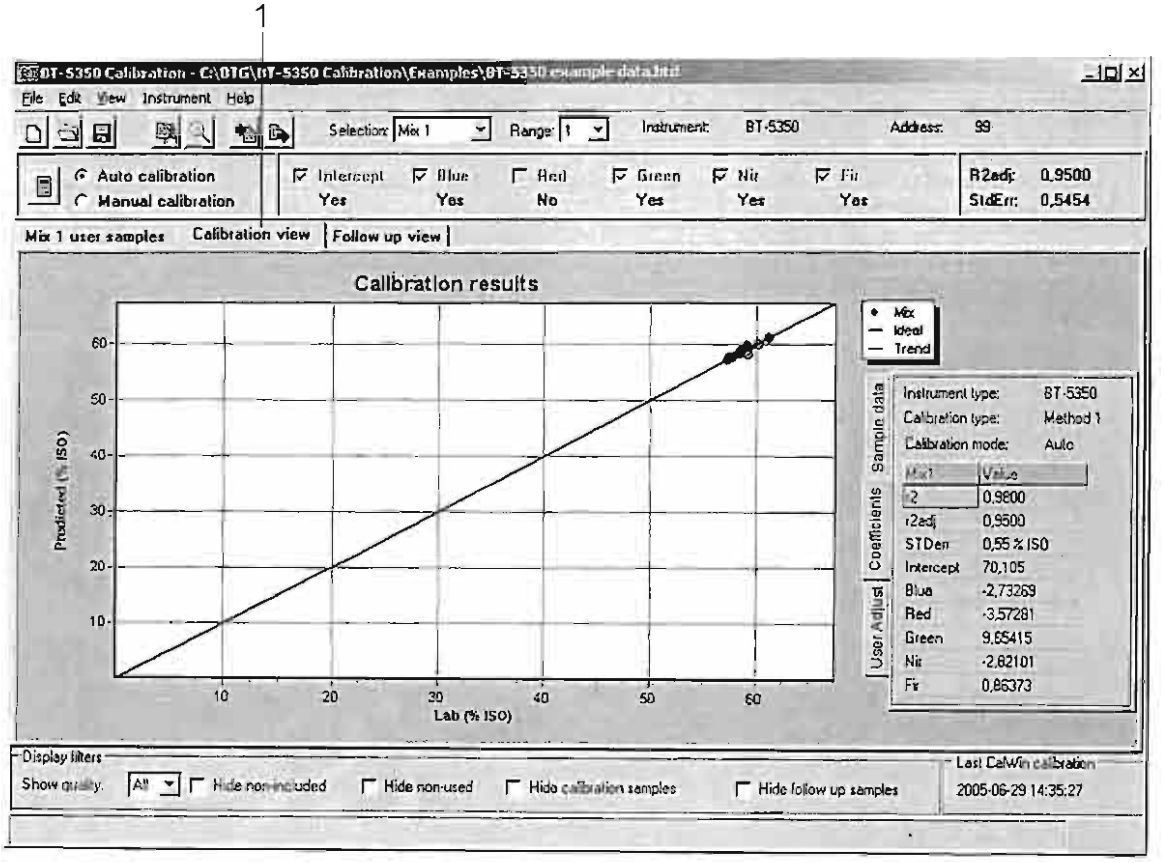
1. Click the **Follow up view** tab (1) to change to Follow-up View.
2. Compare the lab values and predicted values of the follow-up samples and ensure that the difference is acceptable. If necessary, redo the calibration with the follow-up samples included. See appropriate sections in section 3.1: *Make a calibration for the first time* for instructions.



For detailed information about the Follow-up View, see section 1.8: *Follow-up View*.

3.2.6 Verify calibration for mix 1 (Calibration View)

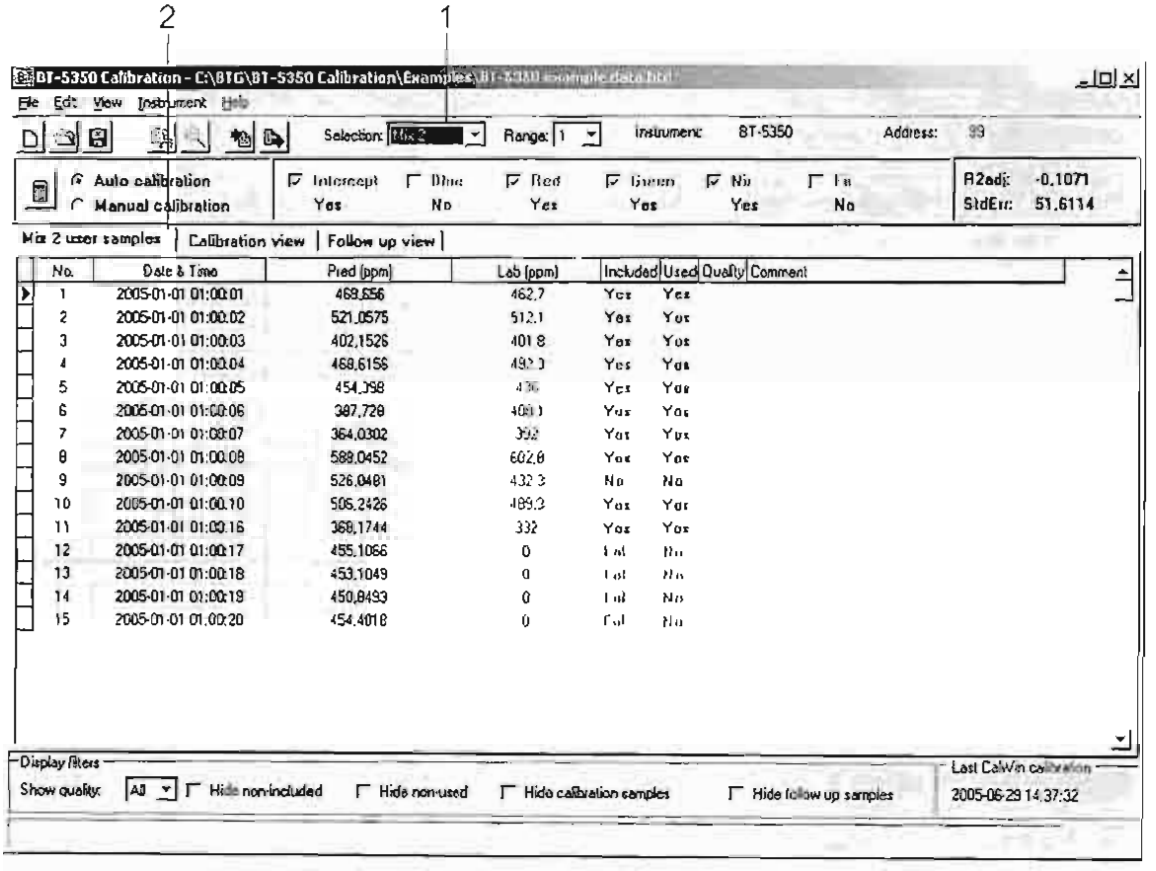
1. Click the **Calibration view** tab (1) to change to Calibration View.
2. Check that the follow-up samples (green dots) are positioned in line with the samples included in the calibration (blue dots). If necessary, redo the calibration with the follow-up samples included. If any of the follow-up samples is positioned beyond the current span of the included samples, a new calibration is also recommended to increase the calibration precision of a wider span. See appropriate sections in section 3.1: *Make a calibration for the first time* for instructions.



For detailed information about the Calibration View, see section 1.7: *Calibration View*.

3.2.7 Insert lab values and verify calibration for other mixes

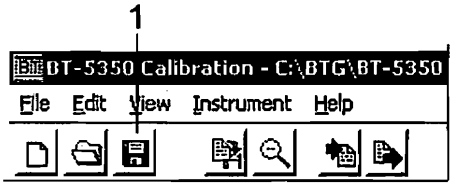
1. Change your selection to desired mix (1).
2. Click the **user samples** tab (2) to change to User Samples View.



3. Follow the same procedure as described for mix 1 to insert lab values and to verify calibration for the other mixes.

3.2.8 Save Calibration

1. Click on the **Save** button (1) to save your calibration database.



3.2.9 Finished!

You are now finished updating your calibration database.

3.3 Copy samples between ranges

BT-Calibration supports four ranges of sample values in each calibration database. Sample data are read into the corresponding range in the program as saved in the instrument. Once samples are saved in the database it is possible to copy (but not move) them to other ranges. This is useful when testing new calibrations or separating samples into a cleaner view.

BT-Calibration has two copy functions: a single sample copy function, and a copy function based on sample quality value. The example shown in this chapter uses both kinds. A single sample, with no quality value is first copied, then all samples with quality value 3 are copied.

A sample cannot be copied from one range to another if the destination range contains a sample with an identical date and time value as the sample being copied. A sample is always copied entirely or not at all. Thus if an individual sample cannot be copied due to an identical date and time value or a lack of space in the destination range, no samples at all will be copied.

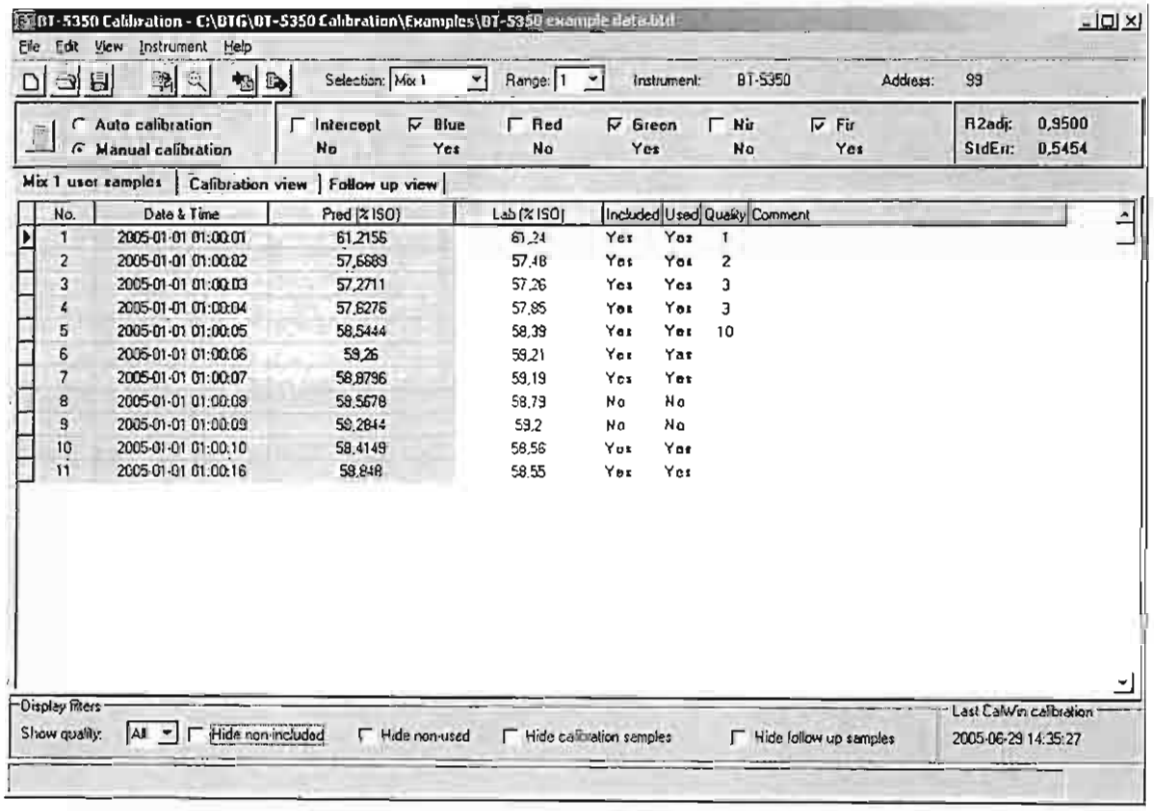
Numbers within parentheses in the body text refer to callouts in the picture(s) within the same section.

Index:

3.3.1 Open an existing calibration database

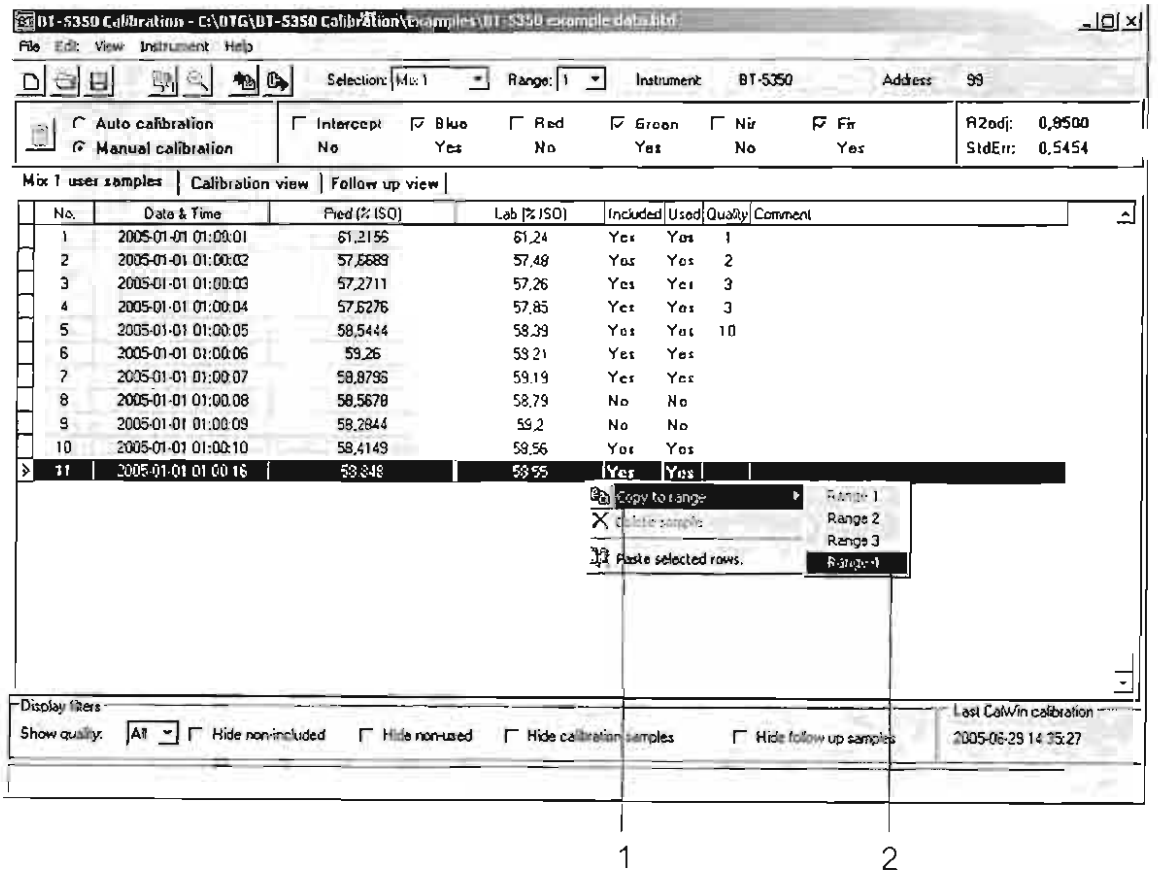
1. Start BT-Calibration and open an existing calibration database (described in section 1: *User Interface Overview*).

An open database



3.3.2 Copy a single sample

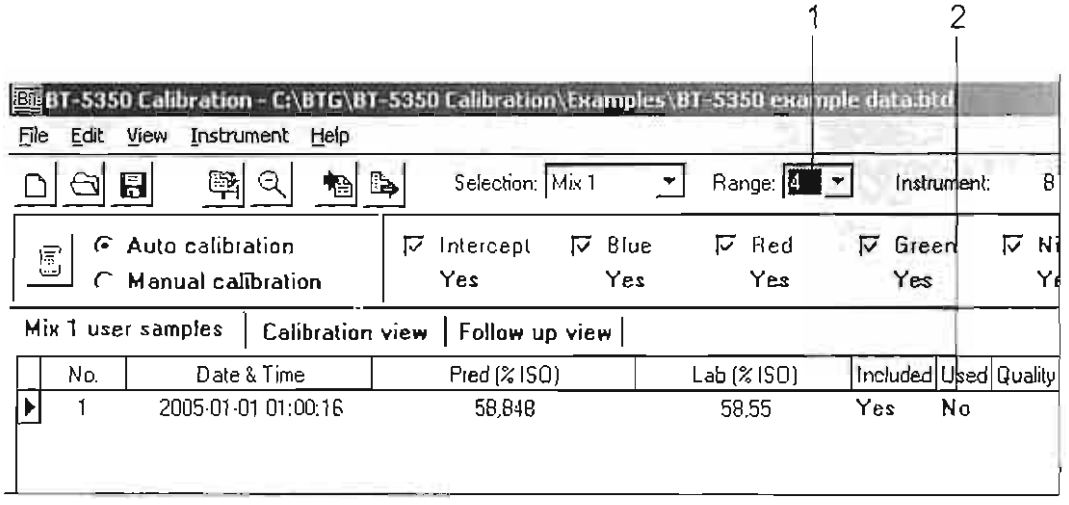
1. Right-click on the sample you want to copy (in this example, sample number 11 is selected). A pop-up appears (1).
2. Point to **Copy to range**, and then select a destination range from the sub-menu (in this example, range 4) (2)
   The sample is now copied.



3.3.3 Verify copied sample in destination range

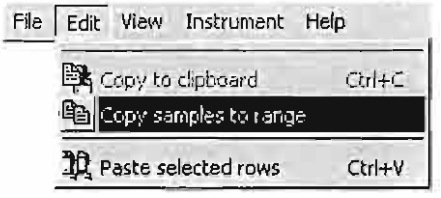
1. Change to range 4 (1) to verify the copy operation.

In range 4, the sample displays exactly the same values with the exception of the *Used* column. Since this sample has not been used in a calibration in this range, the value in the *Used column* is set to No (2).



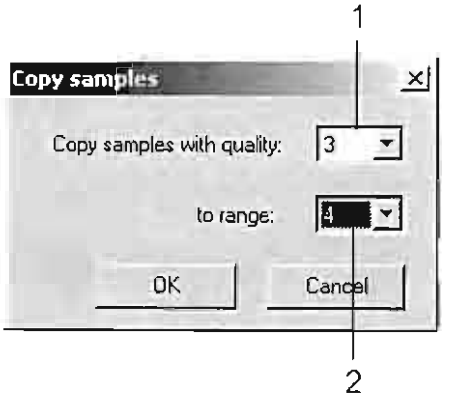
3.3.4 Copy samples with quality value 3

1. Return to range 1.
2. On the **Edit** menu, click **Copy samples to range**.



A dialog opens, where quality value (1) and destination range (2) must be entered.

3. Set the quality value to 3 and the destination range to 4.
4. Click **OK**.

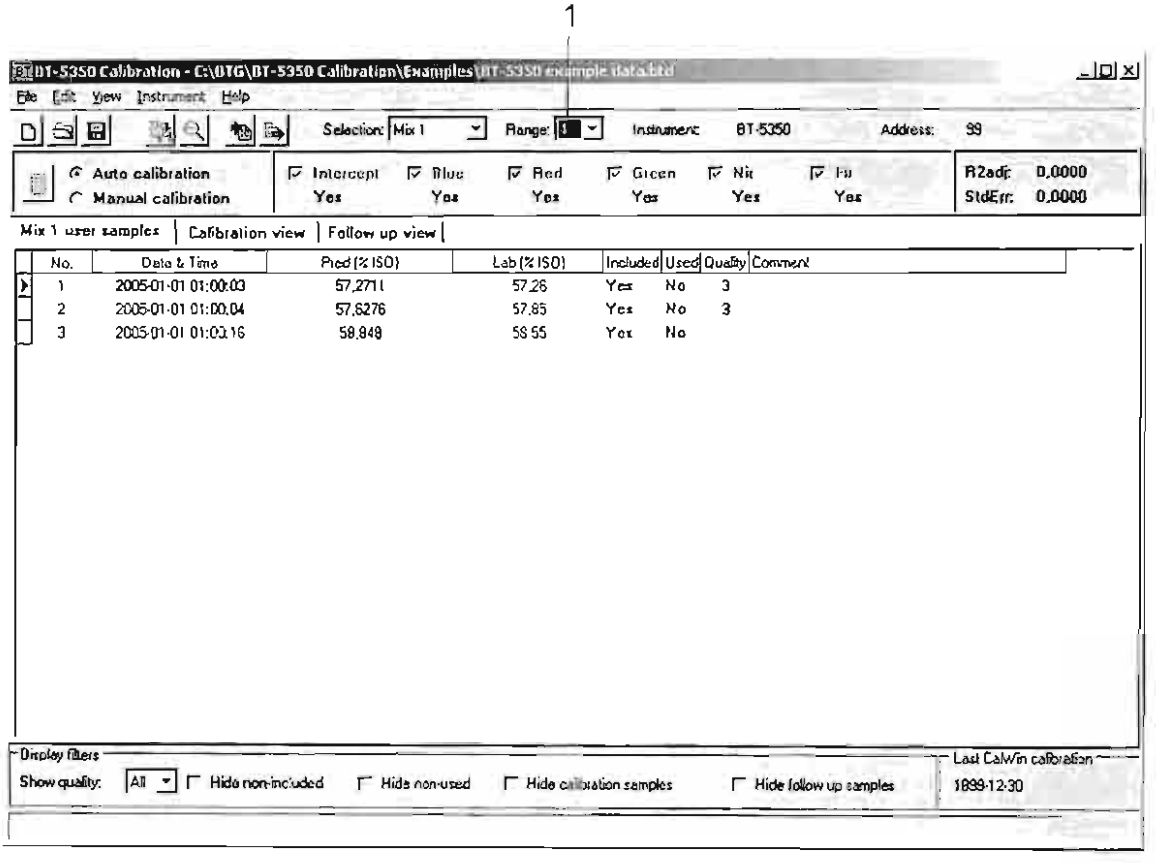


All samples with quality value 3 are now copied to range 4. In this case sample 3 and 4.

3.3.5 Verify copied samples in destination range

1. Change to range 4 (1) to verify the copy operation.

In range 4, the samples are shown with identical values as in range 1, except for the *Used* column, as explained in section 3.3.3: *Verify copied sample in destination range*



3.4 Paste sample data

It is possible to paste sample data from external programs, such as MS Excel or MS Word, into the *Lab* and *Comment* columns of BT-Calibration.

Sample data can be pasted for multiple samples at the same time, provided that the sample data is located on separate rows (separated by a carriage return) in the external program. If the copied data consists of numerical characters only, for example 1.234, it will be regarded as a lab value and pasted into the *Lab* column. Otherwise it will be pasted into the *Comment* Column. It is not possible to paste sample data into both columns at the same time.

This chapter provides an example of how comments can be copied from a MS Excel file to all included samples in an existing database.

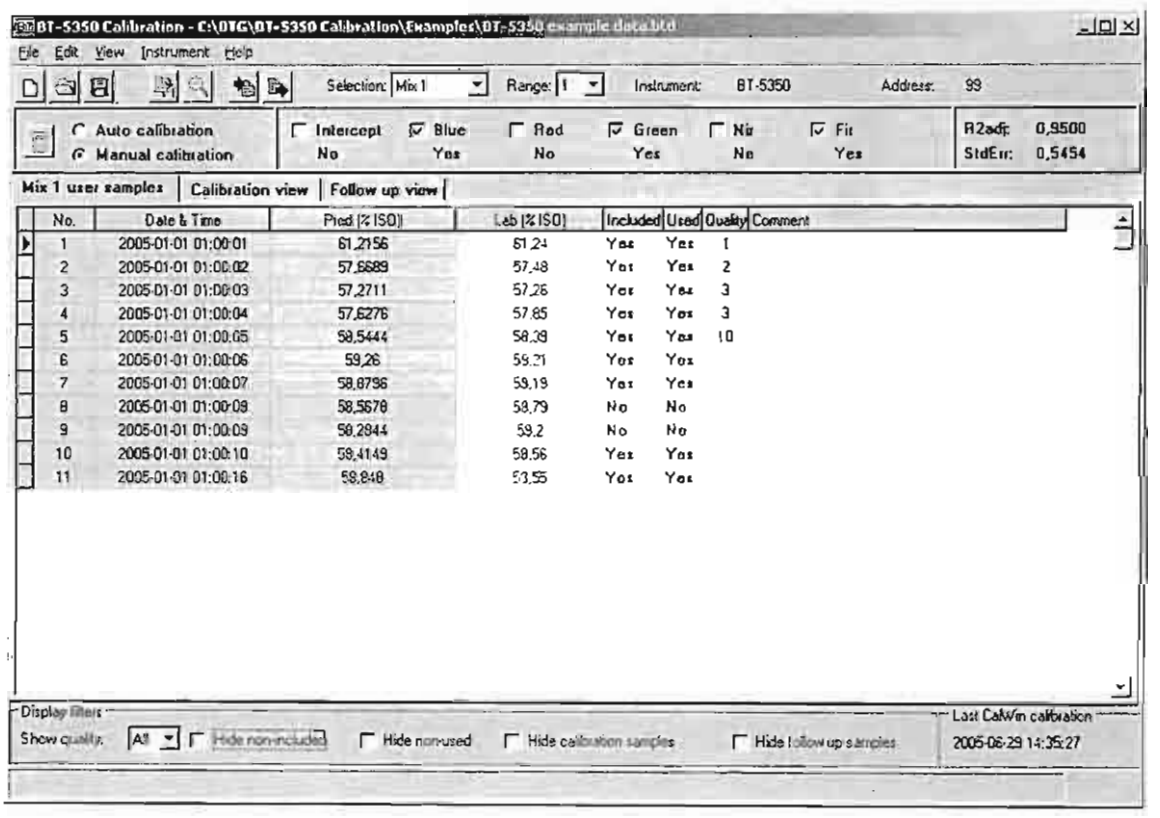
Numbers within parentheses in the body text refer to callouts in the picture(s) within the same section.

Index:

3.4.1 Open an existing calibration database

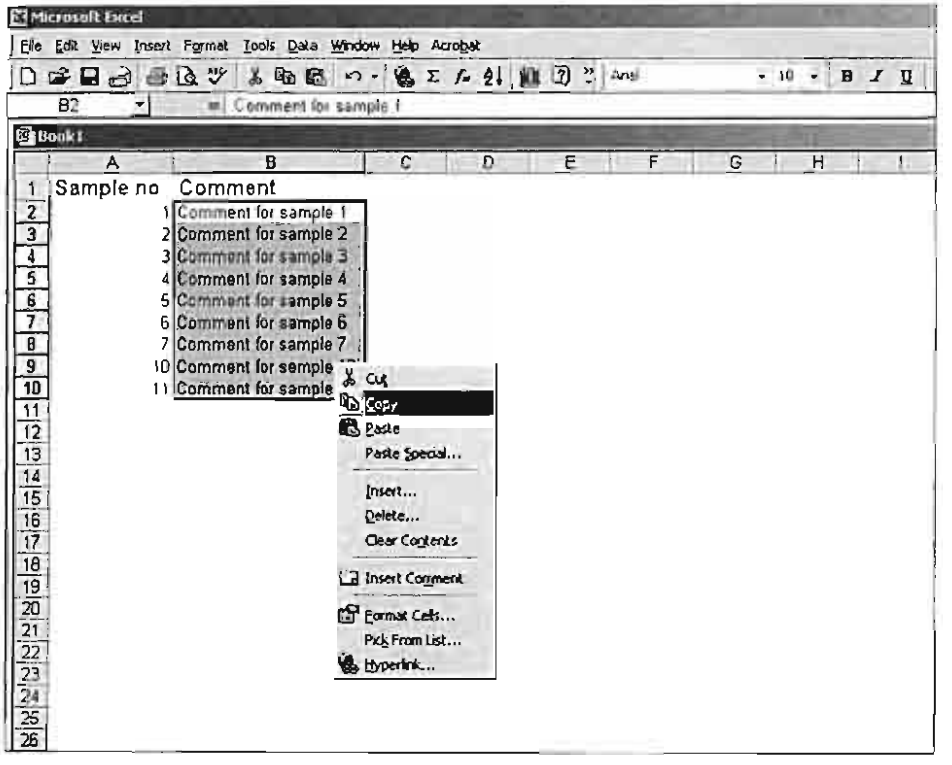
1. Start BT-Calibration and open an existing calibration database (described in section 1: *User Interface Overview*).

An open database



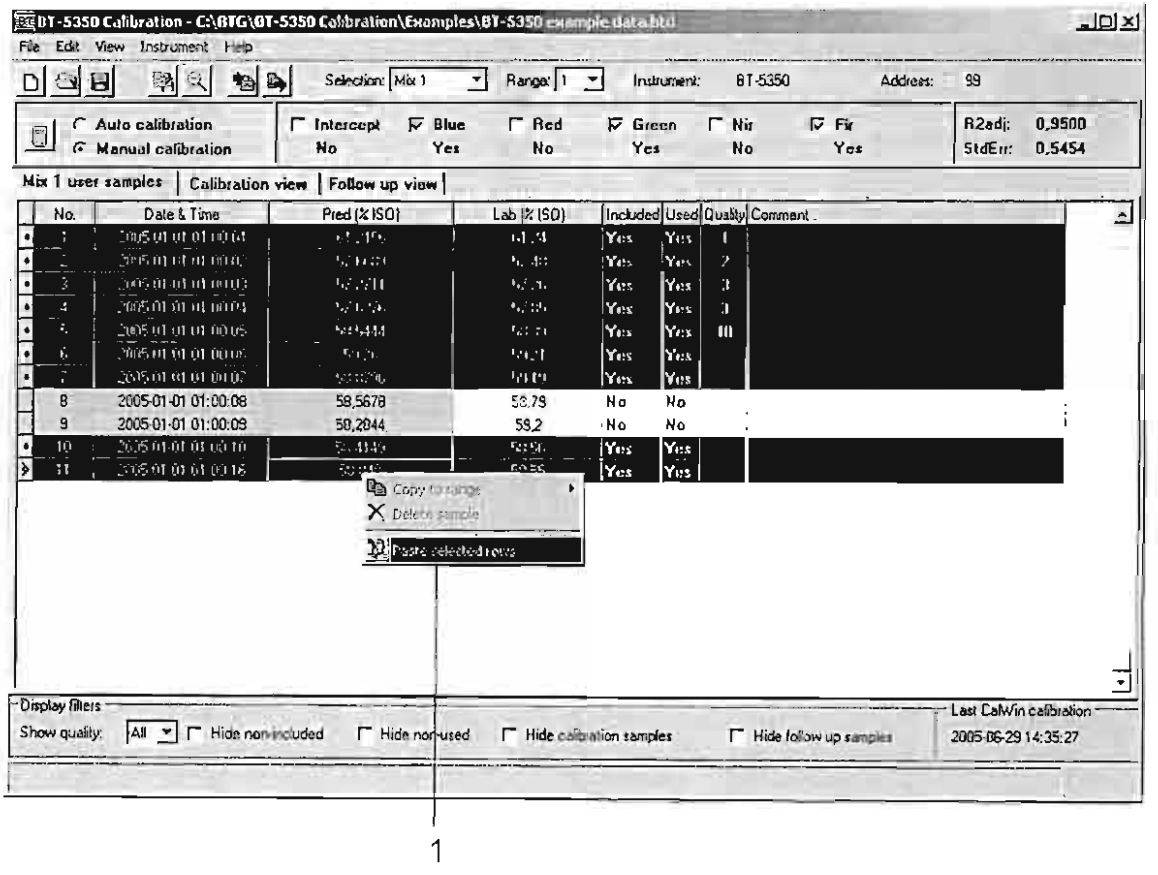
3.4.2 Copy sample data from an external program

1. Copy the sample data to be pasted into BT-Calibration from the external program.
   This example shows how comments are copied from MS Excel for all included samples.

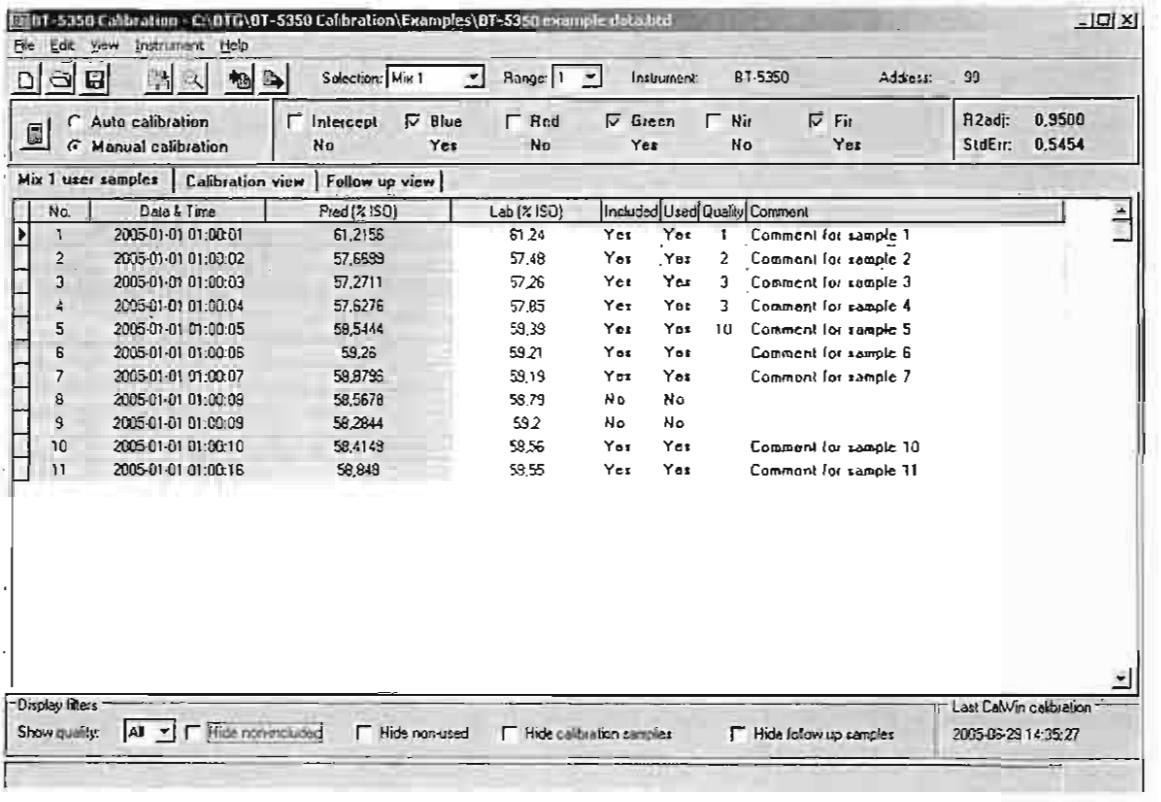


3.4.3 Paste sample data into BT-Calibration

1. Select the rows into which sample data are to be pasted (in this example, all rows with *Yes* as value in the *Included* column).
   To select multiple rows, press and hold the CTRL key, and click on the rows you want to select. Alternatively, select a single row and use SHIFT+ARROW UP/DOWN to select adjacent rows.
2. Right-click on any of the selected rows.
3. In the pop-up menu that appears, click **Paste selected rows** (1).



Since the copied data consists of non-numerical characters, it is now pasted into the *Comment* column as shown in the figure below.



3.5 Delete samples

It is possible to delete samples from a calibration database, provided that the samples were not included in the most recent calibration.

Samples that have been deleted from a calibration database are automatically deleted from the instrument at the same time as the current calibration data is sent to the instrument. If no calibration data exists (that is, if no calibration has been performed), it is still possible to delete samples from the instrument. However, it is important to be aware that if calibration data exists, it will always be sent to the instrument when samples are deleted.

Samples are deleted for all mixes at the same time. It is not possible to delete samples for a single mix alone.

This chapter provides an example of how to delete a sample from a calibration database as well as from the instrument.

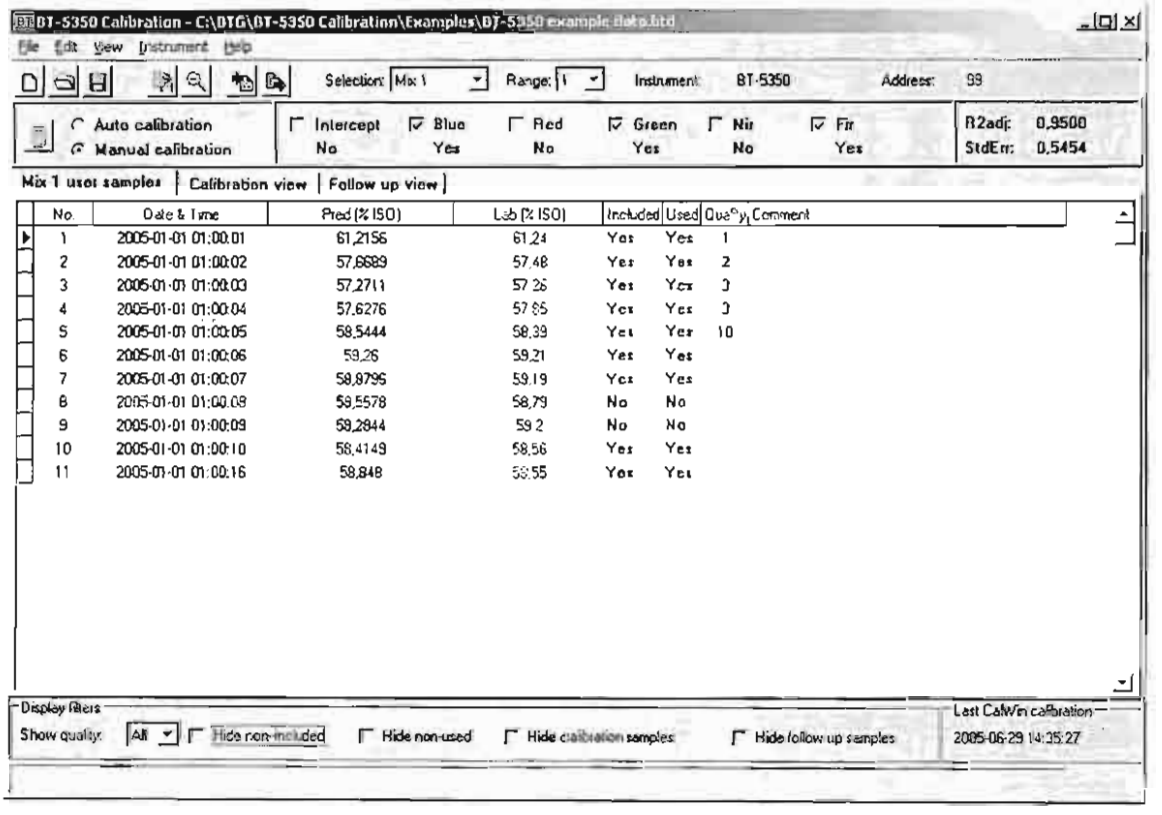
Numbers within parentheses in the body text refer to callouts in the picture(s) within the same section.

Index:

3.5.1 Open an existing calibration database

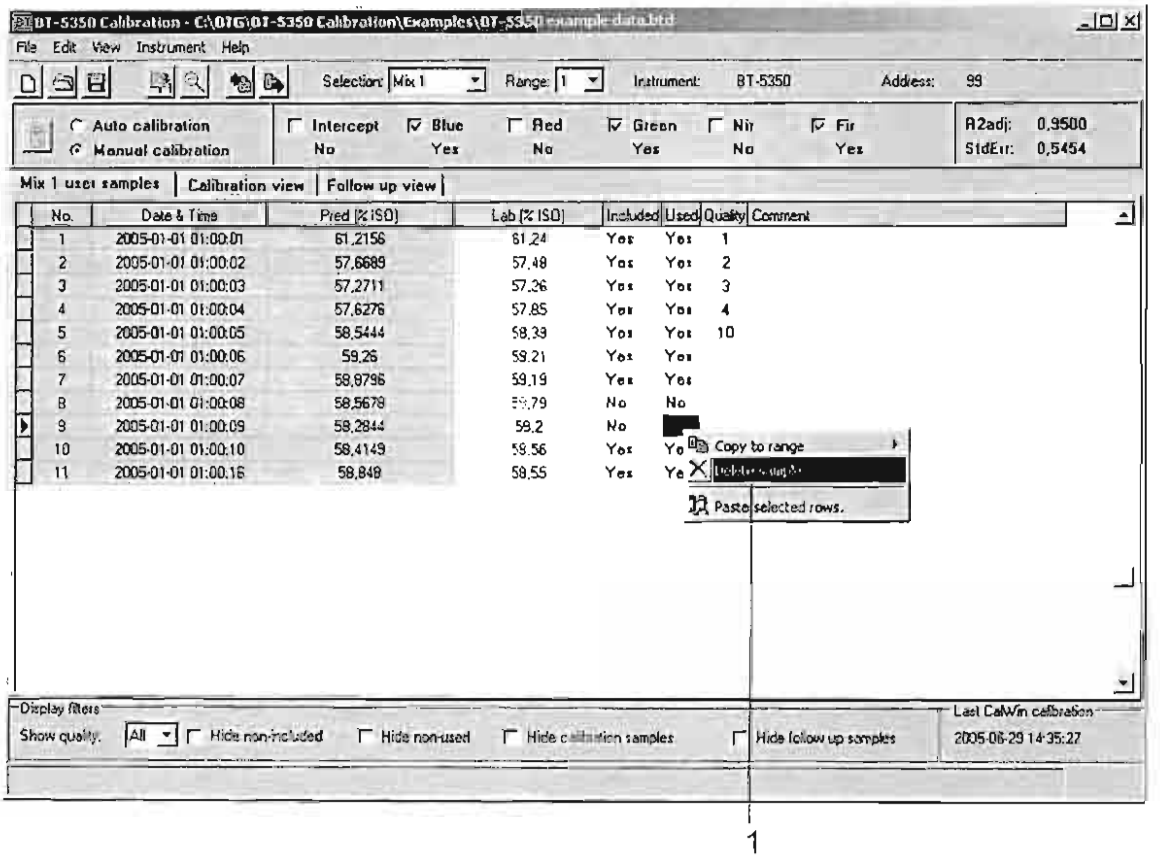
1. Start BT-Calibration and open an existing calibration database (described in section 1: *User Interface Overview*).

An open database

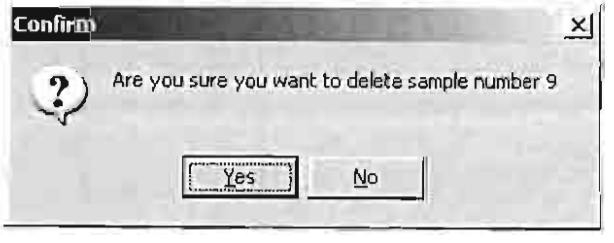


3.5.2 Delete a sample from the calibration database

1. Right-click on the sample you want to delete (in this example, sample number 9).
2. In the pop-up menu that appears, click **Delete sample** (1).



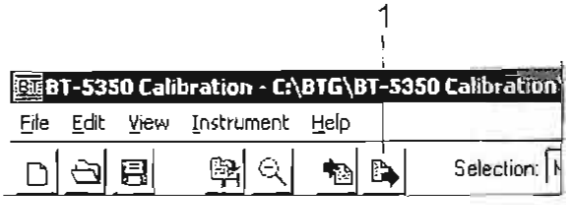
3. In the dialog box that appears, click **Yes** to confirm deletion of the sample.



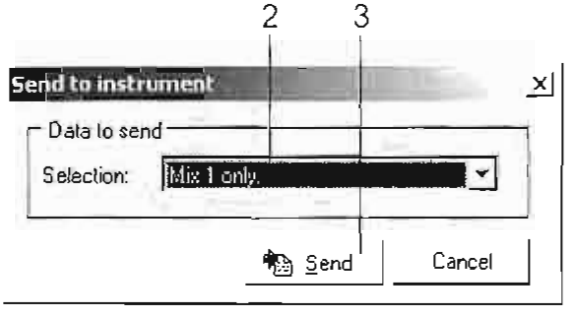
3.5.3 Delete the sample from the instrument

Deletion of the sample from the instrument can only be performed at the same time as a calibration is sent to the instrument.

1. In the toolbar, click the **Send to instrument** button (1).

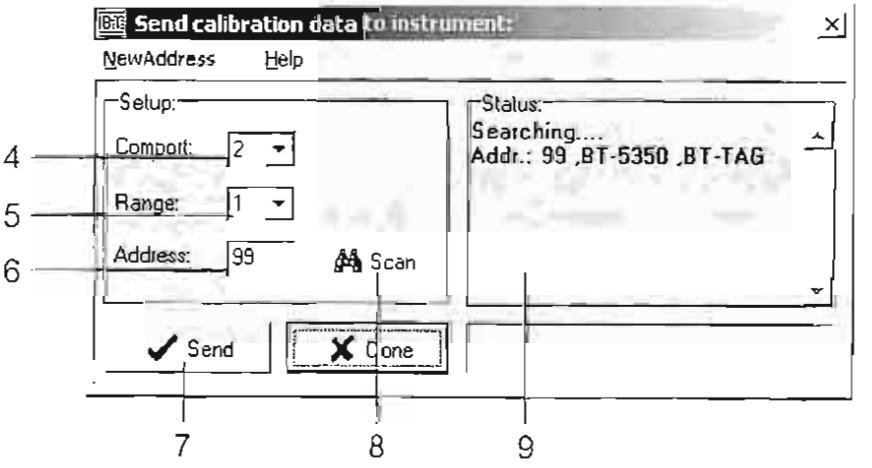


2. In the dialog box that appears, select desired mix to send calibration data for (2), and click the **Send** button (3).



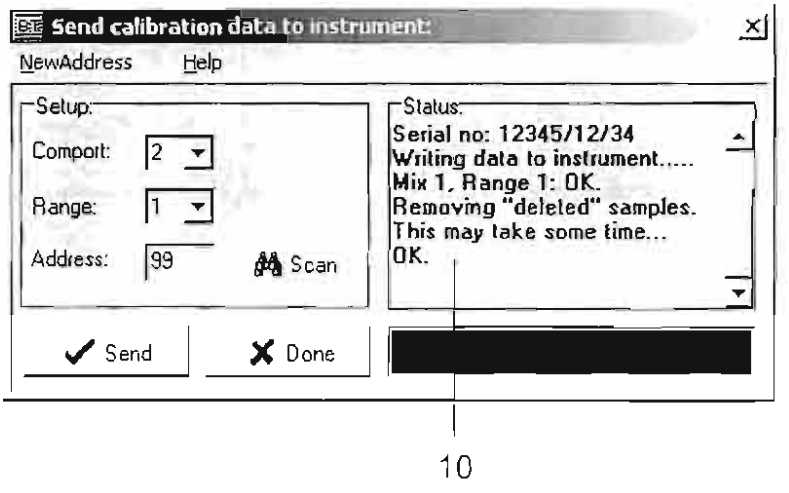
3. Check that correct COM port (4), range (5), and instrument address (6) are specified in the send data dialog.
   If you don't know the instrument address, you can search for connected instruments by clicking **Scan** (8). All connected instruments will be listed, together with their addresses, in the Status area (9). Double-clicking on an instrument address in the Status area will copy it to the address field (6).

4. Click **Send** (7).



If calibration data exists, it is sent to the instrument. At the same time, the sample is deleted from the instrument, which is indicated in the status area by the text "Removing "deleted" samples. This might take some time" (10). When the deletion is completed, "OK." will appear in the status area.

Note! If an error message is displayed in the status area, consult section 4: *Trouble Shooting*.



5. Click **Done** to return to the BT-Calibration main window.

4 Trouble Shooting

This chapter covers trouble shooting related to communication between BT-Calibration and connected instruments. If something goes wrong when BT-Calibration tries to send data to, or read data from, the instrument, an error message is displayed in the status area of the Read Data and Send Data dialogs. All error messages that can appear are presented in the following table, along with probable causes and suggested solutions.

For detailed descriptions of the Read Data and Send Data dialogs, see section 1.9: *Read Data Dialog* and section 1.10: *Send Data Dialog.*

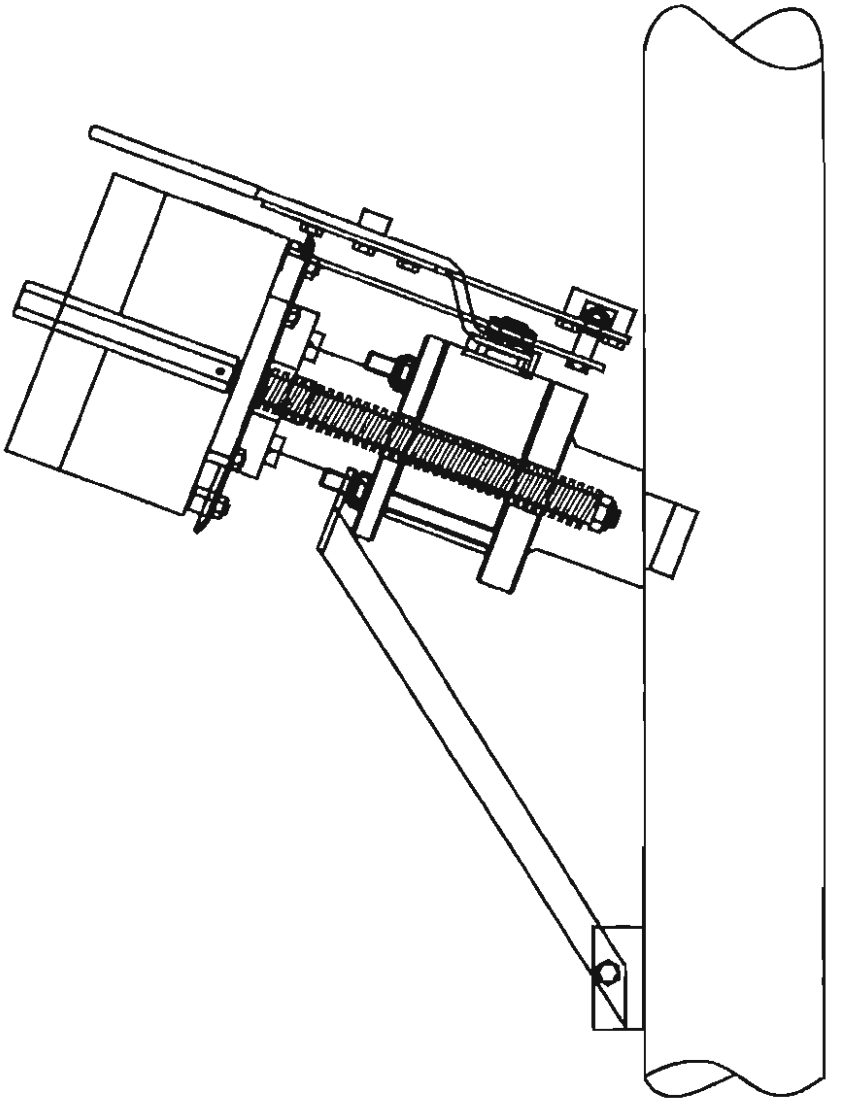
Error Message	Probable Cause	Solution
Error: Not the same instrument type!	The open calibration database is created for another instrument type than the selected instrument	Make sure that the selected instrument is of the same instrument type as the open calibration database is created for
Error: Instrument not supported!	The selected instrument is not supported by BT-Calibration. The Program only supports instruments of the type BT-5350 and BT-5400.	Make sure that the selected instrument is of a supported type
Error! Unable to open COM n	The COM port used is either occupied, not available or broken	Close any application that occupies the COM port or connect the instrument to another COM port
Comm error: No response	Wrong instrument address specified	Scan for connected instruments and specify an instrument address from the list of connected instruments
	Connection cable loose or not connected	Check the cable connection to the instrument, as well as to the computer
	The instrument is switched off or has no power supply	Make sure the instrument is switched on, and check the power supply connections
	The instrument is faulty	See the trouble shooting section of the instrument manual
Comm error: Could not read/ write to table	Incompatible version of the connected instrument	Close and restart the program or restart the computer

Comm error: No application data allocated Comm error: Could not allocate memory Comm error: Could not init FIFO Comm error: Could not get record from FIFO Comm error: Can't set RTS control Comm error: Port number too big Comm error: Already initialized by other process Comm error: An unknown error occurred	Internal program error	Close and restart the program or restart the computer

BTG
RAISING YOUR PRODUCTIVITY

Pulptec™ BT-5400

Brightness Transmitter



Disclaimer

The contents of this document are subject to revision without notice due to continued progress in methodology, design, and manufacturing. BTG shall have no liability for any error or damages of any kind resulting from the use of this document.

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Table of Contents

1 Product Introduction

1.1 General

The BT-5400 is designed for monitoring pulp bleaching in distributed control, supervisory or stand-alone applications. Due to a unique method of measuring brightness and a user-programmable algorithm, the BT-5400 can calculate compensated brightness signals that consider variables and inputs from a variety of process measurements.
The BT-5400 is available in a UV (Ultra Violet) light source variant for measurement of fluorescence.

There are five analog output signals specifically designed for brightness and color measuring, including ERIC (Effective Residual Ink Count) and flourescence (UV).

BT-5400 is a part of the BTG's "smart transmitter" product line. It is an intelligent, microprocessor-based transmitter that, in conjunction with the hand-held terminal SPC-1000, can be connected at any point on the 4-20 mA output signal loop.
Calibration is done using a PC software, called BT-Calibration.

The BT-5400 is mounted through a ball valve assembly (SS 2343 or titanium grade 2) to a weld-in stud or FRP stud. The BT-5400 can be used to measure brightness and color in all types of bleaching process. It is suitable for both mechanical pulps (TMP, CTMP, groundwood), and chemical pulps (kraft), and in recycled fiber deinking.

When brightness measurements are used to control chemical additions, variations in reaction rate due to changes in temperature, pH and chemical concentration become more important. Changes in reaction parameters must be compensated. Time effects such as production rate and stock flow must also be taken into account. The BT-5400's built-in temperature transmitter can be used for brightness signal compensation, temperature control or merely observation purposes.

1.1.1 Measuring Principle

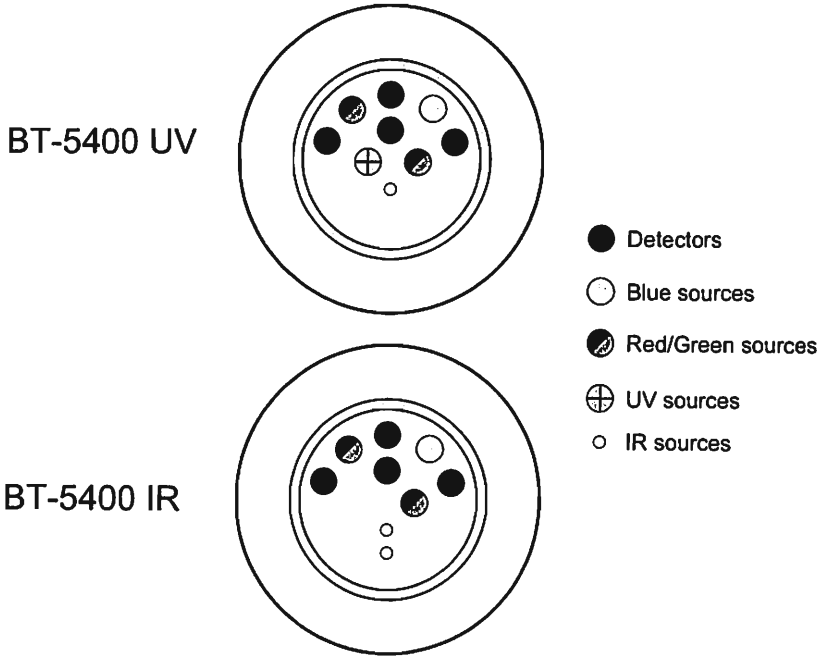
Pulp properties is measured at four (five for UV) discrete wavelengths. This is done by pulsing four (five for UV) groups of LEDs which are exemplary light sources thanks to their longevity, predictable beam pattern and monochromatic output, therefore no need for rotating color filters and motors. Color, brightness, ERIC, and flourescence (UV) with their different requirement on applied wavelength can be measured. In BT-5400 the four wavelengths can be combined to find the optimum correlation to lab in a specific application.

Light from the LEDs is directed into the process stream via flexible transmitting fiber optics. It passes through the probe window and is diffused by the pulp or other medium. The scattered light is then gathered by receiving fiber optics and conducted to a photo detector.

Optical feedback and software control routines, based on the tried and tested BTG 4-Beam™ Principle that minimizes drift due to temperature or aging of optical components, enable continuous compensation for changes in process temperature and allow for inevitable degradation of signal sources and detectors. These active equalization techniques give the signal stability needed.

The UV-channel in the BT-5400 UV measures fluorescence, which may appear from FWA (Fluorescent Whitening Agents) present in the pulp. An optical filter is used in front of the detector transmitting only the part of the emitted UV-light which is reflected in the visible wavelength region. Thus, the part of the UV-light which is reflected as UV is removed. Subsequently, pulps without FWA will have a measured signal at zero, or very close to zero, for the UV channel.

Fig 1 BT-5400 probe source/detector arrangement



1.2 Technical Data

General

Manufacturer
BTG, Säffle, Sweden

Quality Assurance
ISO 9001

Product Safety
Fulfills all relevant CE, UL, and CSA standards.

Functional Specification

Measuring Data

Measuring Range
Approx. 5-96 ISO

Temperature Measurement
Process temp. accuracy ±0.8°C/1.5°F
Internal temp. accuracy ±1°C/1.8°F

Damping
Mean value of 0-40 measuring cycles.

Measuring Cycle
Maximum 6 s

Event Log
Maximum 40 events are stored.

Signalling Data

Alarm Signal
Output signal at measuring span limits.
Also accessible via the communications link.

Vibration Testing

Resonance Frequency
160-170Hz and 450-500Hz within 4-600Hz

Source Data

Light Source
Light emitting diode

Detector Data

Photo Detectors
Photodiode (semi-conductor)

Process Specification

Process Limits
ANSI 150
PN 16

Process Temperature Limits
5-120°C (41-248°F)

Ambient Temperature Limits
0-50°C (32-122°F)

Performance Specification

Repeatability
± 0.3 ISO

Reproducibility
± 0.4 ISO

Temperature Effect
< -0.05 ISO per °C (°F=°Cx1.8)

Physical Specification

Probe

Degree of Protection
IP 65 / NEMA 4x

Material
Stainless steel SS2343 with EPDM O-rings
Titanium grade 2 with Kalrez O-rings

Window Material
Sapphire

Electronic Housing Material
FRP

Probe Weight
Stainless steel: 6.3 kg (14 lb)
Titanium: 5.0 kg (11 lb)

Valve Assembly Weight
Stainless steel: 5 kg (11 lb)
Titanium: 4.3 kg (9.5 lb)

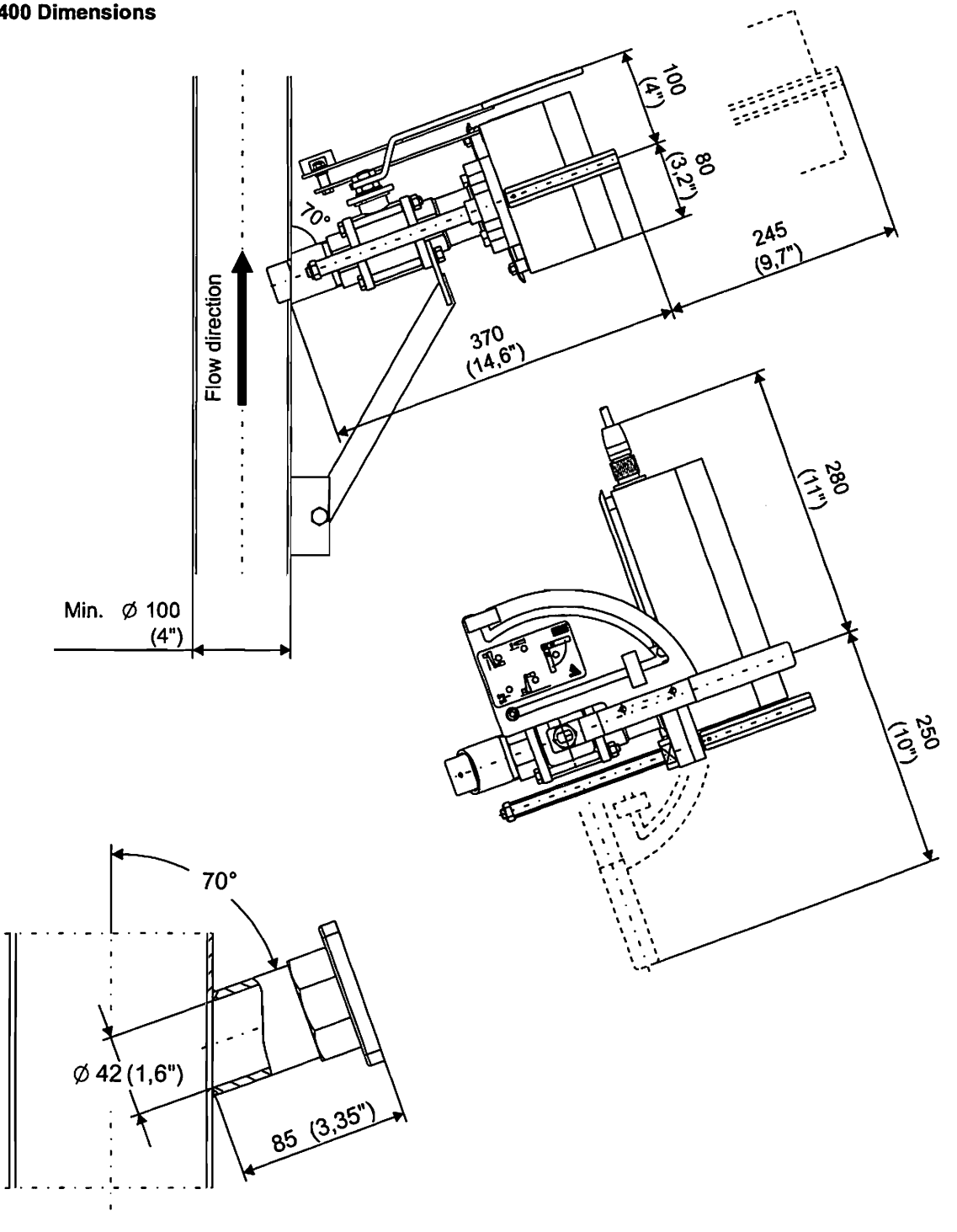
Storage Temperature
Minimum: -20°C (-4°F)
Maximum: 70°C (158°F)

Junction Box

See section 8.1.2.

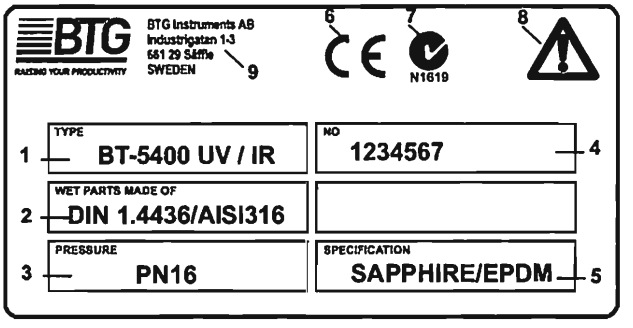
1.3 Dimensions and Mounting

Fig 2 BT-5400 Dimensions



1.4 Type Sign Explanations

Fig 3 Type sign



1. **Transmitter model**

   UV or IR type.

2. **Wetted parts made of**

   Stainless steel SS2343 (AISI 316 SS, DIN 1.4436) or Titanium grade 2.

3. **Pressure**

   PN 16 = Pressure class rating.

4. **Manufacturing number**

   BTG internal product identification number.

5. **Glass and rubber quality in wetted parts**

   Probe window = Sapphire.

   EPDM = O-rings for stainless steel, pH 8-14.

   Kalrez = O-rings for Titanium

6. **CE-marking**

   The BT-5400 is approved according to CE directives.

7. **C-TIC marking**

   The BT-5400 is approved according to Australian C-TIC N1619 directives.

8. **Warning sign**

   The device is designed for industrial use. Installation, handling and service must only be carried out by trained and authorized personnel and according to relevant standards. Read the manual for detailed information and pay special attention to the warning signs!

9. **Manufacturer**

2 Safety Instructions

2.1 General

These safety regulations are based on a risk analysis carried out in accordance with the requirements of relevant CE directions in order to comply with European standards for CE marking.

In practice, an operating brightness transmitter is only hazardous while covers are removed during installation and service.

Read these safety regulations before installing the transmitter. Follow the regulations when installing the transmitter, starting up and when carrying out service. Use warning signs for safety information!

Mounting parts, such as the weld-in stud, are dealt with in accordance with the pressure vessel standards of the countries in question.

Always take precautions when handling equipment in pressurized pipes.

All installation, operation, service, and other handling must be carried out by trained and authorized personnel and according to valid standards.

NOTE!
Follow this manual for all installation, operation, and service.

NOTE!
For good personal and functional safety: Use only parts which have been manufactured or approved by BTG.

2.2 Conventions

The following conventions are used in this manual:

- **DANGER!**

  A **DANGER!** admonition is used when there is a hazard with a risk for *injury or possible death* to a person.

- **WARNING!**

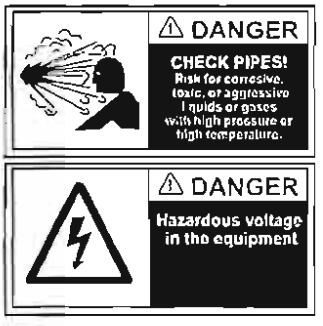
  A **WARNING!** admonition is used when there is a risk for *damage* to program, device, machine, sampler and so on.

- **CAUTION!**

  A **CAUTION!** admonition is used when there is a risk for *system failure, service interruption, disturbances* to plant operation, a measuring application and so on.

The admonitions above are hierarchic. A **DANGER!** admonition includes the possibility of both a **WARNING!** and a **CAUTION!** admonition.

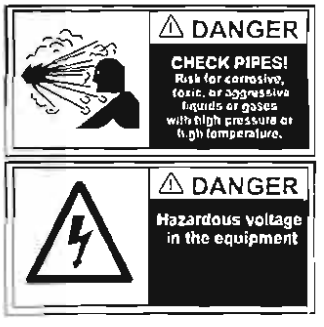
2.3 Safety Regulations



2.3.1 Safety Regulations for Installation

All welding must take place in accordance with current standards and regulations.

All handling of electrical units must take place in accordance with current standards and regulations. The junction box should only be connected by a qualified electrician in accordance with instructions. The ground should be connected safely and be checked. It should be possible to switch off the voltage in the distribution center. A clear warning, such as a sign, should let other people know that work is in progress and that the switch must not be touched.



2.3.2 Safety Regulations for Service

All handling of electrical units must take place in accordance with current standards and regulations. The junction box should only be connected by a qualified electrician in accordance with instructions.

Before removing the probe from the valve assembly, verify that the valve is closed. Hot or corrosive liquid that leaks out while under high pressure may cause serious chemical burn injuries!

2.4 CE declaration

When using the units in other combinations than tested for, BTG can not guarantee the CE directive conformity.

The units in combination with customer installed external devices may conform with EMC and safety requirements when properly installed and using an adequate CE marked equipment.

The system operator is responsible for the CE directive conformity. The conformity must be verified by inspection.

CE Declaration of Conformity

According to EN 45014

Manufacturer's Name	BTG Pulp & Paper Sensors AB
Manufacturer's Address	P.O. Box 602 S- 661 29 SÄFFLE, Sweden
declares that the product:	
Product Name	Brightness Transmitters
Model Number	BT-5300/BT-5400
complies with the amendments and requirements of the:	**Low Voltage Directive** 73/23/EEC **EMC Directive** 89/336/EEC **PED Directive** 97/23/EEC **RoHS** 2002/95/EC **WEEE** 2002/96/EC
and conforms with the following product standards and the PED conformity assessment procedure	
Safety	EN ISO 12100-1
LVD **ETL Reg. No. 401689** **Low Voltage Power Supply**	EN 61010-1 CAN/CSA-C22.2 No. 1010.1-92 NEC Class 2/IEC 60950/IEC 60601
EMC	EN 61000-6-4:99 EN 61000-6-2:04
PED	**Pressure equipment for piping.** In accordance to Article 1, Table 9, art.3 (3), Annex II (Sound eng. practise) **Must not bear CE-marking**
CSA/CRN 0C11058.5	**Sluis valve device acc. to ASME**
WEEE **RoHS**	-n.a.-, not Annex 1 -n.a.-
Quality System	ISO 9001 monitored by Lloyd's Register Quality Assurance
Säffle, **March 2007**	Anders Hjort, MD

3 Installation Instructions

3.1 Unpacking

The following is included in a BT-5400 delivery:

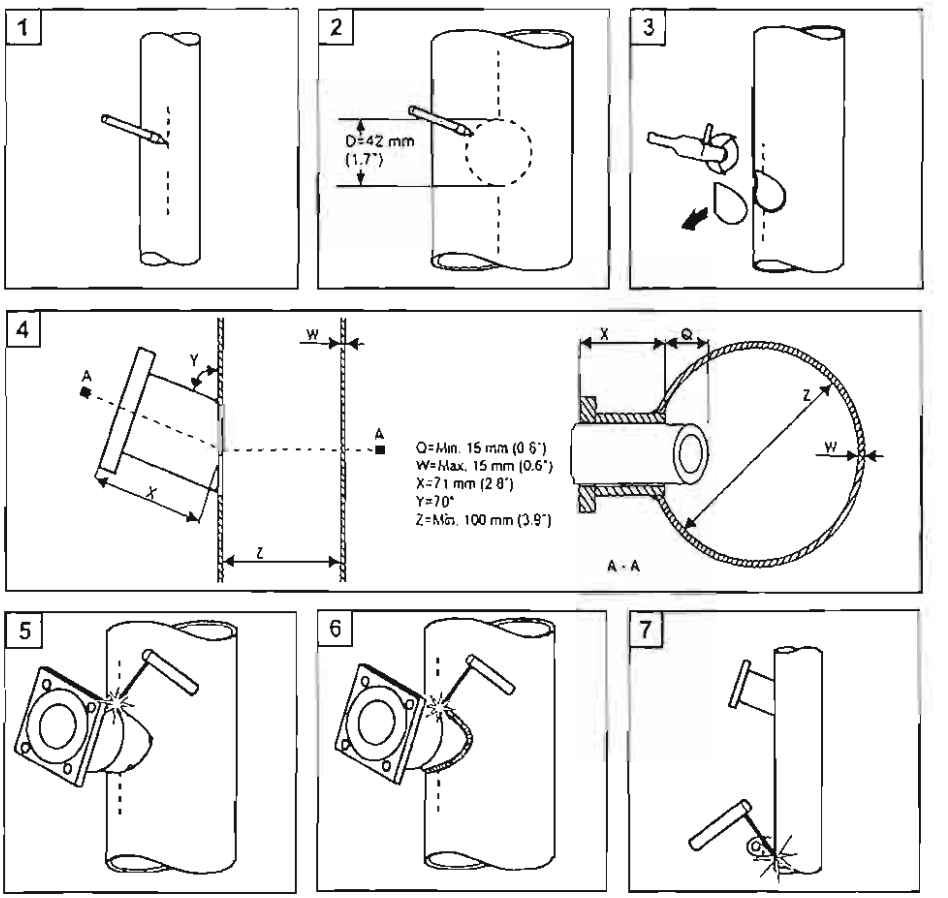
1. 1 x Measuring probe
2. 1 x BT-5400 test report
3. 1 x Reference kit
4. 1 x Ball valve
5. 1 x Brace
6. 1 x Block wrench (17 mm)
7. 1 x Weld-in stud
8. 1 x Transmitter cable
9. 1 x JCT-1100 electronics box
10. 1 x Hand held terminal, SPC-1000
11. 1 x User manual
12. 1 x BT-Calibration installation CD

3.2 Welding Instructions

3.2.1 Stainless Steel Weld-in Stud Installation

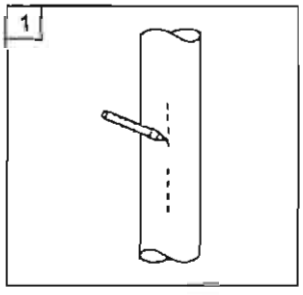
NOTE!
Pipe thickness shall not be more than 15 mm.

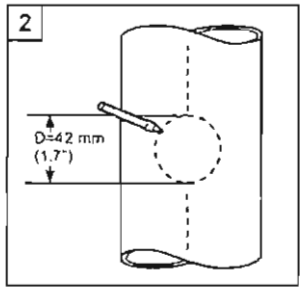

DANGER
CHECK PIPES!
Risk for corrosive, toxic, or aggressive liquids or gases with high pressure or high temperature.
DANGER
Use protective clothing

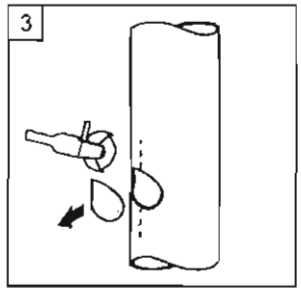

1
2
D=42 mm (1.7")
3
4
A
Y
W
X
Z
Q=Min. 15 mm (0.6")
W=Max. 15 mm (0.6")
X=71 mm (2.8")
Y=70°
Z=Min. 100 mm (3.9")
A - A
5
6
7

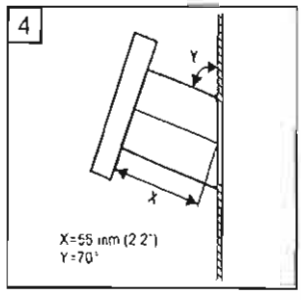
3.2.2 SMO 254 and Titanium Weld-in Stud Installation

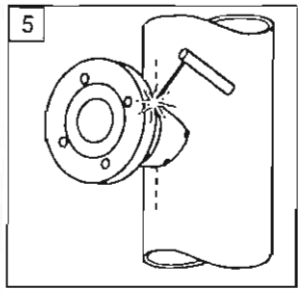
NOTE!
Pipe thickness shall not be more than 15 mm.

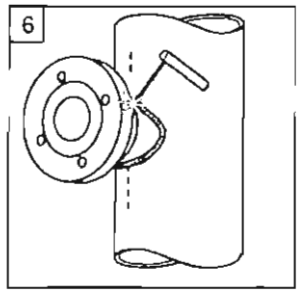


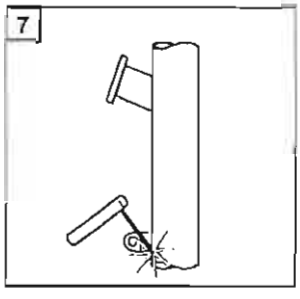






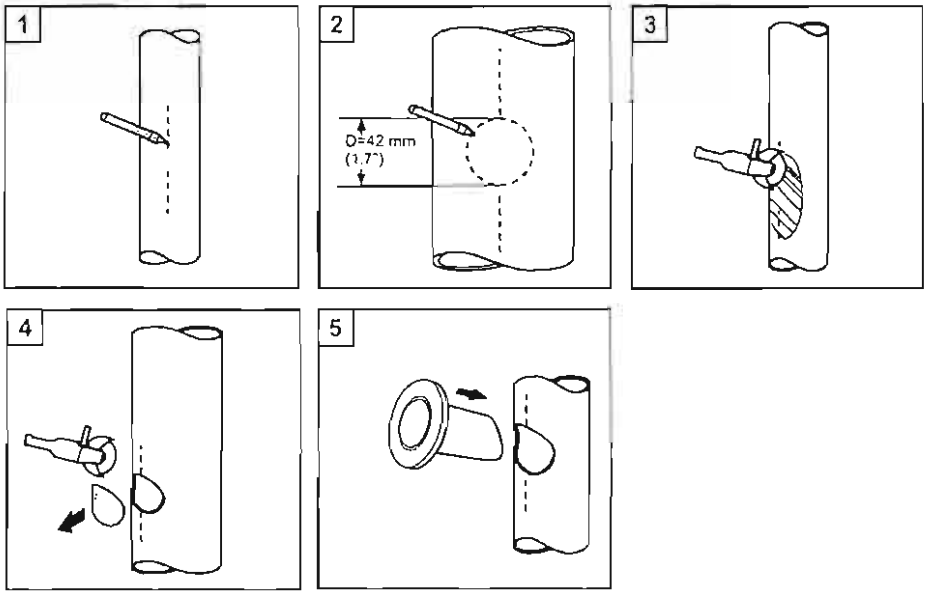


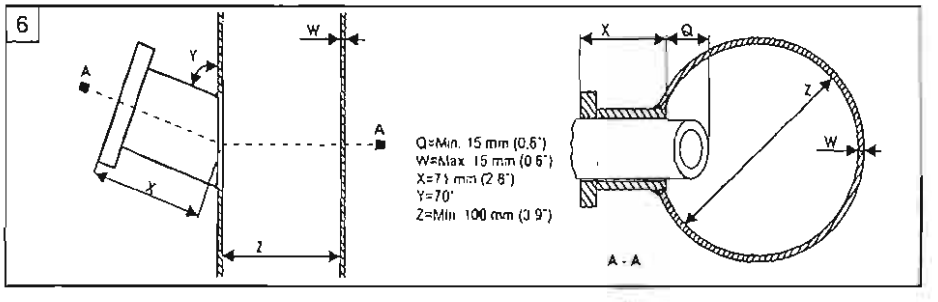


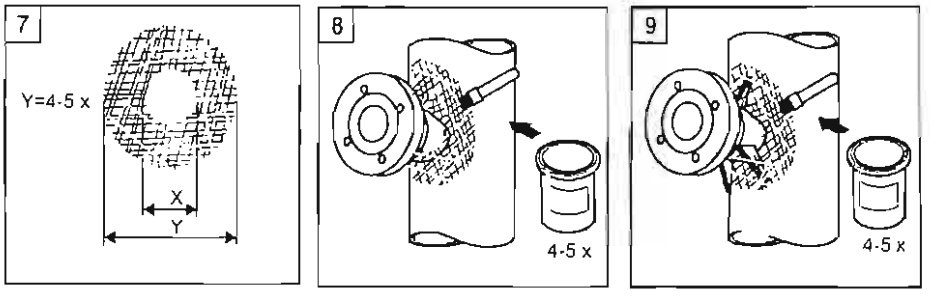


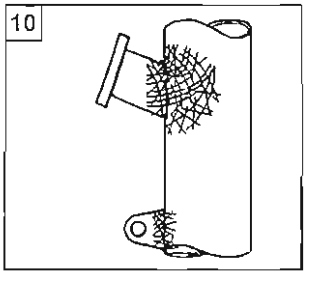
3.2.3 FRP Stud Installation

NOTE!
Pipe thickness shall not be more than 15 mm.





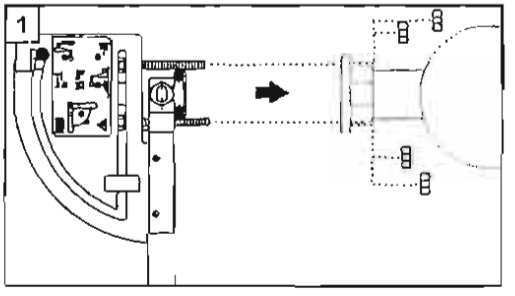




3.3 Mounting Instructions

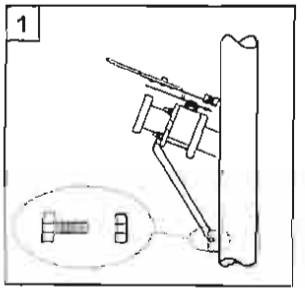
3.3.1 Mounting the Sluice Valve

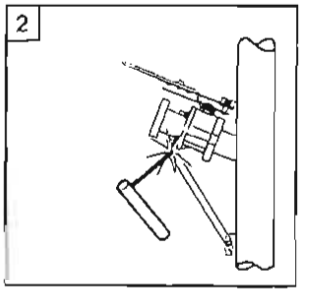
Tools required:
Spanner



3.3.2 Mounting the Brace

Tools required:
Spanner Weld equipment

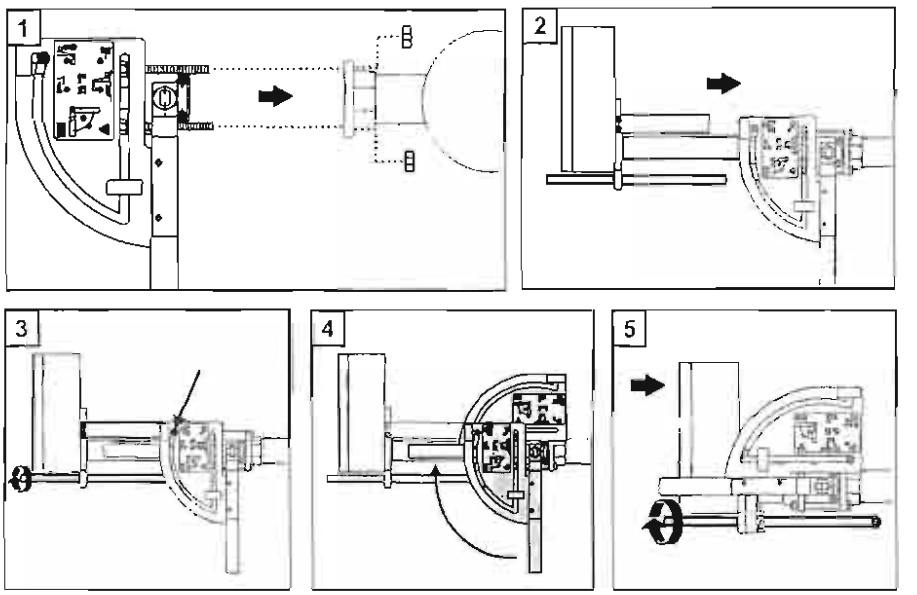




3.3.3 Mounting the Probe

Tools required:
Spanner

Parts required:
1 x Sealing kit, Article no. 84514280



3.4 Connection Instructions

3.4.1 Electric Connection

See section 8.3.

4 Operation Instructions

4.1 Hand-held Terminal SPC-1000

For more information about the SPC-1000, see section 7.4.

4.2 Commissioning

4.2.1 Startup

When you are confident that your BT-5400 has been correctly installed and you are ready to power up the system for calibration and/or testing, you should run through this brief check list before powering up. Using this list can help ensure trouble-free initialization of your system.

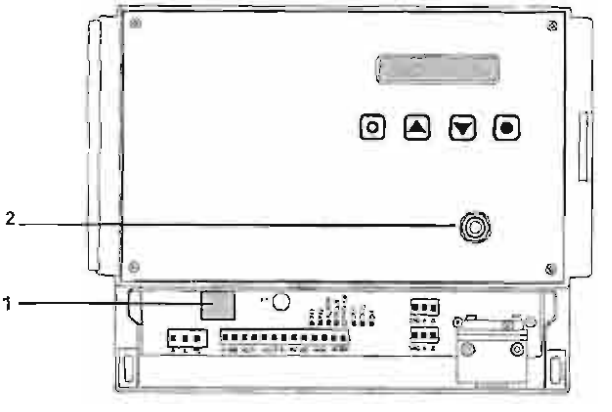
NOTE!
To ensure that the ball valve assembly and the probe are correctly installed and free from leakage it is recommended that you pressure test the system with water.
The pressure should be kept higher than the rating according to applicable regulations.

1. Ensure that the system is turned **OFF** before attaching the system cable to the transmitter.

NOTE!
Tighten the system cable contact securely!

2. Check all wiring.
3. Install the brightness transmitter BT-5400.
4. Remove the lower cover of the electronics box, power up the transmitter, and reattach the cover.

Fig 4 Electronics box
1 Power button
2 SPC-1000 connection



5. Connect the SPC-1000 hand-terminal to the front of the electronics box and power up the SPC-1000.
6. Press **BT-5400** (version 1.0 and higher) to enter the BT-5400 main menu.
7. Press **Read data** to make sure the transmitter and the SPC-1000 are synchronized.Use analog output 1 for brightness (blue LED).
8. Press the **Yes** button.
9. Wait 3-5 minutes.
10. Check that **Edit range** button is 1 and that the square in the lower right hand corner of the SPC-1000 shows **A.out 1**.

11. Find out the expected brightness in the process.
12. Look at the square in the lower right hand corner. Read the ISO value. Add an offset so that the output signal agrees with the brightness expected in the process.
13. Press the **Offset** button .
14. Enter the calculated offset value and press the **Enter/Menu** button.
15. Press the **Send data** button and then the **Send change** button.
16. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).

4.2.2 Set Time, Date and Supply Frequency

1. From the main menu, press **Configure** button.
2. Enter code **5400** and press **Enter/Menu** button.
3. Press **Config.setup**.
4. Press **Set clock**.
5. Enter the correct date and time and press the **Enter/Menu** button.
6. Check that the correct supply frequency is set (50 or 60 Hz), or edit by toggle the **Supply freq.** button.
7. Press the **Send page** button and then the **Send change** button.
8. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).

4.2.3 Select Range or Alarm Function

It must be decided if external measuring range selection inputs or alarm output is needed in the BT-5400 application. The two functions share the same connection points in the JCT-1100 and one must be selected if to be used.

If range inputs are selected this means that the BT-5400 uses two external range selector inputs to select measuring range (pulp quality). In this case, no alarm output exists.

If alarm output is selected, this means that external measuring range selection is not possible, but can be done manually from the SPC-1000 if needed.

1. From the SPC-1000 main menu, press **Configure** button.
2. Enter code **5400** and press **Enter/Menu** button
3. Press **Config.setup**.
4. Press **Range** button.

NOTE!
The **Range** button is only visible if **Mode** is set to **ALARM**.

In this case the BT-5400 is configured to handle an alarm output.

Depending on the chosen function, the white eight-pole connector on the circuit board inside the BT-5400 has to be placed accordingly, in either Alarm or Range position. Open the BT-5400 casing to get access to the connector.

1. From the SPC-1000 main menu, press **Configure** button.
2. Enter code **5400** and press **Enter/Menu** button
3. Press **Config.setup**.
4. Select the desired funtion with **Mode**.
5. Send changes to BT-5400 by pressing **Send page** button and then the **Send change** button.
6. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).

NOTE!
Default setting at delivery is Range.

4.3 Precalibration

This section describes the procedure for precalibration and how to check the reference calibration of the BT-5400.

Since the UV-channel measures only the fluorescence component of the reflectance, it must be calibrated using a different reference than the other channels; a fluorescent paper. For the 'high' reference, this paper is put on the probe tip with the common reference cylinder then put on top of it, and for the 'low' reference the dark side of the reference is used, without the paper. The value to be used for the 'high' reference thus is the fluorescence component of the brightness of the standard fluorescent paper, typically approximately 10 % ISO, and the value for the 'low' reference is zero, corresponding to no fluorescence.

4.3.1 Calibrate using Reference

This section describes the procedure for precalibration of the BT-5400 using reference cylinder with high and low brigthness. For the BT-5400 UV variant the UV-channel uses a fluorescent paper to add on the reference for the high level of brightness.

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.

1. Remove the BT-5400 from the process.
2. Wipe the probe window with a cotton cloth.
3. From the SPC-1000 main menu, press **Calibr.** button.
4. Enter code **5400** and press **Enter/Menu** button.
5. Press the **Ref.Calib.** button.
6. Put the reference with the highest ISO value on the probe tip.

NOTE!
The side with the white plastic inside the reference cylinder is the highest ISO value.

7. Wait two minutes for the signal to stabilize.
8. Press **Next Column** button until the cursor is placed in the **High probe** column.
9. Check that the signal is stable, then press **Copy meas** button to copy the measured signal to the **High probe** column.
10. Press **Next row** button.
11. Check that the signal is stable, then press **Copy meas** button to copy the measured signal to the **High probe** column.

NOTE!
For the **UV** -channel use a fluorescent paper from the black plastic box on the probe tip and the reference cylinder on top of the paper.

12. Repeat step 8 and 9 until measured signals are registered for **BLUE**, **RED**, **GREEN**, **N.IR**, and **F.IR/UV** in the **High probe** column.

13. Press **Next Column** button once so the cursor is placed in the **Lab** column.
14. Press the **Edit** button.
15. Enter the high ISO value noted in the test report (Reference measurement Lab) for the reference. Press **Enter/Menu** button
    (for the UV-channel the value with the fluorescent paper).
16. Press **Next row** button.
17. Enter the high ISO value noted for the reference. Press **Enter/Menu** button.
18. Repeat step 14 and 15 until all **Lab** values are entered.
19. Press the **Send** button and then the **Send change** button .
20. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).
21. Turn the reference cylinder on the probe tip so the lower ISO value is used.
22. If used, put the fluorescent paper back into the black plastic box.

NOTE!
The side with the dark plastic inside the reference cylinder is the lower ISO value.
For the **UV** -channel the fluorescent paper is **not** used for the lower value.

23. Wait two minutes for the signal to stabilize.
24. Press **Next Column** button until the cursor is placed in the **Low probe** column.
25. Repeat step 7 to step 18. Note that when entering **Lab** values the **Low** reference values must be used, from the test report (Reference measurement Lab).
26. Mount the BT-5400 in the process.

4.3.2 Check Reference Calibration

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.
- All **Meas Probe** values + **M.temp** have been noted.

1. Remove the BT-5400 from the process.
2. Wipe the probe window with a cotton cloth.

NOTE!
Warm probe and a cold reference can lead to condesation on the probe window.

3. From the SPC-1000 main menu, press **Ref.Check** button.
4. Put the reference with the highest ISO value on the probe tip.

NOTE!
The side with the white plastic inside the reference cylinder is the highest ISO value.
For the **UV** -channel use a fluorescent paper from the black plastic box on the probe tip and the reference cylinder on top of the paper.

5. Wait two minutes for the signal to stabilize.
6. Compare the **Meas.Probe** value with the **High Probe** value. Maximum difference should not exceed ±0.5 ISO.
7. If used, put the fluorescent paper back into the black plastic box.

NOTE!
The side with the dark plastic inside the reference cylinder is the lower ISO value.
For the **UV** -channel the fluorescent paper is **not** used for the lower value.

8. Turn the reference on the probe so the lower ISO value is used.
9. Wait two minutes for the signal to stabilize.
10. Compare the **Meas.Probe** value with the **Low Probe** value. Maximum difference should not exceed ±0.5 ISO.

NOTE!
If the values differ more than ±0.5 ISO, check the probe window for dirt or condensation and repeat this check. If the values still differ, do a new reference calibration.

4.4 Configure

This chapter describes how to configure the BT-5400 for brightness, ERIC, lightness, redness, yellowness, and if applicable UV -measurement.

4.4.1 Configure Brightness Measurement

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.
- Reference calibration and reference check have been performed.

NOTE!
To demonstrate the brightness configuration process, hypothetical lab samples are used with a lab value of 80 ISO

1. Take a physical sample for lab analysis.
2. On the SPC-1000 view **A.out1** (MIX, that means blue led) and read the measured value.
   Example: 40 ISO
3. Calculate the difference between the lab value and the measured value.
   Example: 80-40= 40 ISO.
4. Press the **Offset** button.
5. Enter the calculated offset value. Example: 40.
6. Press the **Enter/Menu** button.
7. Press the **Send data** button and then the **Send change** button.
8. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).

4.4.2 Configure ERIC Measurement

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.
- Reference calibration and reference check have been performed.

NOTE!
To demonstrate ERIC configuration, hypothetical lab samples are used with a lab value of 300 ppm.

1. From the SPC-1000 main menu, press **Configure** button.
2. Enter code **5400** and press **Enter/Menu** button.
3. Press **Config.setup** button.
4. Choose an analog out signal. In this example **A.out 2** is used.
5. Toggle the **A.out 2** button until **MIX** is selected.
6. Toggle the **Unit** button until **PPM** is selected.
7. Enter the following values:

Mix BLUE	0
Mix RED	0
Mix GREEN	0
Mix N.IR	-20
Mix F.IR/UV	0
Offset	1000

8. Press the **Send page** button and then the **Send change** button.
9. Enter the code **42600** and press the **Enter** button (only needed if send code is ON).
10. Press the **Menu** button three times to go back to the main menu.
11. Take a physical sample for lab analysis.

NOTE!
The same lab sample can be used to configure brightness, ERIC, lightness, redness, and yellowness measurements.

12. View **A.out 2** and read the measured value. Example: 1200 ppm
13. Calculate the difference between the lab value and the measured value. In the example here the lab value was 300 ppm with an offset of 1000. The offset is then calculated as 1300-1200=100 ppm.
14. Press the **Offset** button.
15. Enter the calculated offset value. Example: 100.
16. Press the **Enter/Menu** button.
17. Press the **Send data** button and then the **Send change** button.
18. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).

4.4.3 Configure Lightness Measurement (L*)

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.
- Reference calibration and reference check have been performed.

NOTE!
To demonstrate lightness configuration, hypothetical lab samples are used with a lab value of 70.

1. From the main menu, press **Configure** button.
2. Enter code **5400** and press **Enter/Menu** button.
3. Press **Config.setup** button.
4. Choose an analog out signal. In this example **A.out 3** is used.
5. Toggle the **A.out 3** button until **MIX** is selected.
6. Toggle the **Unit** button until no values are selected.
7. Enter the following values:

Mix BLUE	1
Mix RED	0
Mix GREEN	0
Mix N.IR	0
Mix F.IR/UV	0

8. Press the **Send page** button and then the **Send change** button .
9. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).
10. Press the **Menu** button three times to go back to the main menu.
11. Take a physical sample for lab analysis.

NOTE!
The same lab sample can be used to configure brightness, ERIC, lightness, redness, and yellowness measurements.

12. View **A.out 3** and read the measured value. Example: 10
13. Calculate the difference between the lab value and the measured value. In the used example the lab value was 70. Then the offset is calculated as 70-10=60.
14. Press the **Offset** button.
15. Enter the calculated offset value. In the used example 60.
16. Press the **Enter/Menu** button.
17. Press the **Send data** button and then the **Send change** button.
18. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).

4.4.4 Configure Redness Measurement (a*)

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.
- Reference calibration and reference check have been performed.

NOTE!
To demonstrate redness configuration, hypothetical lab samples are used with a lab value of -0.5.

1. From the main menu, press **Configure** button.
2. Enter code **5400** and press **Enter/Menu** button.
3. Press **Config.setup** button.
4. Choose an analog out signal. In this example **A.out 4** is used.
5. Toggle the **A.out 4** button until **MIX** is selected.
6. Toggle the **Unit** button until no values are selected.
7. Enter the following values:

Mix BLUE	1
Mix RED	-1
Mix GREEN	0
Mix N.IR	0
Mix F.IR/UV	0

8. Press the **Send page** button and then the **Send change** button.
9. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).
10. Press the **Menu** button three times to go back to the main menu.
11. Take a physical sample for lab analysis.

NOTE!
The same lab sample can be used to configure brightness, ERIC, lightness, redness, and yellowness measurements.

12. View **A.out 4** and read the measured value. Example: 0.0
13. Calculate the difference between the lab value and the measured value. In the example here the lab value was -0.5.
    The offset is thus calculated as -0.5-0=-0.5.
14. Press the **Offset** button.
15. Enter the calculated offset value. In the used example -0.5.
16. Press the **Enter/Menu** button.
17. Press the **Send data** button and then the **Send change** button.
18. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).

4.4.5 Configure Yellowness Measurement (b*)

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.
- Reference calibration and reference check have been performed.

NOTE!
To demonstrate yellowness configuration, hypothetical lab samples are used with a lab value of 7.0.

1. From the main menu, press **Configure** button.
2. Enter code **5400** and press **Enter/Menu** button.
3. Press **Config.setup** button.
4. Choose an analog out signal. In this example **A.out 5** is used.
5. Toggle the **A.out 5** button until **MIX** is selected.
6. Toggle the **Unit** button until no values are selected.
7. Enter the following values:

Mix BLUE	1
Mix RED	0
Mix GREEN	-1
Mix N.IR	0
Mix F.IR/UV	0

8. Press the **Send page** button and then the **Send change** button.
9. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).
10. Press the **Menu** button three times to go back to the main menu.
11. Take a physical sample for lab analysis.

NOTE!
The same lab sample can be used to configure brightness, Eric, lightness, redness, and yellowness measurements.

12. View **A.out 5** and read the measured value. Example: 0.0
13. Calculate the difference between the lab value and the measured value. In the example here the lab value was -0.5. The offset is thus calculated as 7.0-0=7.0.
14. Press the **Offset** button.
15. Enter the calculated offset value. Example: 7.0.
16. Press the **Enter/Menu** button.
17. Press the **Send data** button and then the **Send change** button.
18. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).

4.4.6 Configure UV Measurement

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.
- Reference calibration and reference check have been performed.

NOTE!
To demonstrate UV measurement configuration, hypothetical lab samples are used with a lab value of 8 % ISO.

1. Take a physical sample for lab analysis.
2. From the SPC-1000 main menu, press **A.out** until **5** is selected.
   A value of 9.5 % ISO is presumed.
3. Calculate the difference between the lab value and the measured value.
   In the example here the lab value was 8.
   The offset is thus calculated as 8-9.5=-1.5.
4. Press the **Offset** button.
5. Enter the calculated offset value. Example: -1.5.
6. Press the **Enter/Menu** button.
7. Press the **Send data** button and then the **Send change** button.
8. Enter the code **42600** and press the **Enter/Menu** button (only needed if send code is ON).

4.5 Operation

4.5.1 Enter Main Menu

1. Switch on SPC-1000.
2. Press **BT-5400** (version 1.0 or higher).

It is recommended to turn off the communication between the JCT-1100 and the BT-5400. Analog out 4 and 5 will be disabled to ensure trouble free communication between SPC-1000 and the BT-5400.

4.5.2 Read Data from BT-5400 to SPC-1000

1. **Read data** flashes in the main menu to indicate that data in the SPC does not correspond with data in the instrument.
2. Press **Read data** button.
3. Press **Yes** button.
4. Communication between the SPC-1000 and the instrument is now established and can take approx. 3-4 min. to complete (shown by a progress bar). If communication with the instrument doesn't work - see SPC-1000 error message or troubleshooting.

4.5.3 Configure Tag

1. Press **Configure** button.
2. Enter code **5400** and press **Enter/Menu** button.
3. Press **Tag**.
4. Enter tag number, for example **35AI345**.
   Press **3**, wait two seconds and the cursor will jump to the next position. Press **5**. Press **1ABC** twice for letter **A**, this must be done within two sec. Continue entering the tag number and press **Enter/Menu** once again when completed.
5. Select **Config. setup** button. (**Send page** button flashes if the tag number is altered.)
6. Press **Send page** button.
7. Press **Send change** button.
8. Enter code **42600** and press **Enter/Menu** button (only needed if send code is ON). Communication between the hand terminal and the instrument is established and the latest changes have been sent.

4.5.4 View Analog Output Signals

1. Press **Menu** button to enter the main menu.
2. In the large square to the right you see **A.out 1**.
   By pressing the square you can scroll between analog output signals 1 to 5.

4.5.5 Take Samples

4.5.5.1 JCT-1100

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.
- Reference calibration and reference check have been performed.

1. Press the **Sample** button on the JCT-1100.
   The sampling process starts. Default value are five samples.
2. While the sampling process is ongoing, take a physical sample for lab analysis.
3. When the sampling process is finished the display will show SAMPLE SAVED.
4. Press **Enter** button to show the date. Note the date.
5. Press **Enter** button again to show the time. Note the time also
6. Press **Enter** or any other button at this stage will finish the sampling procedure.
7. Save the sample (0-100). Press **Enter**.
8. To use the saved samples for calibration, the PC-software BT-Calibration is available from BTG.

4.5.5.2 SPC-1000

Prerequisites:

- BT-5400 has been mounted and in contact with the process for at least three hours and has the same temperature as the process.
- Reference calibration and reference check heve been performed.
- On the JCT-1100 communication must be **OFF**.

1. From the BT-5400 main menu on the SPC-1000 press the **Calibr.** button.
2. Enter code **5400** and press **Enter/Menu** button.
3. Press **Take sample** button.
4. Select the nurnber of samples by pressing **Avrg. of** repeatedly.
5. Press **Take sample**. Collect a pulp sample from the line for lab evaluation at the same time.
6. If the sample is OK, press **Accept**. (If not OK, press **Discard** and take a new sample). The value is now stored in the BT-5400.
7. Repeat steps above until the desired number of samples has been taken.
8. When finished, press **Menu** twice to return to the BT-5400 main menu.

4.5.6 Check Events Log

1. Press **Misc.** button.
2. Press **Alarm & diagnostics** button.
3. Enter code **5400** and press **Enter/Menu** button.
4. Press **Show log** button.
   Here you will find the latest 40 alarms or events stored.
5. Press **Prev** to scroll backwards in the list.

4.5.7 Check Range Selection on the JCT-1100

NOTE!
Mode = Range

1. Check that the transmitter cable inside the JCT-1100 box is connected to J1 (*Range*-inputs).
2. On the JCT-1100 communication must be **ON**.
3. Short-circuit the JCT-1100 between Gnd and Range A(C), the *Range* in the main menu on SPC-1000 will change from "1" to "2".

4.5.8 Check Range Selection on the SPC-1000

1. Check that the the white eight-pole connector on the circuit board inside the BT-5400 is connected to Alarm.
2. Press **Configure** button in the main menu.
3. Enter code **5400** and press **Enter/Menu** button.
4. Press **Config setup** button.
5. The **Mode** button should show **Alarm**.
6. Press **Range** button and select 1.
7. Press **Send page** button.
8. Press **Send change** button.
9. Enter code **42600** and press **Enter/Menu** button (only needed if send code is ON).

4.5.9 Measuring range and edit range

The BT-5400 (as most of BTG instruments) use the range concept to select different calibration setups to distinguish between pulp types and qualities.

As described in section 4.2.3: *Select Range or Alarm Function*, the selection of measuring range can be controlled from the process via external range selector inputs or set manually by SPC-1000 setting.

This function should not be confused with the SPC-1000 **Edit range**, which is simply a selection of which of the four available ranges to edit. This means, **Edit range** does not select the measuring range of the BT-5400, it gives access to settings and viewing of measurement results for the different ranges.

The selection of which range (calibration) to use for measurement is done by external range selector inputs or via SPC-1000 Config setup selection (see section 4.2.3: *Select Range or Alarm Function*).

4.6 Calibration by Sampling

For tuning of the calibration it is recommended that process samples are taken covering the intended span of operation, with respect to the brightness parameters of interest.

Depending on application this may be one or more of the following three:

1. Brightness according to laboratory standard with UV-filter, that is without the fluorescence component.
2. Brightness according to laboratory standard without UV-filter, that is including the fluorescence component.
3. The difference between 1 and 2, that is the fluorescence component only. If more than one of them are to be used, then they should be varied independently in order to achieve a robust calibration. It is recommended that BT-Calibration is used since more than one channel normally is required for calibration.

In BT-Calibration the channels to be included in the calibration procedure can be set, provided that manual calibration mode is used. For all parameters without influence of fluorescence, such as brightness according to the laboratory method with UV-filter, L*a*b* and ERIC, the UV-channel should be de-activated in order to avoid overfitting. Subsequently, for calibrating parameters with influence of fluorescence, such as brightness according to the laboratory method without UV-filter, or the fluorescence component itself, the UV-channel naturally must be activated. Furthermore, for calibrating the brightness according to the laboratory method without UV-filter, in addition to the UV-channel also at least one of the RGB LED's must be activated, presumably the blue one.

4.6.1 General Remarks on Sampling

NOTE!
The only way to calibrate the transmitter correctly is to take correct laboratory samples and adjust the transmitter accordingly.

To ensure acceptable precision in laboratory samples, *we recommend usage of BTG sampling valves.*

Sampling procedure:

1. Install the sampling valve close to the transmitter on the same side of the pipe. The valve should be installed so there is no interference from pipe bends, pumps, etc. Recommendations regarding turbulence damping zones are the same as for the transmitter itself.
2. Take a number of samples that cover your entire brightness span. Calculate the mean value and reject samples that deviate widely from the mean. Take an adequate volume for sampling – at least 500 ml (1/2 US quart) for a reliable sample.
3. Make sure that samples for calibration and subsequent checking are **always taken in the same manner** regardless of who does the sampling. Similarly, the **laboratory procedure** must always be exactly the same.

The design of, and compliance with, sampling routines is crucial in assuring uniform treatment of samples. Calibration and future precision of measurement by the transmitter depends on this.

During calibration, the pulp flow past the Transmitter must be *representative* for the position in which it is installed.

4.6.2 Take Samples

- On the JCT-1100 communication must be **OFF.**

1. From the BT-5400 main menu on the SPC-1000 press the **Calibr.** button.
2. Enter code **5400** and press **Enter/Menu** button.
3. Press **Take sample** button.
4. Select the number of samples by pressing **Avrg. of** repeatedly.
5. Press **Take sample**. Collect a pulp sample from the line for lab evaluation at the same time.
6. If the sample is OK, press **Accept**. (If not OK, press **Discard** and take a new sample). The value is now stored in the BT-5400.
7. Repeat steps above until the desired number of samples has been taken.
8. When finished, press **Menu** twice to return to the BT-5400 main menu.

4.6.3 View Reference Values

1. Enter the SPC-1000 main menu. See start-up.
2. Press **Ref. Check** button.
3. View all reference values.

4.6.4 Update Reference Values

This section describes the procedure to check whether internal reference values are valid or not.

Over time, changes in the measurement accuracy can occur due to ageing etc. Measured values must not differ more than 0.5 % ISO from the latest values noted in the Reference measurement section of the test report.

For update of reference values see section 4.3.1: *Calibrate using Reference*.

NOTE!
It is important to note the new values in the Reference measurement section of the test report for the BT-5400.

4.7 Damping and Measuring Span

Caution!
A too long damping time constant will reduce the accuracy of the control system .

The damping time constant is set after calibration has been completed. Set it so that the signal is stable. Use a mean value of 0-40 measurements, allowing 6 seconds for each measurement.

If a very long time constant is needed due to an unsteady probe signal, the transmitter is probably working in an unstable, poorly mixed pulp flow. In this case you should consider:

- Relocating the transmitter further from the pump.
- Improving the remixing system or the supply of dilution water, etc.

Setting a too long time constant reduces the benefit of the transmitter's high precision. Contact BTG for further advice.

4.7.1 Set Damping

1. From the BT-5400 main menu on the SPC-1000 press the **Trend** button. Study the stability of the signal.
2. Press the **Menu** button and select **A.out** for the desired channel.
3. Press the **Damp** button and enter a suitable mean value, for example 5.
4. Press **Send data** followed by **Send change.**
5. Enter code **42600** and press **Enter/Menu** button.
6. Press **Trend** and study the result.
7. If necessary, adjust the damping.

4.7.2 Set Measuring Span

Try to keep the measuring span as narrow as possible.

1. Select **A.out** for the desired channel.
2. Set the brightness level for the lower limit of the measuring span. Press **4 mA** for the lower limit (4 mA).
3. Enter the new value and press **Enter/Menu.**
4. Press **20 mA** for the upper limit (20 mA).
5. Enter the new value and press **Enter/Menu.**
6. Check that the settings are correct.
7. Press **Send data** followed by **Send change** to transfer the values to the transmitter.
8. Enter code **42600** and press **Enter/Menu** button (only needed if send code is ON).

4.8 Compensation

To compensate for consistency the BT-5400:s analog input can be used by connecting the signal from an external consistency transmitter.

To get a consistency span, it is best to perform a process dilution for approx. 10 minutes and during the process read the signal from both the brightness transmitter and the consistency transmitter. Samples should be taken during and after dilution.

4.8.1 Adjust mA Input Signal

1. Connect the mA-source "+" to JCT-1100 terminal AUX In+ (F) via a DMM (digital multimeter) set on current metering to 20 mA (smallest possible range) and "-" to terminal ground (GND).
2. From the SPC-1000 main menu, press **Misc** button.
3. Press **Factory setting** button.
4. Enter code **1632** and press **Enter/Menu** button.
5. Press **A.in** button.
6. Apply 4.0 mA input current. Read the value.
7. Press **Set 4 mA** button.
8. Enter the value and press **Enter/Menu** button.
9. Apply 20.0 mA input current. Read the value.
10. Press **Set 20 mA** button.
11. Enter the value and press **Enter/Menu** button.
12. Press **Send** button
13. Press **Send change** button to transfer the values to the transmitter.
14. Enter code **42600** and press **Enter/Menu** button (only needed if send code is ON).
15. Press **Menu** three times to enter the main menu.

4.8.2 Collect Compensation Values

This procedure is divided into two phases.
The first phase is to collect physical samples from the pulp line and at the same time note the values **A.out-process-eu** for output signal value and the **A.inp-EU** for the compensation signal.

The second phase is to use collected and noted values to activate compensation.

For example:

PHASE 1:

1. Take physical lab samples from the pulp line.
2. On the SPC-1000 press **Misc** button.
3. Press **Factory setting** button.
4. Enter code **1632** and press **Enter/Menu** button.
5. Press **All signals** button.
6. Press **A.out** button to scroll between the output signals (**OUT.1**). Select the output signal that to be compensated.
7. Note the **A.out-process-eu** for output signal value and the **A.inp-EU** for the compensation signal.

PHASE 2:

1. Press **Menu** button three times to enter the main menu.
2. Press **Configure** button.
3. Enter code **5400** and press **Enter/Menu** button.
4. Press **Comp A.out (1-5)** button.
5. Select **A.out (1-5).**
6. Press **Select comp.** button to scroll to **A.IN** if that signal is to be used for compensation.
7. Press **Set comp. table** button.
8. Press **Edit sample** button to scroll to line 1. Line 1 can, for example, be low consistency (low analog input signal), line 2 can be the nominal value (operating point) and line 3 high consistency (high analog input signal).
9. Press **Load EU value** button to enter the analog output signal value noted from step 7 in phase 1 and press **Enter/Menu** button.
10. Press **Load comp. fact** button to enter the required compensation in percent noted from step 7 in phase 1 and press **Enter/Menu** button.
11. Press **ON/OFF** button to activate the compensation factor **ACT=ON.**
12. Proceed in the same manner for all the rows.
13. Press **Menu** button.
14. Press **Send page** button.
15. Press **Send change** button to transfer the values to the transmitter.
16. Enter code **42600** and press **Enter/Menu** button (only needed if send code is ON).
17. Press **Menu** twice to enter the main menu.

5 Service Instructions

In section 5.1 you will find a summary of maintenance that must be carried out and the maintenance intervals. In section 5.2 to section 5.7 you will find the instructions for performing the maintenance.

5.1 Continuous Maintenance

5.1.1 Calibration Period (approx. 1 month)

- Check against reference once weekly.

5.1.2 Guarantee Period (approx. 6 months)

- Check against reference once monthly.

5.1.3 Daily Checks

- Check the output signal.
- The output signal from the transmitter must not deviate from lab samples. How often a lab sample should be taken depends on positioning and requirement. Determine the tolerance level.

5.1.4 Weekly Checks

- Ensure that the transmitter is in position. Check for leaks.

5.1.5 Monthly Checks

- Trend follow up against lab samples. Determine the tolerance level.
- Make a note of internal signals.

5.1.6 Semi-annual Checks

- Check the transmitter with the reference to ensure ISO-values are still valid. If not, update reference values, see section 4.3.2: *Check Reference Calibration.*
- Check the ball valve and its O-rings for leakage.
- Clean the window and lubricate the probe tube.
- Check the box for moisture.

5.1.7 Annual Checks

- Check the ball valve
- Check the mounting stud
- Clean the exterior of the transmitter.

5.1.8 Bi-annual Checks

- Replace any leaking sealings
- Check the reference against lab values. Update values.

5.2 Alarm and Events

The system has an Eventlog, which is accessible from the SPC-1000. Alarms and exceptions should be recorded in the log.

All alarms start with * in the Eventlog to avoid being confused with Exceptions.

5.2.1 Alarms

The following alarms can be set by the user:
Analog out 1, Analog out 2, Analog out 3, Analog out 4, Analog out 5, Analog inp.

In SPC-1000 programming the following abbreviations are used:
"Aout1", "Aout2", "Aout3", "Aout4", "Aout5", "Inp"

Four different alarm conditions are reported in the Eventlog:
"Hi", "Lo", "Ok", "Off"

"Hi" and "Lo" refer to the limits, High and Low, which can be set for the alarms. When these are passed, a text stating the alarm is shown in the Eventlog and whether the upper or lower limit is exceeded (Hi or Lo). The actual value at the time of the alarm is also shown.

Example:
Aout 1 has exceeded its upper alarm limit of 74.0:

Appearance in SPC

Date:	2007-03-16 11.12.02
Event:	*Aout1 Hi
Value:	75.2
Range:	1

When the value is back within the alarm limits, it is logged with the addition OK.

Example:
The Aout 1 value is below the alarm limit 74.0.

Appearance in SPC

Date:	2007-03-16 11.32.12
Event:	*Aout1 OK
Value:	70.4
Range:	1

An active alarm that is shut off is marked in the log by "Off".

If the alarm output is activated by one or several alarms, all active alarms must be deactivated before the alarm output is deactivated. Set the alarms to OFF to do this.
This event will be logged with "Car alarm".

5.2.2 Exceptions

Exceptions are reported to be used for diagnosis or troubleshooting, mainly by BTG personnel.

Why and when Exceptions are reported can not be influenced by the user.

The following things may cause an Exception:

Event	Description Text	Description
System start	"Started	"When the system is restarted after a power-fail. (voltage drop)
New program version	"New progr.	"All settings are reset to basic settings when a new program is downloaded to the transmitter (same or new version).
Cleared Eventlog	"Clr.EvLog	"From the table Device column ClearEvents all items in the Eventlog can be cleared.
Changed settings	"New config	"Changes made from SPC-1000 generate an exception. At certain occasions additional information will occur (see below).
Overflow	"Pre.T err	"T-DETECTOR: Cannot increase amplification further. Preamplification max= 32.
Underflow	"Pre.T err	"T-DETECTOR: Cannot reduce amplification further. Preamplification min= 1.
OK	"Pre.T OK	"T-DETECTOR: Within the control range again.
Overflow	"Pre.M err	"M-DETECTOR: Cannot increase amplification further. Preamplification max= 32.
Underflow	"Pre.M err	"M-DETECTOR: Cannot reduce amplification further. Preamplification min= 1.
OK	"Pre.M OK	"M-DETECTOR: Within the control range again.
zero division	"K1=0	"Calibration: The constant is zero.
zero division	"K1 is OK	"Calibration: Constant OK.
zero division	"K2=0	"Compensation: The constant is zero.
zero division	"K2 is OK	"Compensation: Constant OK.

Additional information may occur in the Value field for some events:

- When a new program version ("New progr.") is loaded, it is shown here.
- Alarm
- Preamp

Otherwise the value is 0.00.

5.2.3 SPC-1000 Error Messages

The SPC communicates with the transmitter using HART® protocol. The SPC-1000 and the transmitter has a Master-Slave relationship where the SPC-1000 is Master (secondary master) and the transmitter is Slave.
The error messages that occur on the SPC-1000 always starts with Cmd*, where * represents the command which led to the error.

The following error messages can occur:

Error message	Description	Action
Comm line busy	The line is busy by another Master. The SPC-1000 will try to find an opening in the line 5 times.	The other Master does not follow the HART standard. Disconnect or turn the other Master off.
Not from slave	The answer comes from another Master and not from the transmitter.	Disconnect the HART unit which is not the one that you want to communicate with since there are terminals that do not function properly.
Comm error	Communication error / parity error.	Can be due to disturbances in the environment or bad cables. Check all cables and fittings.
Wrong slave ID	The answer comes from another Slave than the SPC-1000 sent the command to.	Normally there is only one Slave and the error will not occur. Disconnect any Slave other than the one you want to communicate with.
Wrong reply cmd	Wrong answer to the command. The transmitter has given answer to a question the SPC-1000 did not send.	Probably there are other units connected to the cable that disturb the communication. Disconnect them.
Cmd resp error	A protocol error between the SPC-1000 and the transmitter. The transmitter does not understand the SPC-1000 properly.	Update the software in the SPC-1000 or the transmitter so that they can communicate.
Data length err	The command is too short.	Update the software in the SPC-1000 or the transmitter so that they can communicate.
Invalid message	Error in the message part as for checksum (below).	Check the cables between the transmitter and the SPC-1000.
Invalid chksum	Wrong checksum on package (results normally in re sending).	Check the cables between the transmitter and the SPC-1000.
Reply time out	The instrument do not respond to command (Waiting time 256 ms).	The SPC-1000 is not connected to the transmitter or the transmitter is not turned on. Check the cables between the SPC-1000 and the transmitter.
HART rev error	Wrong version of the HART protocol. It should be version 5.	Update the software in the SPC-1000 or the transmitter so that they can communicate.
Not BT-5400 dev	Wrong transmitter to what is chosen in the SPC.	Choose the right transmitter when starting the SPC-1000.
BT-5400 rev err	Right transmitter but incompatible version of the protocol.	Update the software in the SPC-1000 or the transmitter so that they can communicate.
Dev change/repl	The SPC-1000 is connected to another transmitter than where the data comes from. It is identified by the serial number.	Connect to the right transmitter and start with READ DATA. If it is the right transmitter go to READ DATA.

5.3 Sampling, Sheet Determination, Brightness Determination and Instrument Follow-up

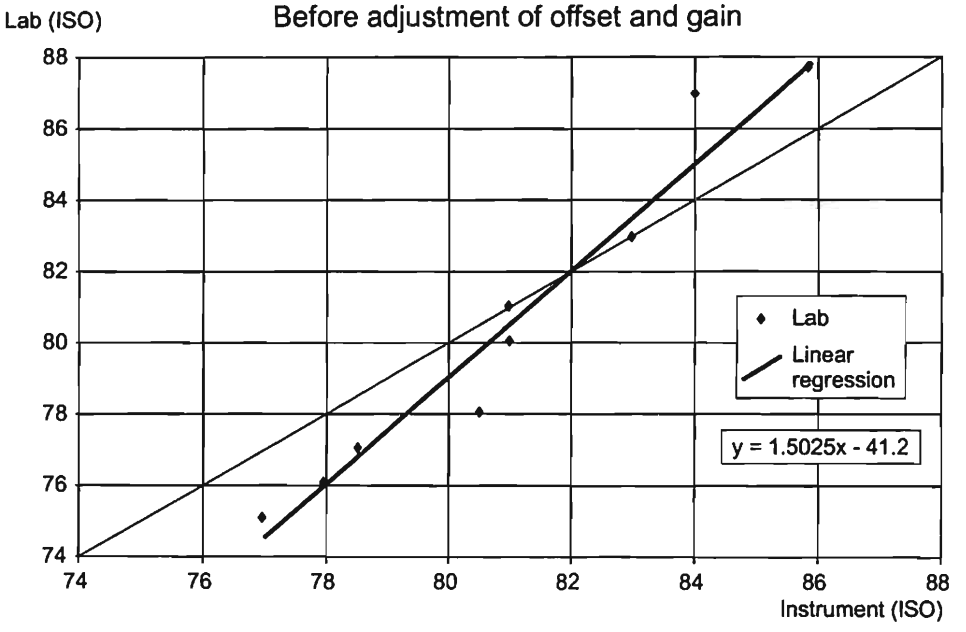
Sampling to determine brightness and the subsequent laboratory analysis provides a reference for calibration and follow-up of the transmitter. It is therefore most importance that both sampling and laboratory analysis prioritize accuracy and repeatability. The tranmitter's accuracy and repeatability is based on these criteria:

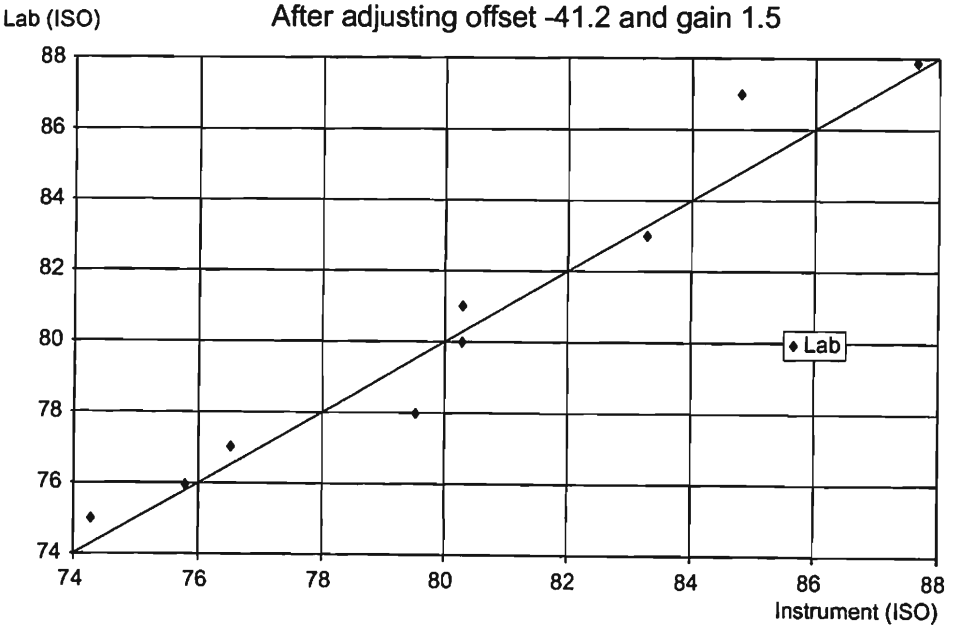
- **Sampling.** The sampling equipment and its positioning determine whether or not a representative sample can be extracted from the pipe. The sampling technique is necessary to transfer the sample to a safe vessel. A sample taken from a completely different position, such as a wash filter, at an uncertain time, will provide a less reliable result than a sample extracted close to the transmitter while measuring signals were noted. Some important aspects to consider are: the variations in samplers (ball valve vs mushroom valves), transmitter filtering time, sample accuracy, process variations and process parameters for personal safety (burns can occur at temperatures over 50°C / 122°F, dangerous or acid chemicals, process pressure).
- **Sheet determination** according to SCAN CM 11:95 (=ISO 3688).
- **Determination of brightness** according to SCAN P 3:93 (=ISO 2470, =T525 On-92).
- **Determination of fluoresence** in Anex B (=ISO 2470, =T525 On-92).
- **Follow-up.** It is advisable to follow up the transmitter using [Error = Lab.sample - Transmitter] as a follow-up. It is also worth setting a suitable tolerance level at which actions must be taken. See document SSG 5252. Another important follow-up procedure is to check transmitter measurements against references and to check the references.

NOTE!
BTG is not allowed to publish the SSG or SCAN standards but they are available from SCAN (Scandinavian Pulp, paper and board) and SSG (Pulp and paper industries engineering Co.).

- **Adjust offset and gain.** Re-calibration or adjustment of offset (zero point adjustment) and gain (amplification) may be required after some time. Example: Before adjustment: offset = 0, gain = 1 and standard deviation=2. After adjustment: offset = -41.2, gain = 1.5 and standard deviation=1.
- **Mixing.** When you have sufficient number of sample values you can make a linear multiple regression. Use a specific program or MS Excel and the following formula:

EXAMPLE:
MIX(ISO)= Offset+Gain*[mixfactor*Proc.Eu(Blue) + mixfactor*ProcEu(Green)]


Lab (ISO)
Before adjustment of offset and gain
88
86
84
82
80
78
76
74
74
76
78
80
82
84
86
88
Instrument (ISO)
Lab
Linear regression
y = 1.5025x - 41.2


Lab (ISO)
After adjusting offset -41.2 and gain 1.5
88
86
84
82
80
78
76
74
74
76
78
80
82
84
86
88
Instrument (ISO)
Lab

5.4 Mechanical Maintenance

Material:
Screw driver
Universal screw wrench
Flash light
Lubricant for sealings

5.4.1 Remove Moisture from Circuit Board

1. Loosen the cover.
2. Check the gasket to make sure that no liquid can penetrate.
3. Carefully lift the cover.
4. Use a lamp to check for any condensation on the circuit board.
5. Check that LED 3 is lit and that LED 4 flashes once every five seconds.

5.4.2 Retract Transmitter from Sluice Valve

1. Use protective goggles and chemical-resistant equipment. Inform the operator what you are doing.
2. Turn off the transmitter at JCT-1100.
3. Disconnect the cable connections.
4. Loosen the two safety screws behind the box.
5. Screw out the transmitter.
6. Close the valve.
7. Loosen the locking nut on the trapezoid threaded screw.
8. Screw out the transmitter.

5.4.3 Check Window

1. The transmitter must be removed.
2. Wipe the window with a cotton cloth.
3. Illuminate with a lamp.
4. Check that the window is intact and also check it for scratches.
5. Check that there is no dirt on or underneath the window.
6. Check that there is no condensate under the window.

5.4.4 Clean Probe and Window, SPC-1000 and References

1. The transmitter must be removed.
2. Wipe the window with a cotton cloth.
3. Use alcohol on the pipe and window. For a more stubborn coating of resin you might need to use diluted 3M hydrochloric acid.
   Dry off with a cotton cloth.
4. Grease the metal surface of the pipe.
5. Clean the SPC-1000 according to section 5.4.5.
6. Clean the references with a small amount of washing detergent and water. Put them in a microwave oven to dry for one minute. Leave in a exicator for 10 minutes. Let rest at room temperature for 30 minutes before making a measurement in the brightness transmitter.

5.4.5 Clean SPC-1000

The terminal can be cleaned using a cotton cloth dipped in water.
Avoid water getting into the edges of the covers.

NOTE!
Use only mild cleaners. Clean and dry with care!

5.4.6 Replace Sluice Valve Seals

1. The process must be shut down and the pipe must be empty.
2. Make the replacement according to the figure.
3. Grease the sealings after the replacement.

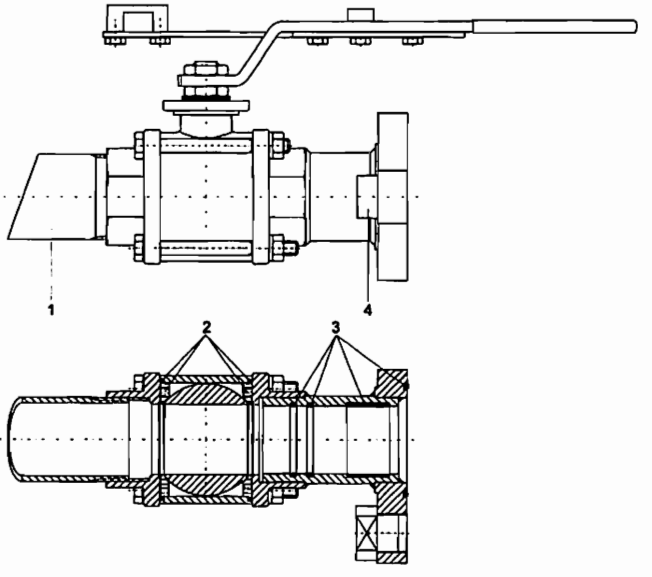


Fig 5 Ball valve with weld-in stud in stainless steel

1 Weld-in stud
2 Sealings
3 Sealings
4 Trapezoid nut

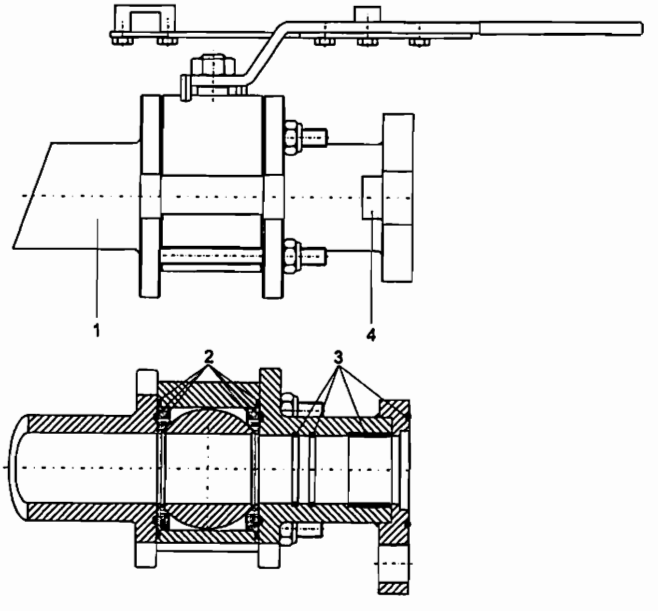


Fig 6 Ball valve with weld-in stud in titanium

1 Weld-in stud
2 Sealings
3 Sealings
4 Trapezoid nut

5.4.7 Insert Transmitter

1. Grease the sealings and the tip of the probe tube. Do not grease the optical surface and the trapezoid threaded nut.
2. Do not forget the O-ring on the flange.
3. Insert with a continuous twisting motion until the probe touches the stop.
4. Fasten the nut on the trapezoid threaded screw.
5. Open the valve.
6. Crank the handle until the O-ring positions correctly. The flange on the probe will meet the flange on the ball valve.
7. Lock the transmitter with two locking screws.
8. Connect the cables.
9. Switch on power to JCT-1100.

5.5 Service Hardware, I/O part

Material:
Digital Multimeter (DMM)
4 to 20 mA meter.
(Oscilloscope)
Reference included with delivery
Screwdriver

5.5.1 Electric Test-points

Check that there is power to the instrument and that the fuses in the junction box are intact. Also check that fuse S1 (250 V Slow 2 A) on the circuit board is intact. Check that LED 3 is lit up, indicating that 24 V DC is present.

Measure the following voltages:

GND (TP0) and TP3 :	+24 VDC± 2V
GND (TP0) and TP1 :	+15 VDC± 0.75V
GND (TP0) and TP2 :	+5 VDC± 0.25V
GND (TP0) and TP4 :	-15 VDC± 0.75V
GND (TP0) and TP5 :	-5 VDC± 0.25V
GND (TP0) and TP7 :	+5 VDC± 0.05V
GND (TP0) and TP8 :	+10 VDC± 0.05V
GND (TP0) and TP9 :+1.235	VDC+ 15mV / -35mV

Check the following if something is wrong::

- **Is the application program running?**

  LED 4 indicates if the boot program or an application program is running or not. If it is flashing once per second, the boot program is running and waiting for the application program to be downloaded via an RS-485 cable (for BTG personel only). If it flashes approximately once every 5 seconds, the application program is running. If the LED is constantly on or off, the program has not started.

- **Are all cables connected correctly?**

  Check that all cables are properly inserted.

5.5.2 Checking Communication to and from SPC-1000

Check that a resistor (250 - 300ohms) is fitted between terminals Out1+(mA1+) and Out1-(mA1-) in JCT-1100.
Connect SPC-1000 to JCT-1100 and switch on the hand terminal. Choose **BT-5400** and the latest version.

5.5.2.1 Check Range-inputs

Check that the transmitter cable (to /from JCT-1100) is placed in contact J1 (Range-inputs).

1. Short-circuit JCT-1100 between terminals Gnd and Range A(C), then check that LED 1 is lit up and that **Range** on the main menu of SPC-1000 changes from **1** to **2**. Note that it can take up to 5-10 seconds before the range changes.
2. Short-circuit between terminals Gnd and Range B(D), then check that LED 2 is lit up and that **Range** changes to **3**. Note that it can take up to 5-10 seconds before the range changes.

5.5.2.2 Check Alarm-output

1. Turn off JCT-1100 and move the transmitter cable to the circuit board from J1 to J4.
2. Put on the reference on the probe.
3. Switch on JCT-1100 again. Wait until the meter has stabilized (approx. 2 minutes) and make a note of the measured value shown in the lower right hand box on **Range1**.
4. Press **Configure** button.
5. Enter code **5400**, and press **Enter** button.
6. Press **Config setup** button.
7. Press **Mode** button until the text under **Mode** shows **Alarm**.
8. Press **Menu** button until the main menu comes back.
9. Press **Misc** button.
10. Press **Alarm & diagnostic** button.
11. Enter code **5400** and press **Enter** button.
12. Check that the button to the left shows **Set alarm A.out1**. The button second from the far left shall show **Alarm ON**, if not press this button.
13. Press **Low** button and enter the measured value +10 units.
14. Check that **High** is greater than **Low**.
15. To download new limit values to the transmitter, press the (flashing) button **Send page** and then **Send change**.
16. Check (diode meas) between terminals 14 and 15 on JCT-1100 "+" on Range A(C) and "-" on Range B(D). It should be less than 0.1V.
17. Check that LED 5 is lit up when the alarm is activated.
18. Press **Alarm ON** until it shows **Alarm OFF**.
19. Press **Send page** button and **Send change** button and check that LED 5 goes out and that the DMM measures "OL".

20. Switch off the JCT-1100 and move the transmitter cable back to contact J1 (Range-inputs) and change so that **Mode** shows **Range**.

5.5.2.3 Check the Temperature Sensor

Remove the transmitter from the process and allow it to cool for 3 hours.

1. From the SPC-1000 main menu select **Misc.**
2. Press **Factory setting** button.
3. Enter code **1632** and press **Enter** button.
4. Select **All signals**.
   Wait for 5 seconds before the page is updated. **Mraw temp** (temperature at the probe tip) should be approx. 25°C / 77°F (room temperature) and the **Internal temp** (temperature of the circuit board) approx. 40°C / 104°F. If the transmitter is installed the process, the internal temperature could be up to 20°C / 68°F higher than the ambient temperature. The temperature of the medium should however be less than or equal to the process temperature. Temperature transmission to the temperature sensor can vary, depending on the mounting stud material.

5.5.2.4 Check or Calibrate mA Input Signal

1. Connect a mA-source "+" to JCT-1100 terminal AUX In+ (F) via the DMM set on current metering to 20 mA (smallest possible range) and "-" to terminal Gnd.
2. From the SPC-1000 main menu, press **Misc.** button.
3. Press **Factory setting** button.
4. Enter code **1632** and press **Enter** button.
5. Press **A.in** button.
6. Adjust the mA-meter to exactly 20.00 mA. Read the value in **Input (0-1023):**.
7. Press **Set 20 mA**.
8. Enter the value and press **Enter** button.
9. Adjust the mA-meter to obtain 4.00 mA. Read the value in **Input (0-1023):**.
10. Press **Set 4 mA**.
11. Enter the value and press **Enter** button.
12. Press **Send** button.
13. Press **Send change** button to transfer the values to the transmitter.

5.5.2.5 Check or Calibrate mA Output Signal

1. Connect the DMM set to mA (the smallest range for 20 mA) in series with the resistor in JCT-1100 on mA-output #1 (terminals **mA1-** and **mA1+**).
2. From the SPC-1000 main menu, press **Misc.** button.
3. Press **Factory setting** button.
4. Enter code **1632** and press **Enter** button.
5. Press **A.out** until **A.out OUT.1**.
6. Press **Test value** button.
7. Enter **20** and press **Enter** button.
8. Press **Send** button.
9. Press **Send change** button.
10. Adjust using the buttons **20 up** or **20 down** and then press **Send** button.
11. Press **Send change** button to obtain the new signal.
    Keep repeating these actions until exactly 20.00 mA is obtained. The test signal **Test value** is active for approx. 15 sec. before the output signal is reset.
12. To calibrate 4 mA, press **Test value** button.
13. Enter **4** and press **Enter** button.
14. Press **Send** button.
15. Press **Send change** button.
16. Adjust with the buttons **4 up** or **4 down** and then press **Send** button.
17. Press **Send change** button to obtain the new signal.
    Keep repeating these actions until exactly 4.00 mA is obtained.
18. Then move the DMM to mA-output #2 (terminals mA2- and mA2+).
19. Press **A.out** until **A.out OUT.2**.
20. Repeat the above procedures and then test output #3, #4, #5 in the same manner.

5.6 Testing of Optics

5.6.1 Check LEDs and Measuring Cycle

1. Remove the transmitter and turn it so that the probe pipe is pointing upwards.
2. Check to make sure that the LEDs light up one at a time for one second and then emit a flash. During the measuring sequence the LED will be lit up for a second and during a test for 20 milliseconds. A measuring cycle takes about 5 seconds.

   The blue LED can light up when it should be switched off due to leaking current. The light however is so weak that it will not affect other LED measurements.

5.6.2 Perform Reference Check

1. Press **Ref. Check**.
   Check if all values are valid.

5.6.3 Set Optical Part

1. It is important that the probe window and references are kept clean.
2. Put on the reference with the highest ISO value (included with the transmitter) on to the probe-tip. Check that the brightness reference is fixed in position. Put down the transmitter on the box part, with the probe pipe pointing upwards.
3. Wait a while for the transmitter to adjust.
4. In the SPC-1000 main menu, press **Configure** button.
5. Enter code **5400** and press **Enter** button.
6. Press **Config setup** button.
7. Press **LED** button.
8. Select **Config** until **Config T-LED** is visible.
9. Set the **TM.Meas** to 2800 ± 100 and **Preamp.M** to 1 by pressing **LED curr.** and entering a new value. Press **Enter** and then **Send page**.

NOTE!
The measuring range for XM.meas and XT.meas is from 0 to 4095.

10. Check that TM.Dark and TT.Dark are approx. 300 ± 10 units. This tolerance applies when PreAmp readings are lower than 4.
11. Check that (**TM.Meas - TM.Dark**)/ **PreAmp.M** is approx. the same as **TM.diff**. and **PreAmp.M**.
    The same applies to (**TT.Meas - TT.Dark**)/ **Preamp.T**, this should be approximately equal to **TT.diff**. The value indicated by **Preamp.T** is not an exact value but a more exact value has been entered in the transmitter's software.

12. Press **Config.** to get next color and set **TM.Meas** to a value close to 2800 and set **Preamp.M** to 1 for all colors (blue, green, red) by adjusting the LED current if necessary.
    TT.Meas and Preamp.T should be set for N.IR and F.IR.
    Perform these steps for all colors, N.IR, and F.IR, and perform the checks in step 10 and 11 for all colors, N.IR, and F.IR.

5.6.4 Check of Grounding

1. Start by checking the resistance in the DMM measuring cables.
2. Remove the external grounding cable from the probe.
3. Turn off the power on the JCT-1100.
4. Measure between the probe pipe and the JCT-1100 shielding lacquer. Deduct the resistance of the measuring cables. The resulting resistance shall be less than 5 ohms and normally around 1-2 ohms.

5.7 Troubleshooting

Error	Probable cause	Suitable measure
Can't communicate with SPC-1000.	Missing resistor 250 - 300Ω in JCT-1100 terminals mA1+ and mA1-. The resistor is not in series with DCS.	Measure in the JCT-1100 on terminals mA1+ and mA-. The voltage must be more than 1.0 V. Less than 1.0V: wrong resistance. Higher than 18 V: Mount only 249 Ω in terminals mA1+ and mA1-. The voltage must be between 1 and 5 V.
	Cable between the transmitter and the JCT-1100. The shield must be connected in the PG fitting or in the binder contact.	Check the grounding.
	Contacts not tightened.	Tighten contacts.
	Cables inside the JCT-1100 drawn in small loops.	Straighten cables.
	Cable too close to the high-voltage cable.	Move power cables.
	Too much AC signal (more than 50 mVAC) on the shield or the communication cable.	If the AC signal is too high on the shield, mount a 100-220 microF, 16 Volt bipolar capacitor between the shield (on the analog out cable) and terminal mA1+.
	Too high AC signal (more than 120 mVAC) on the external 24 VDC supply.	Mount a 10,000 microF 40 Volt capacitor between the + and the – on the incoming 24 VDC supply.
The SPC-1000 data is not as expected.	The SPC-1000 and instrument are operating in different ranges.	Change edit range (SPC-1000).
Exceptions includes underflows and overflows.	LED current is too high or too low. The LED is faulty. The LED is too weak. The window is broken. There is no pulp in the pipe.	Maintain probe and LED.
Can't communicate over the RS-485 cable.	Faulty electrical connections on A, B or the common contact. Wrong address.	Check connections and troubleshoot RS-485 find address.
The blue signal drops when brightness increases.	Color changes (the liquid turns more yellow) in the process.	Calibrate mix.
Both the blue and the green signal increase and decrease but lab samples are stable.	Consistency variations, compensation needed.	Compensate using analog IN and CS transmitter.
The raw signal fluctuates a lot.	Low flow. High amplification (Preamp). Poorly mixed pulp.	Move the probe to another position.
The dark signal fluctuates a lot.	Poor earthing, check all earthings, shields and contacts against shield lacquer, etc.	Check grounding. Bad 24 VDC. Check capacitor or resistor value from shield to ground.
The raw signal drops significantly 5-10 minutes after the instrument has been inserted in the process.	Moisture on the inside of the window. Fiber optics are not properly fastened.	Clean the probe, make sure that it is dry inside and make sure the fiber optics are fastened.
The raw signal drops in relation to the reference.	Dirt on the window. Dirt or moisture on the inside of the window. Measurements made at different temperature. Fiber optics have loosened. O-ring leakage.	Clean the probe and make a reference procedure. Check the O-rings and the O-ring groove.
The logging program stops or runs slowly.	Too low uptime rate.	Increase the uptime rate from 7 to 10-155.1

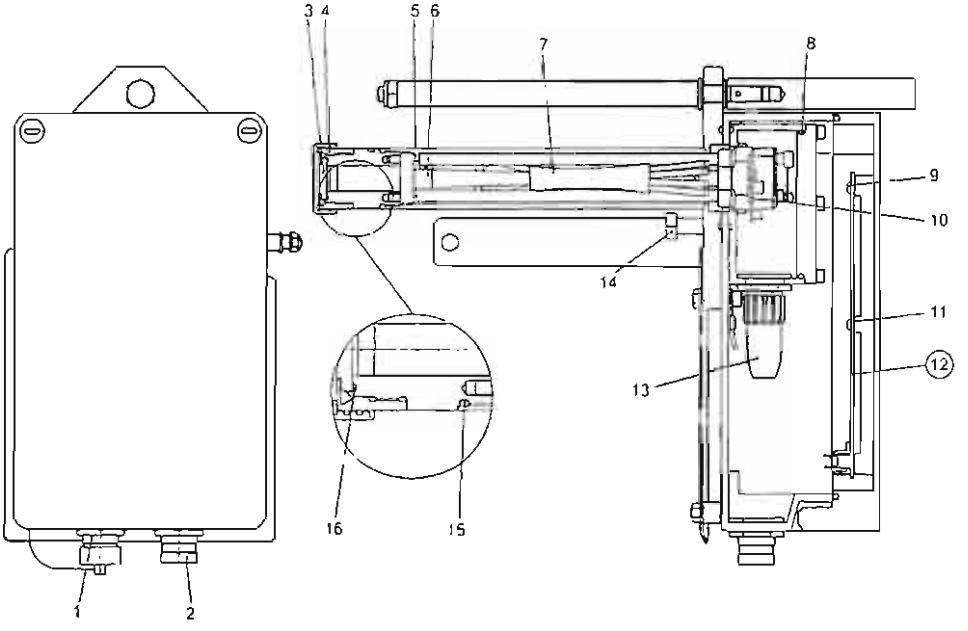
Error	Probable cause	Suitable measure
Leakage from a new ball valve.	The ball valve has been used for taking samples. Wrong sealings. The ball valve is damaged.	Use the ball valve only for inserting the probe. Change sealings. Check the ball valve.

6 Parts List

6.1 Measuring Probe

Fig 7 **Measuring Probe**

1 Contact RS-485
2 Contact junction box
3 Window Saphire
4 Window socket
5 Temperature sensor
6 Fiber optics
7 Fiber optics
8 O-ring 79.5x3 EPDM
10 Optics board
13 Contact second seal
14 Screw M6S 10x25
15 O-ring
16 O-ring



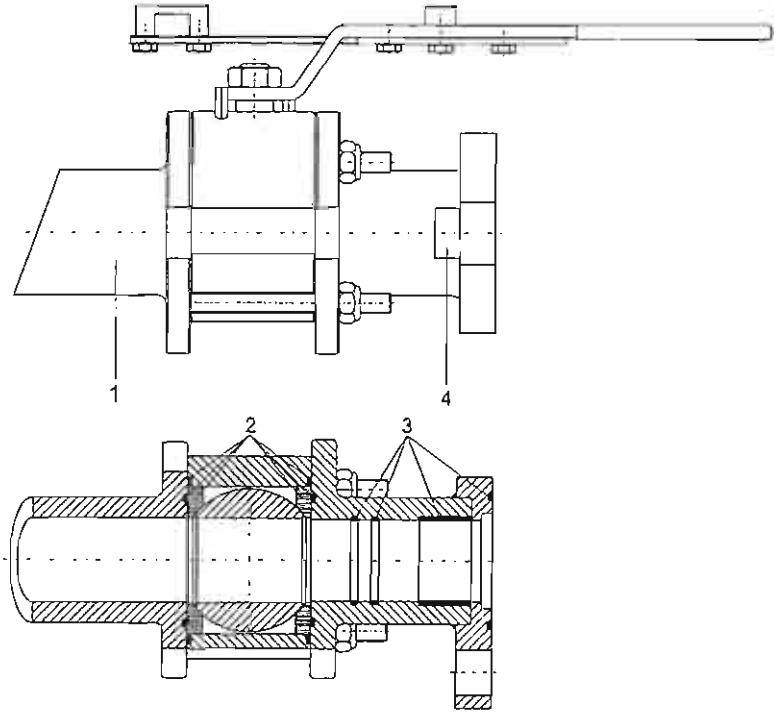
Spare Parts

Item No.	Rec. spare parts	Qty	Part No. Stainless steel	Part No. Titanium	Spare part	Description
9		6			Screw	Included in Sensor board kit, item no. 12
11		1			Nylon washer	Included in Sensor board kit, item no. 12
12		1	B0011163	B0011163	Sensor board kit	

6.2 Ball Valve

Fig 8 Ball Valve

1 Weld-in stud Stainless Steel
1 Weld-in stud Titanium grade2
1 Weld-in stud 254SMO
1 Weld-in stud FRP
2 Sealing EPDM
2 Sealing Zalak
4 Nut for trapeze bar



Spare Parts

Item No.	Rec. spare parts	Qty	Part No. Stainless Steel	Part No. Titanium	Spare part	Description
3	*	1	84514488		Sealing kit	EPDM
3	*	1		84514280	Sealing kit	Zalak

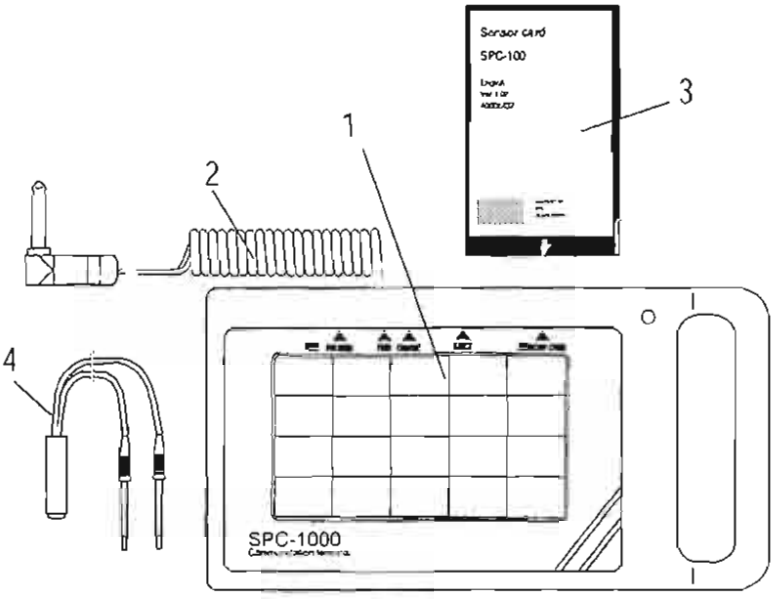
6.3 Accessories

JCT-1100

Item No.	Rec. spare parts	Qty	Part No.	Spare part	Description
		1	A0092155	Analog out extension kit	Analog Out 4 & 5 extension kit for BT-5400.

For more information regarding JCT-1100 parts, see section 8.6.

Accessories



Item. No.	Rec. spare parts	Qty	Part. No.	Spare Part	Description
1	*	1	93253847	Hand-held terminal, complete	SPC-1000
2	(*)	1	84396449	Connection cable, complete	
3	(*)	1	74399536	Sensor card	SPC-1000/A
4		1	74417959	Adapter for terminal connection	
		1	46021309 46021317	Mains adapter (not shown)	220 VAC / 12 VDC 110 VAC / 12 VDC
		1	74417959	Adapter for terminal connection	
	*	1	46019873	Alkaline battery (not shown)	9V 6LR61
		1	A0003632	Reference complete (for UV with fluorescence paper)	
		1	A0003111	RS-485 cable for PC software BT-Calibration	
		1	A0093252	BT-Calibration sofware	

Notes: Recommended spare parts marked * have a typical operating life of two years. Recommended spare parts marked (*) are less likely to be needed but are recommended where many transmitters are in operation.

7 Appendix

7.1 Planning the Installation

7.1.1 Choosing a Site for the Transmitter

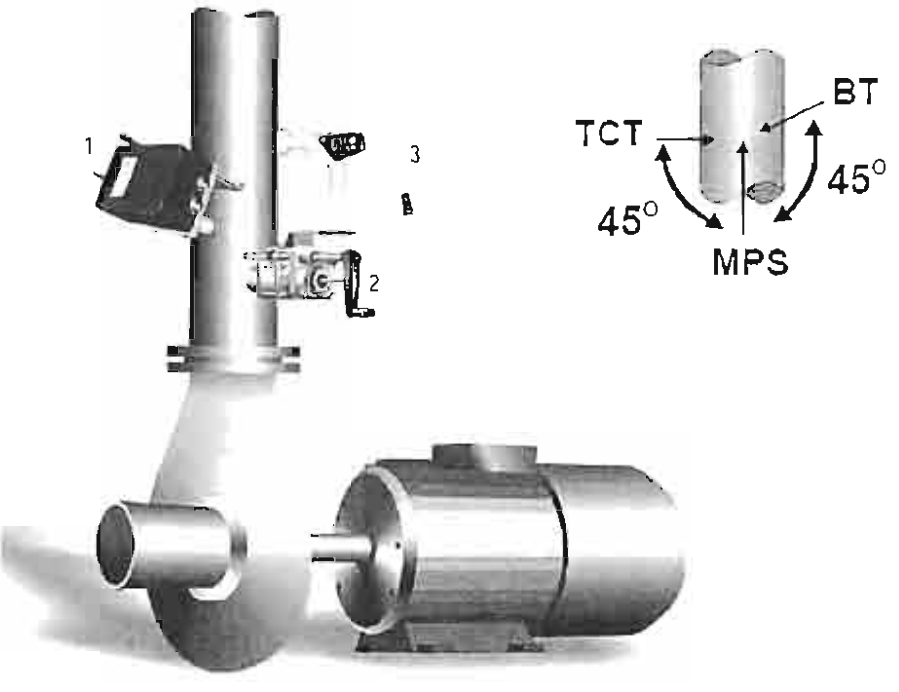
Careful location of the transmitter is essential for optimum performance and ease of maintenance.

The transmitter can be installed in a vertical, horizontal or inclined pipe. If installed in a horizontal or inclined pipe, care should be taken in locating it so that it does not measure large air bubbles trapped in the pulp.

Fig 9 shows a typical installation, the BT, TCT, and MPS can be installed close to a pump. Your BTG sales engineer will be pleased to assist in selecting the location that will give results that are consistent with your specific control strategy.

Fig 9 Typical sensor installation

1 Brightness Transmitter BT-5400
2 Total Consistency Transmitter TCT-230X
3 BTG Sampling valve type MPS-1000



Important recommendations:

The following points should be considered must seriously:

1. Proximity to bends or elbows in pipes is to be avoided due to turbulence and dewatering. For optimum results when the transmitter is positioned downstream of a pump or pipe elbow, it should be located at the outer turn of the pulp stream. See Fig 10, Fig 11, Fig 12 and Fig 13.

2. If the transmitter must be installed in a difficult-to-reach position, build a platform that will make it more easily accessible for service and inspection.
3. Choose a location with sufficient room for insertion and removal of the transmitter and for opening its covers. The overall length of the transmitter is 363 mm (14 in.). Remember to leave sufficient room for insertion and removal.
4. Install the transmitter so that it is protected from direct mechanical damage. Install under a roof overhang if there is any risk of frequent water or pulp spray.
5. Protect the transmitter from heavy vibration such as cavitating or unbalanced pumps. One method is to install a rubber bellows in the line.
6. Install the transmitter where the flow is above 1 m/s (3.3 ft./s) with well mixed pulp that is consistency controlled.
7. Avoid tower and stand pipes.
8. Avoid colored liquid, choose installation after washer

Fig 10 Recommended minimum calming length - distance between pipe elbow/ shut-off valve and transmitter

The minimum distance the transmitter should be located from a bend or elbow is:
The diameter of the pipe multiplied by 3 or 1.5 m (5 ft.).
Always choose the largest value of the calculated measures.

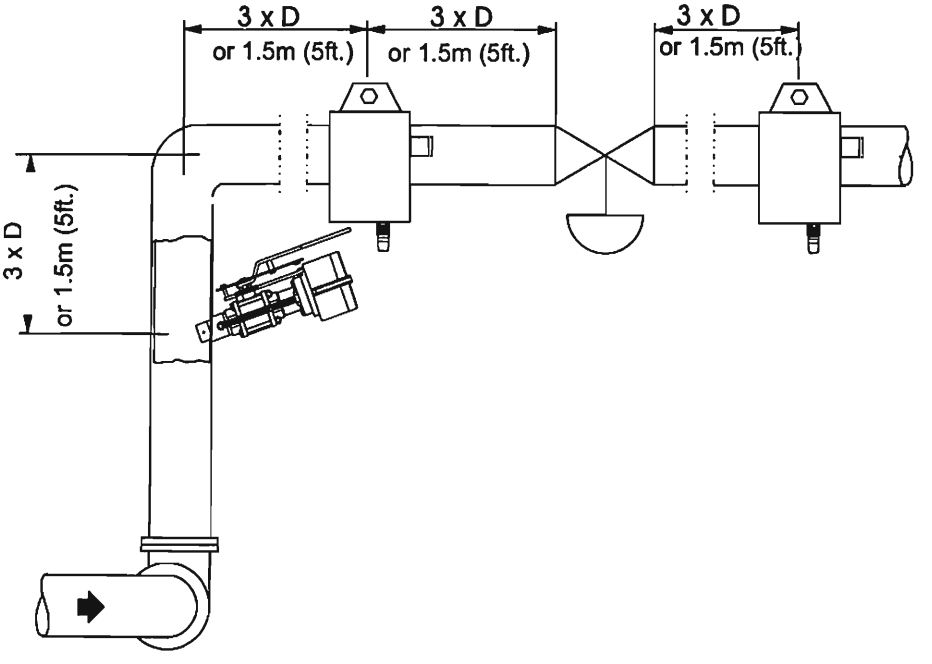
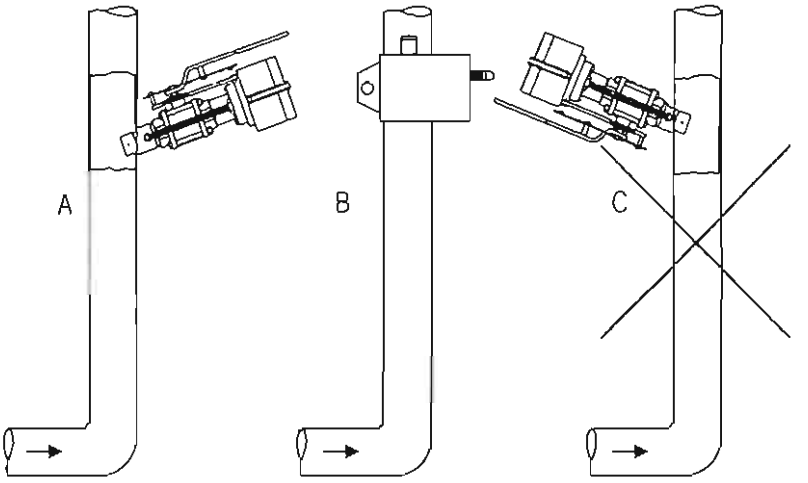


Fig 11 **Installation of the transmitter in relation to a pipe elbow**



NOTE!
Alt. A is the most suitable if possible, avoid using alt. C.

Fig 12 **Installation of the transmitter in relation to pulp flow and pipe elbows.**

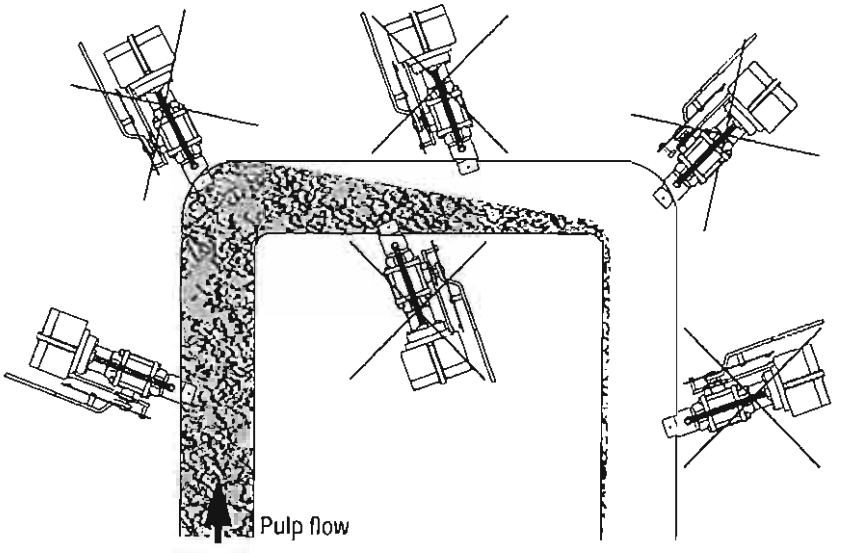
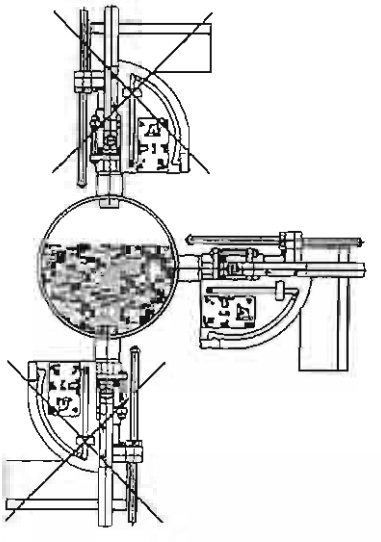


Fig 13 **Installation of the BT-5400 transmitter in a horizontal pipe.**



7.2 Forms and Standards

7.2.1 Analog Configuration Sheet

Configure analog out, BT-5400				VO no.				Mix factor				
Analog out 1 Date	**Name**	**LED**	**Damp**	**Offset**	**Gain**	**4 mA**	**20 mA**	**Blue**	**Red**	**Green**	**NIR**	**FIR**
Analog out 2 Date	**Name**	**LED**	**Damp**	**Offset**	**Gain**	**4 mA**	**20 mA**	**Blue**	**Red**	**Green**	**NIR**	**FIR**
Analog out 3 Date	**Name**	**LED**	**Damp**	**Offset**	**Gain**	**4 mA**	**20 mA**	**Blue**	**Red**	**Green**	**NIR**	**FIR**
Analog out 4 Date	**Name**	**LED**	**Damp**	**Offset**	**Gain**	**4 mA**	**20 mA**	**Blue**	**Red**	**Green**	**NIR**	**FIR**
Analog out 5 Date	**Name**	**LED**	**Damp**	**Offset**	**Gain**	**4 mA**	**20 mA**	**Blue**	**Red**	**Green**	**NIR**	**FIR**

7.2.2 Reference Follow-up

Reference measurement BT-5400									VO. no.								
Date	Name	Ref-eren ce	Lab	Blue	Red	Green	NIR	FIR	Ref-eren ce	Lab	Blue	Red	Green	NIR	FIR	I-temp	New calib

7.2.3 Internal Signal and LED Settings

BT-5400, VO no.										
Internal signals (0-4095)										
Date	**Name**	**Tmdiff**	**Ttdiff**	**T-led**	**Btdiff**	**Rtdiff**	**Gtdiff**	**Ntdiff**	**Ftdiff**	**I-temp**

LED current (0-40 mA), 0=Off							
Date	**Name**	**Blue**	**Red**	**Green**	**NIR**	**FIR**	**TLED**

7.2.4 Calibration Follow Up-sheet

Calibration sheet				BT-5400		VO. no.										
				Result		ISO based on ref					Raw					
Lab no.	Date	Name	Lab val	Jastr.Mix	Error	Blue	Red	Green	NIR	FIR	Blue	Red	Green	NIR	FIR
(no.)	(yy-MM-DD-HH-MM)	(Who)	(ISO)	(ISO)	(ISO)	(ISO)	(ISO)	(ISO)	(ISO)	(ISO)	(raw)	(raw)	(raw)	(raw)	(raw)
Blue (ISO) =kO + k1*Blue(raw)					Green (ISO) =k2 + k3*Green (raw)					NIR (ISO) = k4 + k5*NIR (raw)						
MIX (ISO) = K6+K7 x Blue (ISO) + K8 Green (ISO) + K9 x NIR (ISO)																

7.2.5 Compensating Calibration Sheet

BT-5400	VO no.
Compensating	
Analog out 1, 2, 3, 4, 5	

Date	Name	No.	A.out 1	A.out 2	A.out 3	A.out 4	A.out 5	A.in/NIR	Comp. factor

7.3 Software

The following versions of software are available for BT-5400:

Product	Version
BT-5400	v1.0 or higher
SPC-1000	v1.0 or higher
JCT-1100	v1.5 or higher
BT-Calibration	

Features

- Mixing color calibrations on all analog outputs (MIX default).
- Compensation available on all 5 analog outputs.
- The SPC-1000 front menu displays signal information such as showing which LED is used for analog output.
- I-temp (internal temperature) can be set for alarm indication.

7.4 SPC-1000 – Menu handling

The software is straightforward to program and is very flexible. Learning to use the software in a simulated environment accelerates the learning process and makes mistakes less likely in actual process operation. The software is designed to guide the user, but calls for a basic understanding of how the transmitter works.

HELP functions and other important guidelines are displayed at critical points in the programming process.

Warning notices are included at points where incorrect programming might affect the output signal. A code query has been inserted at highly critical points in the program where basic transmitter settings could be affected.

7.5 Using Hart® Communication

The unit uses the Hart® standard communication protocol; for more information refer to the appropriate user instructions from the Hart® association. BTG is also able to provide advice on the relevant code instructions.

NOTE!
For reliable Hart® communication to the DCS, the polling mode should be used.
Hart communication to the DCS may be inhibited during connection of the SPC-1000.

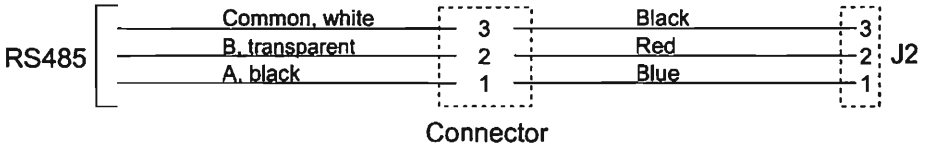
7.6 RS-485 Connection

7.6.1 RS-232 Serial Port

A PC serial port usually has a male DB-25 or DB-9 connector. A female DB-9 to male DB-25 adapter or cable is necessary if the PC has a DB-9 and the converter has a DB-25 connector. The logging program sets DTR high for powering converters without an external power supply. Some PC serial ports can not supply the power needed to drive a converter.

7.6.2 Connection to the Units

Fig 14 Connection to the circuit board



7.6.3 Wiring

According to the RS-485 standard the wiring distance can be up to 1.2 km with up to 32 units connected. Converters with an external power supply can drive a longer line than one taking the power from the PC serial port.

8 JCT-1100

8.1 Product Introduction

This manual is valid for JCT-1100/A junction boxes.

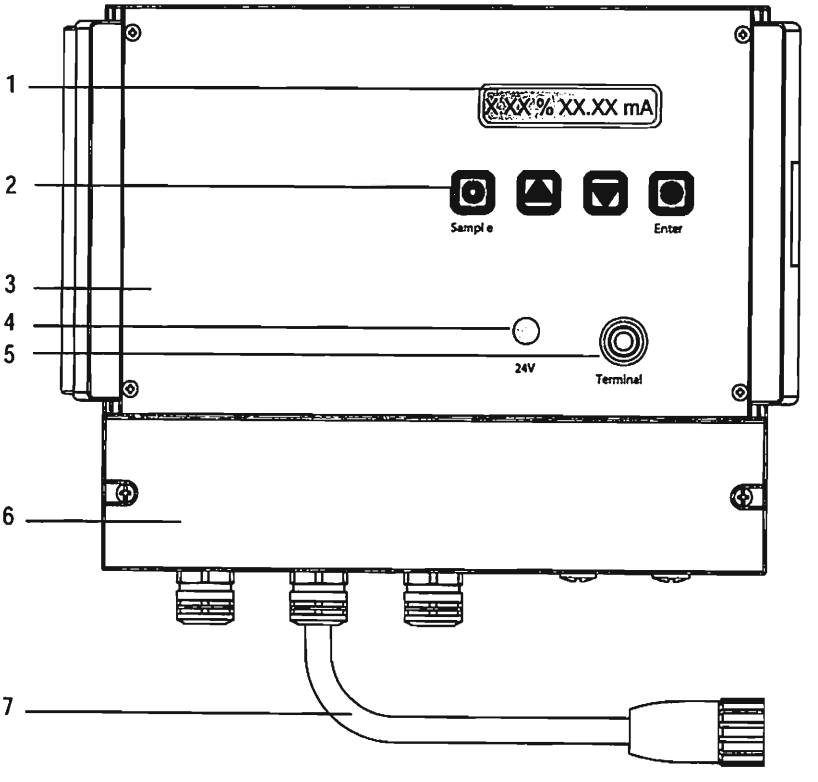
8.1.1 System Description

The JCT-1100 junction box is delivered as a complete unit from BTG and is always delivered together with a transmitter. It has the following functions:

- Local display and console for basic configuration of the transmitter and the collection of measuring values for calibration using the SPC-1000
- Connection point between the transmitter, power supply and the DCS (Digital Control System)
- Local connection for a hand-held terminal SPC-1000, or for a laptop PC.

Fig 15 Front panel overview

1 Single line LCD display
2 Keys for access to basic settings
3 Front cover
4 LED indicating 24 V DC power on
5 SPC-1000 connector
6 Terminal connection box
7 System cable to transmitter



8.1.2 Technical Data

Type	JCT-1100 for BTG transmitters
Manufacturer	BTG, Säffle, Sweden

General

Electronic Enclosure	Made of poly carbonate thermoplastic with a transparent cover. Nickel paint coated internally to protect against EMC interference.
Protection rating	IP65, NEMA 4x
Weight	Electronics box 2.0 kg (4.4 lbs)

Signals

Output signal	4-20 mA. Current limited to 21 mA. Superimposed digital signal according to standard HART® protocol and BELL 202 modem. Follows HART® universal commands.
Maximum loop resistance	With HART-filter: 750 Ω Without HART-filter: 1000 Ω
Analog input	0/4–20 mA
Alarm function [Valid for OCT]	Solid state relay (SSR) optocoupler output.
Measuring ranges	Four separate, individually programmable, externally connectable, using a binary-coded switch. Also accessible via the communications link.

Communication

Junction box	Display for viewing and buttons for adjusting span, offset, damping and calibration constants.
Hand terminal	Using the BTG SPC-1000 hand-held terminal jack plugs into the junction box. The communication is superimposed over the 4–20 mA current loop.
DCS	Directly with the DCS. HART® universal commands can easily be made available.
Fieldbus	Prepared for fieldbus communication, e.g., Profibus PA or Fieldbus Foundation

Connections

Transmitter connection	LIYCY 5x2x0.5, twisted pair, shielded 10 m/33 ft. cable with connector is included in the delivery. This cable is connected to the terminal strip in the junction box. Other cable lengths are available on request, max. 100 m/328 ft.
Cable fittings	Brass, nickel coated.

Supply voltage

Supply voltage	Built-in multi voltage power supply 100–240 V AC, 50/60 Hz (85-264 V AC, 47-63 Hz)
Power consumption	Maximum 60 VA for AC supply

Standardization and approvals

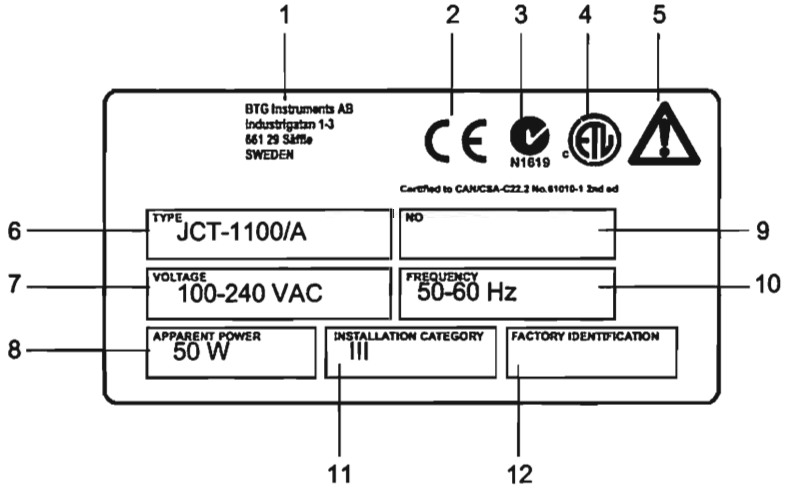
Standardization	Quality-assured in accordance with ISO 9001. Designed in accordance with relevant CE directives and standards. See section 8.1.5: *CE Declaration of Conformity*
Approvals	
Equipment type	Permanently connected equipment. The product is designed for industrial use.
Installation category	III
Shock protection	Class I
Pollution degree	2

8.1.3 Type Sign Explanations

NOTE!
Always refer to the type sign when ordering spare parts.

Fig 16 Type sign for junction box

1 Manufacturer
2 CE-marking
3 C-Tick-marking
4 ETL-marking
5 Warning sign*
6 Product
7 Voltage
8 Apparent power
9 Manufacturing number
10 Frequency
11 Installation category
12 Factory identification



) Warning sign
The device is designed for industrial use. Installation, handling and service must only be carried out by trained and authorized personnel and according to relevant standards and legislation. Read the manual for detailed information and pay special attention to the warning signs!

8.1.4 Revision Information

The following changes have been made in the JCT-1100/A compared with the JCT-1100:

- The language setting for the JCT-1100 is stored in the transmitter memory instead of the JCT-1100 memory.
- In a standard delivery the isolation amplifier has been replaced with a HART-filter in the 4-20 mA output signal. The extra 250 ohm resistor for HART communication is not required as long as the HART-filter is mounted.
- The RS-485 terminal block has been made smaller.

8.1.5 CE Declaration of Conformity

BTG's CE-Declaration of Conformity is only valid when the junction box is used in combination with other BTG equipment.

CE-Declaration of Conformity

According to EN 45014

Manufacturer's Name	BTG Pulp & Paper Sensors AB
Manufacturer's Address	P.O. Box 602 S- 661 29 SÄFFLE, Sweden
declares that the product:	
Product Name	Junction box
Model Number	JCT-1100
complies with the amendments and requirements of the:	**Low Voltage Directive** 73/23/EEC **EMC Directive** 89/336/EEC **RoHS** 2002/95/EC
and conforms with the following product Standards:	**WEEE** 2002/96/EC
LVD	EN 61010-1:93
ETL authorisation to mark	UL/CAN/CSA/-C22.2. No.61010-1, 2nd ed. -04 Control Nr. 3068754
Low Voltage Power Supply	NEC Class 2/IEC 60950/IEC 60601
EMC	EN 61000-6-4:99 EN 61000-6-2:04
WEEE	-n.a.-, not Annex 1
RoHS	-n.a.-
Quality System	ISO 9001 monitored by Lloyd's Register Quality Assurance

Säffle,
December 2006

Anders Hjort, MD

8.2 Safety Recommendations

See section 2 for safety recommendations.

8.3 Installation Instructions

8.3.1 Mounting

NOTE!
Locate the junction box close to the transmitter and sampling valve to achieve a convenient connection of the SPC-1000 hand-held terminal for calibration and monitoring.

For convenient working height and a good operating position the bottom of the junction box should be approximately 1.4 m (4.6 ft.) above the floor. The SPC-1000 can be placed in a holder if one has been mounted close to the junction box.

Install the box in a position where it is protected from mechanical damage.

Fig 17 Recommended clearances

NOTE!
The front cover swings open and is hinged on the left side.

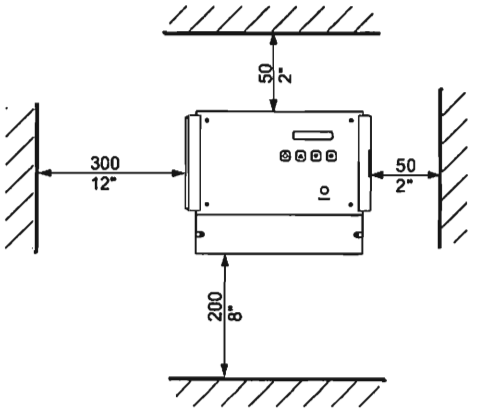
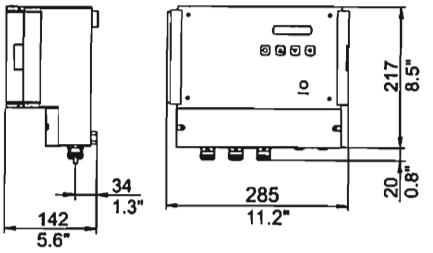
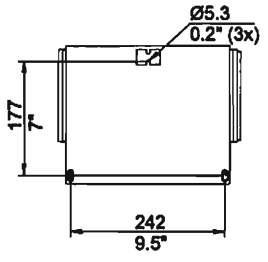


Fig 18 Dimensions



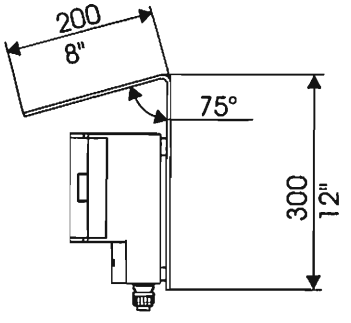
The junction box has three attachment lugs which are bolted to a flat surface.

Fig 19 Attachment lugs



BTG recommends that a roof or overhang is mounted above the junction box to protect it against spray and pulp. If the junction box is located outdoors, a roof should be mounted that protects from direct sunlight which can cause excessive operating temperatures. If possible, the SPC-1000 should also be protected when placed in it's holder.

Fig 20 Protecting roof



8.3.2 Cabling

8.3.2.1 Cable Types

BTG recommends properly dimensioned cables as described below for connections between the junction box and external equipment.

The power cable should be in accordance with the IEC 227/245 standard.

Power supply cable:

- Shielded (≥80 %) 3 x 0.75 mm^2 (3 x AWG18) with PE.

NOTE!
BTG recommends that the power supply cable has a 2 A slow blow fuse.

Signal cables (for Output, Range Select, Alarm, AUX-in, etc.):

- Shielded (100%), twisted pair: Min 2 x 0.3 mm^2 (2 x AWG24). Typical size is 2 x 0.75 mm^2 (2 x AWG18).

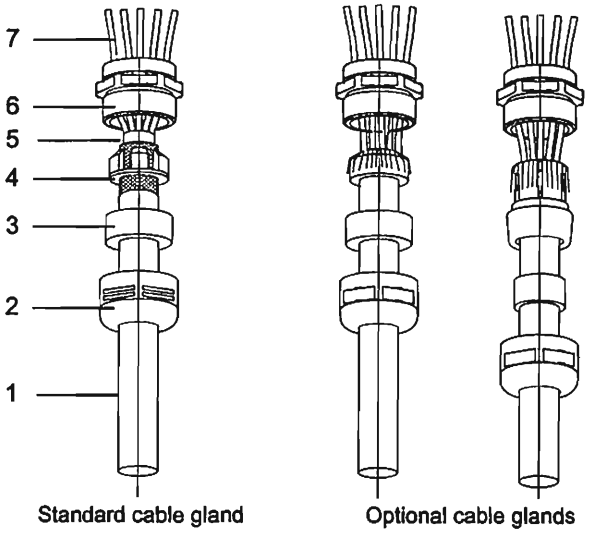
NOTE!
BTG recommends that separate cables be used for analog and digital signals. Multiconductor cables can be used.

8.3.2.2 Guidelines for Cable Connections

- Do not place signal cables and power supply cables close together! This may cause interference.
- Always avoid loops of cable leads in the junction box and make the leads as short as possible.
- The shields for the Alarm, AUX-in and Range select cables should not be connected in the junction box, unless the mill standard specifically requires it. Normally, these shields are grounded to instrument earth at the mill end.
- BTG recommends that the shield for the output signal cable is connected to CONN21 in the junction box. CONN21 is connected to PE via a capacitor.

Fig 21 Grounding of cable shields

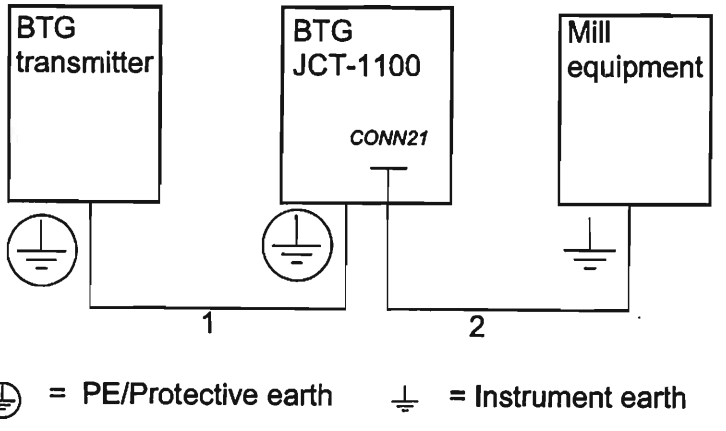
1 Power supply or transmitter cable
2 Nut
3 Sealing ring
4 Insert ring
5 Cable shield
6 Socket
7 Free wires



Cable shields should be connected as shown in Fig 22 below.

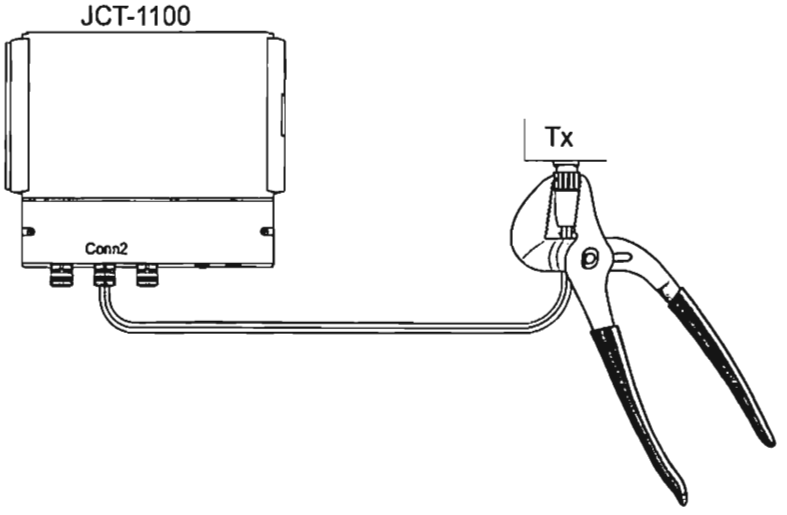
Fig 22 Connection of signal cable shields

1 System cable:
The cable shield must be grounded to the cable glands at both ends.
2 Output signal cable:
In the JCT-1100 the shield is connected to "*CONN21*" and in the mill equipment the shield is connected to instrument earth.



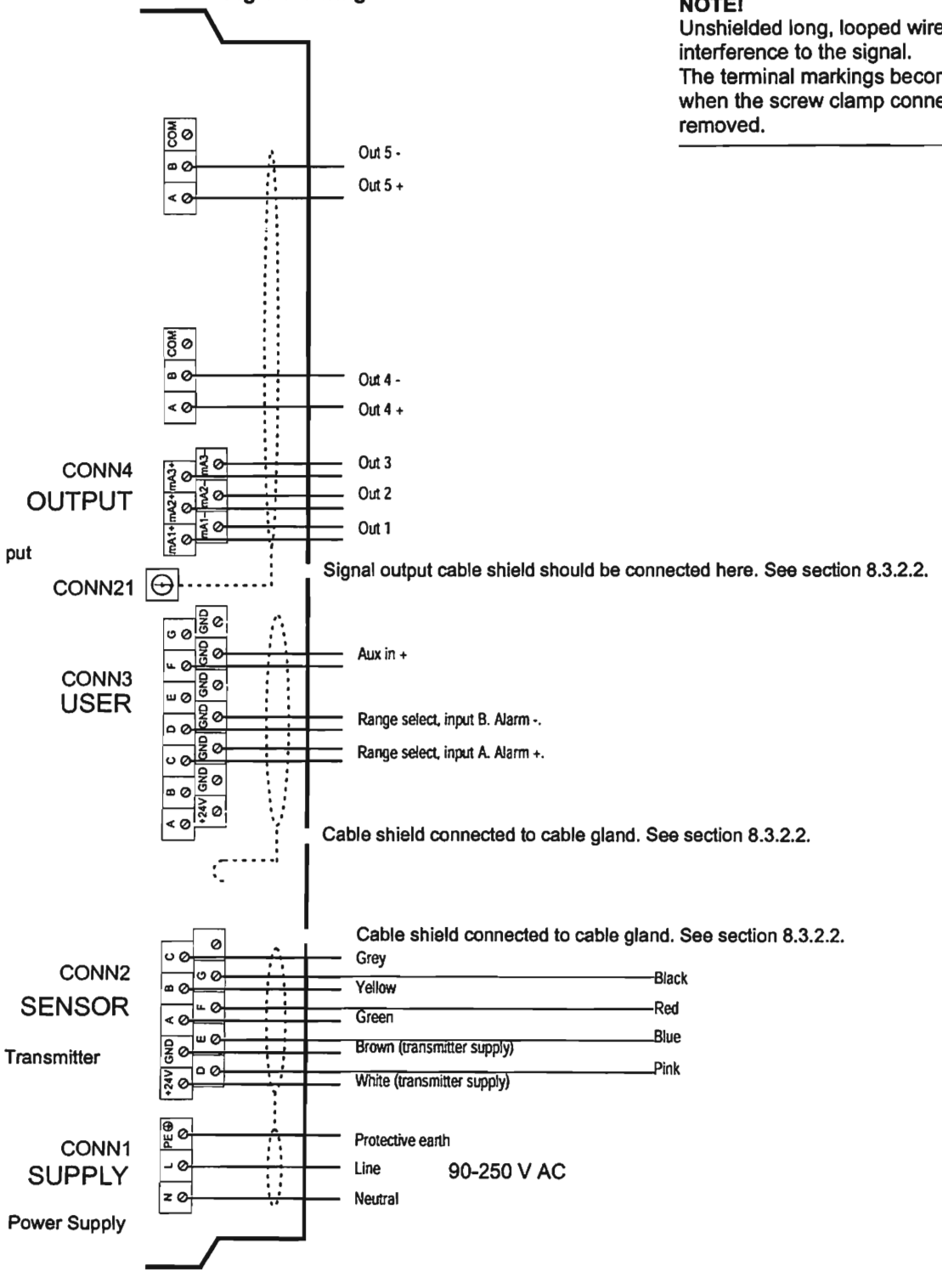
It is important to tighten the cable connector firmly to the transmitter – use a tool! If not tightened firmly, the shield will not be properly grounded.

Fig 23 Transmitter cable connection



8.3.3 Wiring Diagram

Fig 24 Wiring



NOTE!
Unshielded long, looped wires may cause interference to the signal.
The terminal markings become visible when the screw clamp connectors are removed.

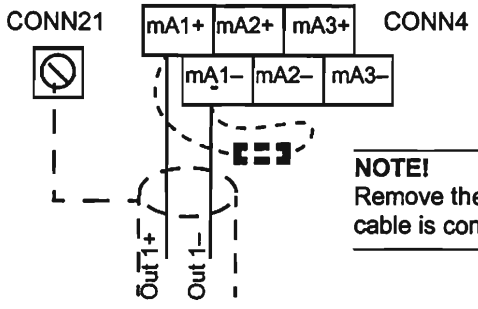
8.3.3.1 HART-communication

The junction box is delivered with a HART filter that removes the superimposed HART signal on the analog output signal from the junction box to the DCS, and so on. If the HART-protocol is used after the junction box, the HART filter must be removed. See section 8.5.2.1.

BTG's hand-held terminal (SPC-1000) and the display in the junction box use the HART-protocol for communication between the transmitter and the junction box. The HART communication requires a 250 ohm minimum loop resistance, which is normally provided by the HART filter. If the HART filter is removed, it must be verified that the output circuit (DCS, etc.) has at least 250 ohms resistance. If this is not the case, then an extra resistor must be connected in series with the output signal cable. Always connect the resistor to the plus (mA+) terminal.

To ensure that there is a closed 4-20 mA loop between the transmitter and the junction box, the output signal from the junction box is jumpered on delivery. This jumper must always be removed when a signal cable is connected. See figure below.

Fig 25 Removal of jumper



NOTE!
Remove the resistor before the output signal cable is connected.

8.3.3.2 Range Select Input

Transmitter calibration ranges for different production circumstances can be changed with binary inputs to the transmitter.

Range	Input A	Input B
1	0	0
2	1	0
3	0	1
4	1	1

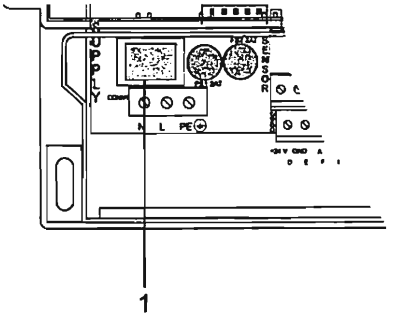
8.4 Operating Instructions

8.4.1 Starting the Junction Box

The junction box is started by switching on the power supply with the switch in the terminal box. See Fig 26 below. See the start-up instructions in the transmitter section of this manual for detailed start-up instructions.

Fig 26 Power supply switch

1 Power supply switch



8.4.2 Transmitter Configuration from the Junction Box

8.4.2.1 General Information

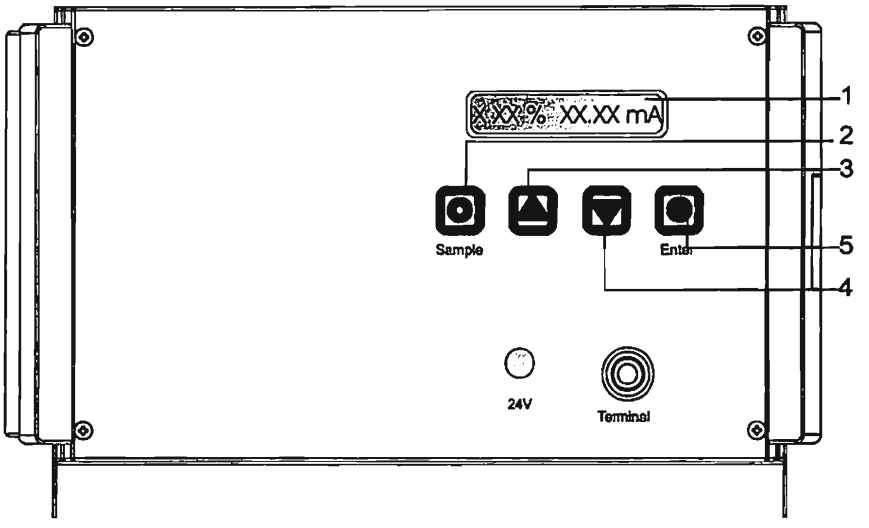
The JCT-1100 junction box is equipped with a display and four push buttons. The display has one row of sixteen characters. The operator can make some basic adjustments using the push buttons and the display without using the hand-held terminal SPC-1000.

To make a complete calibration or to configure some major settings the SPC-1000 must be used. The transmitter settings made from the junction box can be loaded into the SPC-1000. There they may be used for documentation, print-out, or backup.

NOTE!
Do not configure the transmitter from the hand-held terminal and the junction box at the same time. Valuable configuration data can be lost! Always close a configuration session by updating the transmitter.

Fig 27 Front panel with push buttons and display

1 Display
2 Sample button
3 Arrow up button
4 Arrow down button
5 Enter button



The push buttons have the following functions (depending upon position in menu structure):

Push button	Function
Sample	Reads a measurement value from the transmitter that corresponds to a calibration sample value
Arrow up	Scrolls up in the menu structure Change a value upwards Discard a sample value
Arrow down	Scroll down in the menu structure Change a value downwards Discard a sample value
Enter	Select menu options Moves the cursor to the right Stores entered values and calibration samples

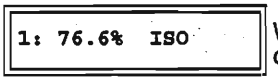
8.4.2.2 Menu Structure

NOTE!
The display on the junction box always returns to the Result display after 15 seconds of inactivity, or after three minutes if a message has been shown. If data was changed, it is automatically saved to the transmitter.

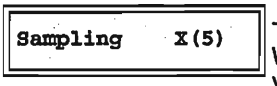
Start up display	BT-5400 UV/IR	The transmitter type is displayed when the JCT-1100 has established contact with the transmitter. While reading or writing data "Wait..." is displayed.
Result display	1: 76.6% ISO	Result display: shows the process value. To access the main menu items, press the up or down on the arrow buttons: ▲ ▼.
Result display	1: 13.5 mA	Result display: shows the output signal 4 - 20 mA.
Channel setting	CHANNEL 1	Channel 1-5.
Range setting	RANGE 1	The present measuring range. Can be changed to access other ranges (ranges 1, 2, 3 or 4).
Span setting	50.0 - 95.0	Measuring span, % ISO.
Offset adjustment	OFFSET +0.00	Process value offset, if required.
Gain	GAIN 1.00	Process value gain.
Damping setting	DAMPING 0	Damping on output signal, if required.
JCT Communication	JCT COMM. ON	Communication ON or OFF between the JCT and the transmitter.

8.4.2.3 Collecting Samples and Changing Settings

Collecting samples



When the Result display is shown samples can be collected to calibrate the transmitter.
Press the sample button ⊙ and collect a process sample for lab calibration.



The "X" in "X(5)" will increment as each value is stored. When all values have been stored, an average sample value will be calculated and displayed.

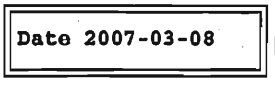
Save the sample value by pressing enter ●, or discard the sample value by pressing ▲ or ▼.

"NOT SAVED" is displayed if the sample value is discarded. Press any button to finish sampling procedure.

"SAMPLE SAVED" is displayed if the sample value is saved.
Press enter ●, to display sample date (note the date).

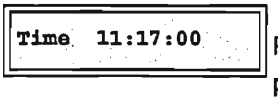
NOTE!
Always mark the lab sample with date and time. The lab sample value for the corresponding calibration cannot be entered from the JCT-1100.
The BT-Calibration sofware must be used.

Date



Press enter ●, to display sample time (note the time).

Time



Press enter ●, to complete and finish sampling procedure.

Channel setting

CHANNEL 1	Press enter ● to select another channel.
1	Press ▲ or ▼ to choose a channel to view/edit. Verify by pressing enter ●.

Range setting

RANGE 1	Press enter ● to select another range.
1	Press ▲ or ▼ to choose a Range. Verify by pressing enter ●.

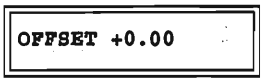
Note! The transmitter will continue operating with the range set by the Range select switch and the output signal will not change.

All Range specific parameters (Span, Offset, Damping & Calibration) can be changed for each Range. However, the changes will not take affect until the transmitter's range is changed via the Range select switch.

Span setting

SPAN 0.50-2.00	Press enter ● to change the Span.
0.50-2.00	When the first number starts to blink press ▲ or ▼ to change the number. Press enter ● to accept. The next number will blink. Repeat the procedure until done.
SPAN 1.00-2.50	After the last value has been entered, the new span is set.

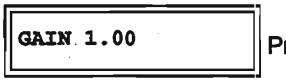
Offset adjustment



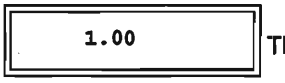
Press enter ● to change the offset.

The sign character starts to blink. Press ▲ or ▼ to change the sign or number. Press the enter ● to accept. The next number will blink. Repeate the procedure until done.

Gain

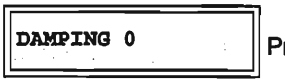


Press enter ● to change the gain.

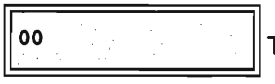


The first number starts to blink. Press ▲ or ▼ to change the value. Press enter ● to accept. The next number will blink. Repeat the procedure until done.

Damping setting

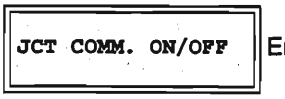


Press enter ● to change the damping value.



The first number starts to blink. Press ▲ or ▼ to change the number. Press enter ● to accept. The next number will blink. Repeat the procedure until done.

JCT Communication



Enter ● toggles communication ON or OFF.

Auto returns to ON after 30 minutes. Should always be set to OFF when the SPC-1000 is used.

8.5 Service Instructions

8.5.1 Maintenance Routines

No special maintenance routines are required. However, it is recommended that the following preventive maintenance is carried out:

- Check that the junction box is not damaged and complies with the protection rating (IP65).
- Check that the cables to and from the junction box are not damaged.
- Keep the junction box clean and free from pulp, etc.

8.5.2 Service Hardware

The different hardware components are identified in Fig 28 below:

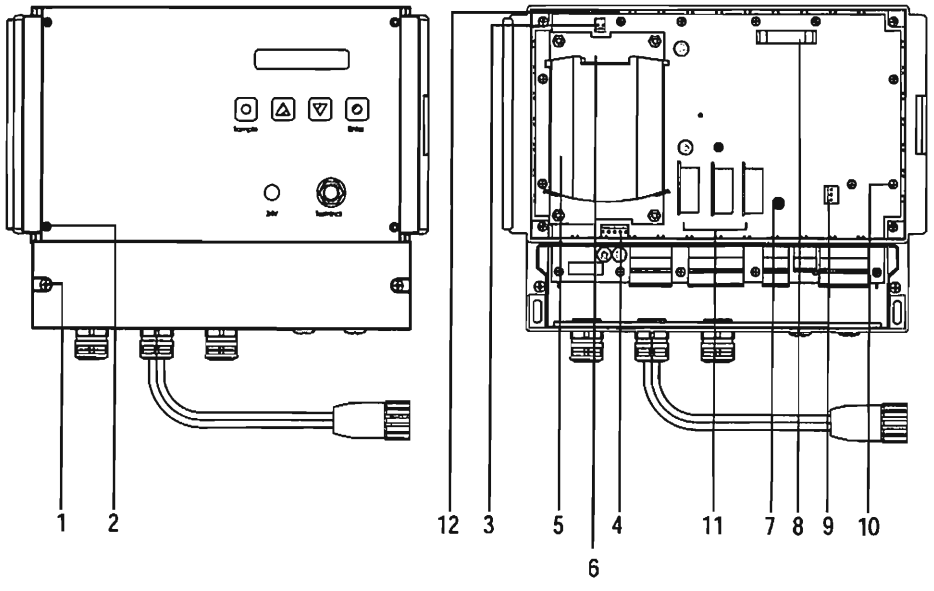


Fig 28 Hardware components

1 Screws for terminal cover (2x)
2 Screws for front panel (4x)
3 24 V DC connector
4 AC power connector
5 AC power supply
6 Mounting plate for power supply unit
7 24 V DC LED
8 Display connector
9 SPC-1000 connector
10 Screws for main circuit board (15x)
11 HART-filter (farthest to the left) or isolation amplifiers
12 Screw for front panel grounding strap

8.5.2.1 Handling of Circuit Boards for Output Signals

Upon delivery a HART-filter on a separate circuit board is mounted (see Fig 29 below). No isolation amplifiers are mounted.

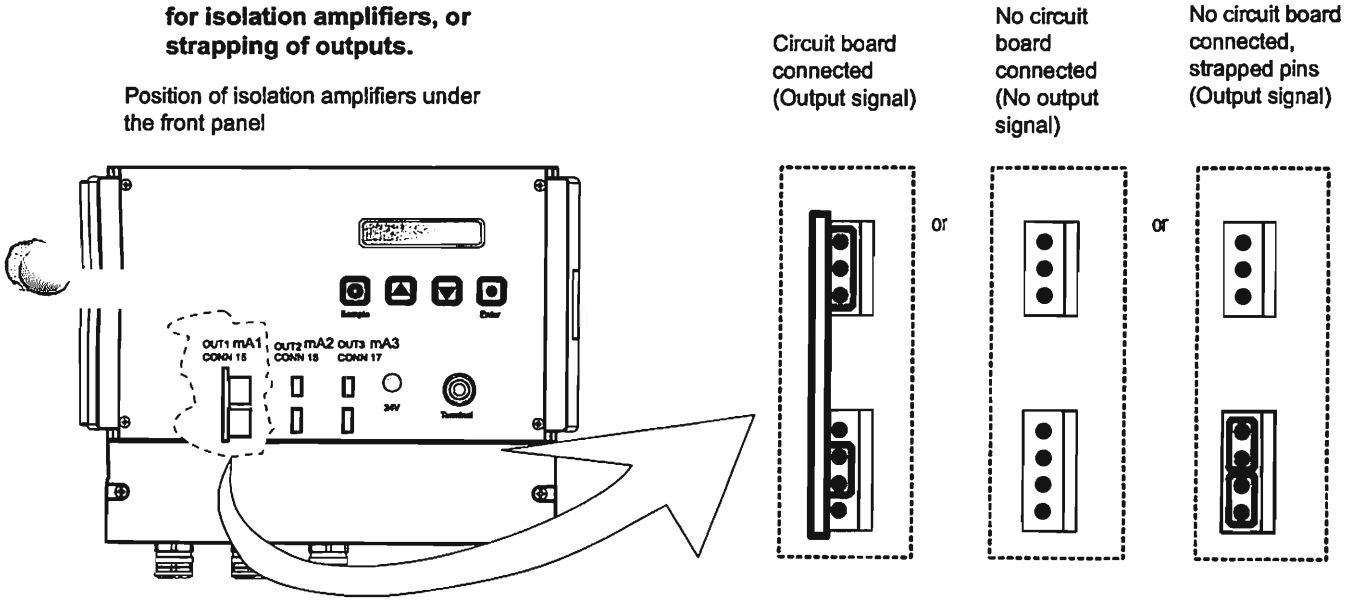
The HART-filter circuit board can be replaced with an isolation amplifier, or removed as required. If the circuit board is removed and not replaced, then the connector pins have to be strapped in order to get an output signal. See Fig 29 below.

It is possible to mount isolation amplifiers for up to three analog output signals (depending upon the transmitter type) in the junction box.

The front panel has to be removed before the circuit boards can be replaced, or removed. See section 8.5.2.3.

DANGER!
High voltage within the junction box.

Fig 29 Mounting of circuit boards for HART-filter, circuit boards for isolation amplifiers, or strapping of outputs.



8.5.2.2 Replacing the Power Supply Unit

If the power supply is faulty, it needs to be replaced.

Tools required:
Star screwdriver (medium size)

DANGER!
High voltage within the junction box. Connections may only be carried out by qualified personnel.

NOTE!
Break and secure the AC power supply voltage to the junction box before the front panel is removed (it is not sufficient to turn it off with the power supply switch in the terminal box.).

All numbers within () below refer to Fig 28.

1. Check that the 24 V DC LED (7) and the display are off.
2. Unscrew the front panel (2) and carefully lift the front panel plate aside.
3. Detach the display connector (8) by pushing the two levers aside and pulling the connector straight out from the main circuit board.
4. Detach the SPC-connector (9) by pulling it straight out from the main circuit board. It might be necessary to loosen the locking flap using a flat screw driver.
5. Unscrew the front panel grounding strap (12) from the main circuit board.
6. Detach connectors for 24 V DC (3) and AC power (4) from the main circuit board.
7. Detach the power supply unit from it's mounting plate by pushing the black lever (located on the right upper corner) to the left.
8. Lift out the power supply unit (5).
9. Move the wiring for 24 V DC (3) and AC power (4) from the faulty power supply unit to the new power supply unit.

To mount the new power supply unit, perform the steps above in reverse order.

8.5.2.3 Replacing the Front Panel

If there is something wrong with the display or the push buttons, then the whole front panel has to be replaced. However, the transmitter will still work properly without the display or the buttons functioning in the junction box. This allows the replacement to be made at a convenient time.

DANGER!
High voltage within the junction box. Connections may only be carried out by qualified personnel.

Tools required:
Star screwdriver (medium size)

NOTE!
Break and secure the AC power supply voltage to the junction box before the front panel is removed (it is not sufficient to turn it off with the power supply switch in the terminal box.)

All numbers within () below refer to Fig 28.

1. Check that the 24 V DC LED (7) and the display are off.
2. Unscrew the front panel (2) and carefully lift the front panel plate aside.
3. Detach the display connector (8) by pushing the two levers aside and pulling the connector straight out from the main circuit board.
4. Detach the SPC-connector (9) by pulling it straight out from the main circuit board. It might be necessary to loosen the locking flap using a flat screw driver.
5. Unscrew the front panel grounding strap (12) from the main circuit board.
6. Move the display wiring (8) from the faulty display panel to the new display panel.

To mount the new front panel, perform the steps above in reverse order. If the front panel sticker is not mounted, it is easier to mount it after the front panel has been replaced in the junction box.

8.5.2.4 Replacing the Main Circuit Board

If the main circuit board is faulty, it needs to be replaced.

Tools required:
Screwdriver (medium size) Star screwdriver (medium size)

DANGER!
High voltage within the junction box. Connections may only be carried out by qualified personnel.

NOTE!
Break and secure the AC power supply voltage to the junction box before the front panel is removed (it is not sufficient to turn it off with the power supply switch in the terminal box.).

All numbers within () below refer to Fig 28.

1. Check that the 24 V DC LED (7) and the display are off.
2. Unscrew the terminal box cover (1).
3. Detach all screw clamp connectors with cables connected to them. Note that the terminal screws do not need to be fully removed, the contact can be pulled out of the screw clamp connector on the main circuit board.
4. Unscrew the front panel (2) and carefully lift the front panel plate aside.
5. Detach the display connector (8) by pushing the two levers aside and pulling the connector straight out from the main circuit board.
6. Detach the SPC-connector (9) by pulling it straight out from the main circuit board. It might be necessary to loosen the locking flap using a flat screw driver.
7. Unscrew the front panel grounding strap (12) from the main circuit board.
8. Unscrew the fifteen screws (10) that attach the main circuit board to the box.
9. The main circuit board can now be removed. Space is tight, so be careful. Lift out the upper part first (where the display connector (8) is located).

To mount the new main circuit board, perform the steps above in reverse order.

8.5.3 Service Software

Software can only be serviced by BTG's technicians. Contact BTG regarding any suspected software problems.

8.5.4 Troubleshooting

This section only covers troubleshooting with regards to possible faults that can occur in the junction box. Please consult the transmitter part of this manual for transmitter related problems.

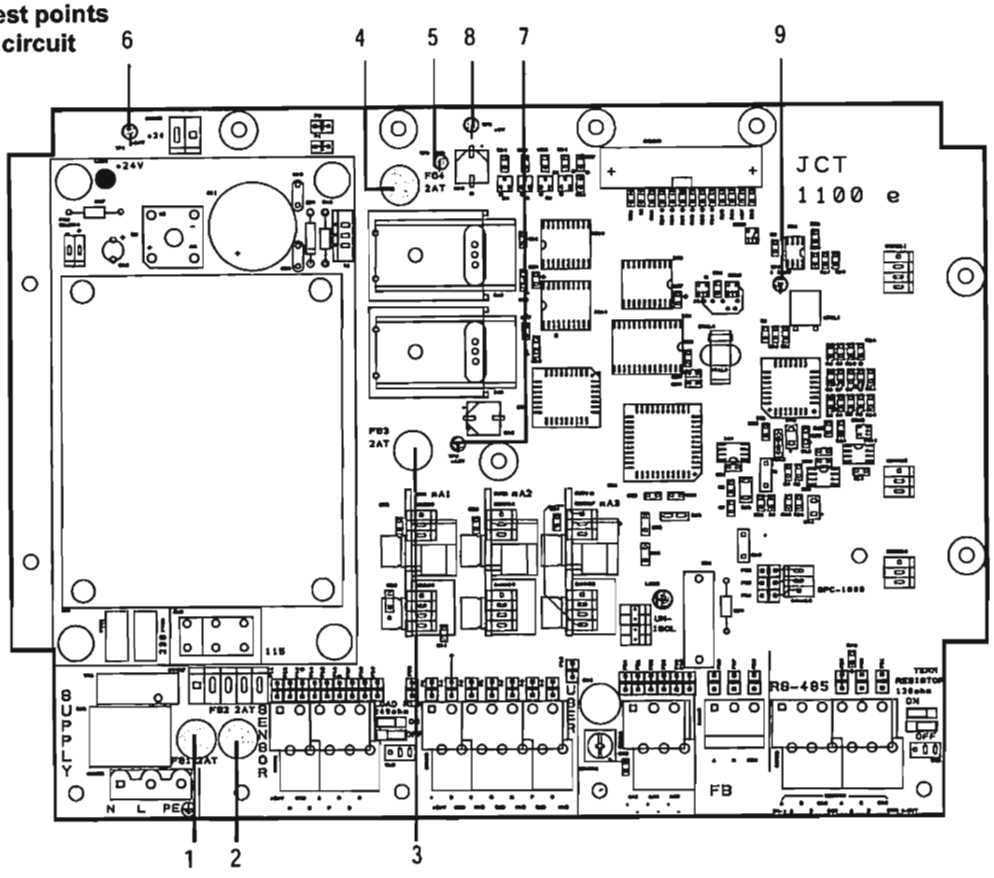
In the trouble shooting table below the probable causes are listed in a logical order. They should be checked in that order.

The fuses and the test points indicated in the troubleshooting table below are shown in Fig 30. All numbers within () in the troubleshooting table below refer to Fig 28.

Symptom	Probable cause	Action
1. The junction box does not power up.	1.1. No power to the junction box	Check the external power supply voltage.
	1.2. Fuse on main circuit board blown	Check fuses. FS1 and FS2 for AC power supply, FS3 for 24 V DC to transmitter, and FS4 for DC/DC converters.
	1.3. Faulty or incorrectly connected cabling to the power supply unit	Check the AC power (4) and 24 V DC (3) wiring.
	1.4. Faulty 24 V DC supply	Check TP1. If out of limits, replace the power supply unit. Seesection 8.5.2.2.
	1.5. Faulty DC/DC converters on main circuit board	Check TP2 and TP3. If out of limits, replace the main circuit board. Seesection 8.5.2.4.
2. There is no information on the display.	2.1. No power to the junction box	See point 1 above.
	2.2. Faulty or incorrectly connected display wiring	Check the display wiring (8) and the groundling strap (12).
	2.3. Display is faulty	Replace the front panel. Seesection 8.5.2.3.
3. Nothing happens when the push buttons are used.	3.1. Faulty or incorrectly connected display wiring	Check the display wiring (8) and the grounding strap (12).
	3.2. One, or more push buttons are faulty	Replace the front panel. Seesection 8.5.2.3.
4. There is no output signal.	4.1. No power to the junction box	See point 1 above.
	4.2. Transmitter not in operation.	Check the display for output signal

Symptom	Probable cause	Action
	4.3. Improperly mounted HART-filter or isolation amplifier	Check if the HART-filter or isolation amplifier is correctly mounted. Seesection 8.5.2.1.
	4.4. Open loop for 4-20 mA output	Check the complete 4-20 mA loop for breaks.
	4.5. Incorrect transmitter analog out configuration	See the transmitter part of this manual for calibration instructions.
	4.6. Faulty HART-filter or isolation amplifier	Replace, or remove the isolation amplifier circuit board. Seesection 8.5.2.1
5. The SPC does not work.	5.1. Incorrect program running in the SPC	Switch to correct sensor card and program in the SPC.
	5.2. Not enough resistance (minimum 250 Ω) in the 4-20 mA output loop	If the output signal is connected to a DCS, check that the total loop resistance is between 250Ω and 750Ω (with HART-filter) or between 250Ω and 1000Ω (without HART-filter.
	5.3. The analog output signal is not between 4-20 mA	See point 4 above.
	5.4. Faulty or incorrectly connected SPC cable	Check the connectors and cabling from the SPC to the main circuit board (9).
	5.5. Faulty Hart communication with the SPC	Check that the SPC functions correctly. If it does, it is necessary to replace the main circuit board. See section 8.5.2.4
6. The analog output signal from the junction box is lower than what the display display shows.	6.1. Faulty HART-filter or isolation amplifier	Replace, or remove the circuit board. Seesection 8.5.2.1
	6.2. Incorrect transmitter analog out configuration	See the transmitter part of this manual for calibration instructions.

Fig 30 Fuses and test points on the main circuit board



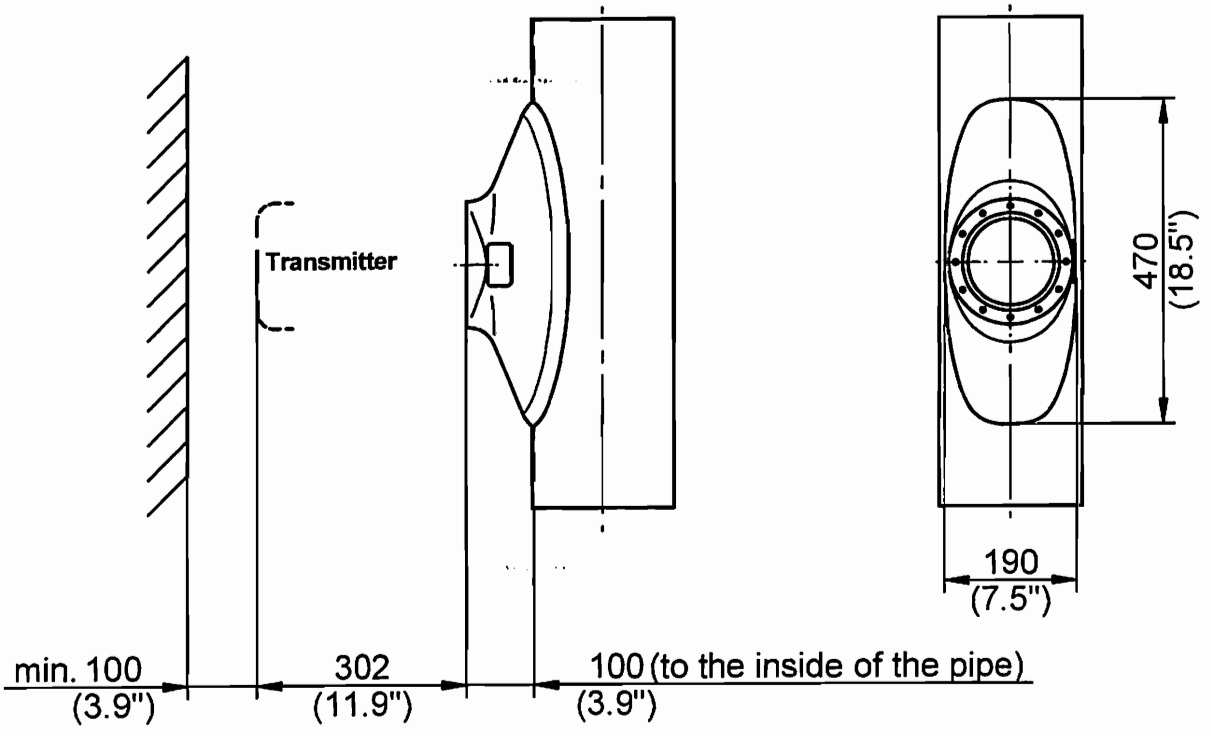
Pos	TP	Label	Min.	Max	Unit	Comment
1		FS1		2	A	Fuse for AC power supply: 250V, 2AT
2		FS2		2	A	Fuse for AC power supply: 250V, 2AT
3		FS3		2	A	Fuse for 24 V DC power supply: 250V, 2AT
4		FS4		2	A	Fuse for DC/DC converters: 250V, 2AT
5	TPØ	GND				Ground reference for all voltages (test points)
6	TP1	+24V	23.5	24.5	V	Output voltage from 24 V DC power supply
7	TP2	+12V	11.5	12.5	V	SPC-1000 supply voltage from DC/DC converter
8	TP3	+5V	4.95	5.05	V	Regulated system supply voltage from DC/DC converter
9	TP5	1.23V	1.20	1.25	V	Reference voltage for HART modem

Measure all TP's between TPØ (GND) and the TP at hand using a high impedance digital voltmeter

8.6 Parts List

8.6.1 JCT-1100

Item No.	Rec. spare parts	Qty	Part No.	Spare Part	Description
	(*)		A0012070	Junction box, complete	100-240 V AC version
10		1	A0012146	Main circuit board, with power supply unit	
11		1	27014281	Shield gasket	
12		1	A0006635	Terminal connection	SPC
13		1	A0068726 A0014274	HART-filter (included) Isolation amplifier (optional)	
14		1	A0012229	System cable	Transmitter
15	*	4	46022638	Fuse	TR5 2AT 250V
16		2	46028221	Cable gland	M12
17		1	46028130	Cable gland	M20
18	(*)	1	46027330	Power supply unit	Pulse
19		1	A0012203	Front panel, complete - without sticker	
20		1	XXXXX	Front panel sticker	
21		1	XXXXX	Sticker, inside terminal box	
22		1	A0012112	Junction box	



Dimensional drawing Certified by BTG RAISING YOUR PRODUCTIVITY

Date..... **Sign** .....

All dimensions in mm unless otherwise indicated

DRAWN 2009-12-21 SIGN. CnG

CHECKED SIGN.

PART OF

MAT.

BTG Instruments AB

Industrigatan 1-3, 661 29 Säffle - SWEDEN

BTG RAISING YOUR PRODUCTIVITY

MEK-3000 Saddle Dimensional drawing

REPLACES

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SCALE 1:10

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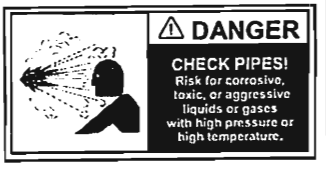
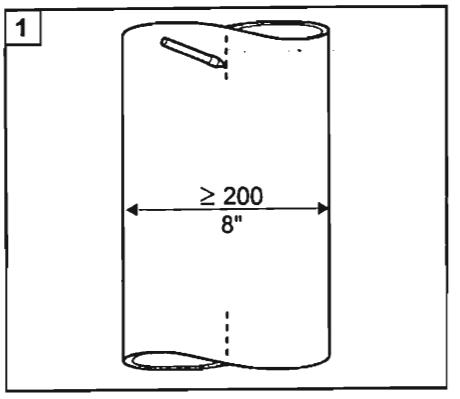
Welding Instruction Saddle

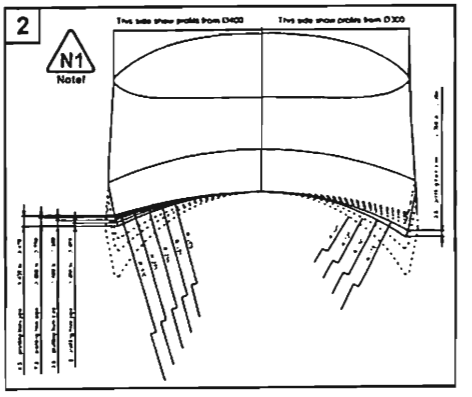
Safety

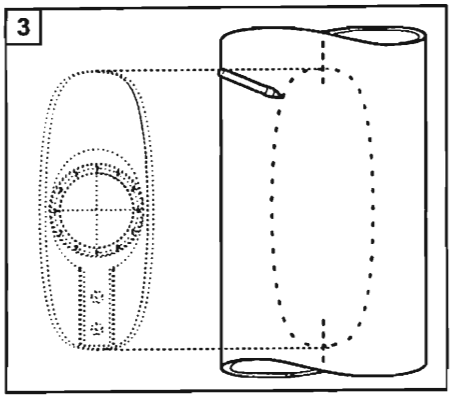


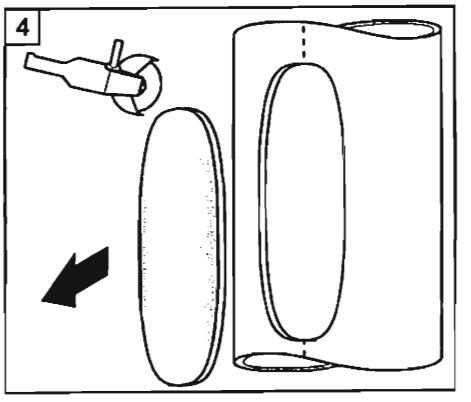
Note!

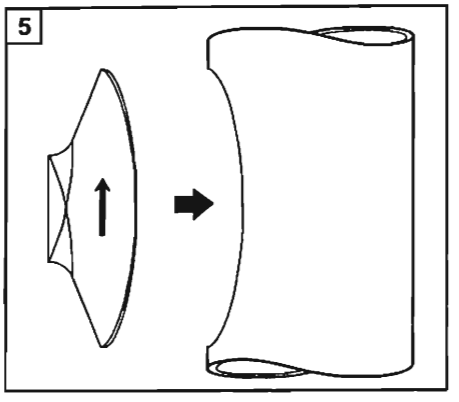
N1 Ensure that the saddle has the right profile in relation to the pipe diameter, see attached drawing MEK-3000 Saddle profiling A010147.

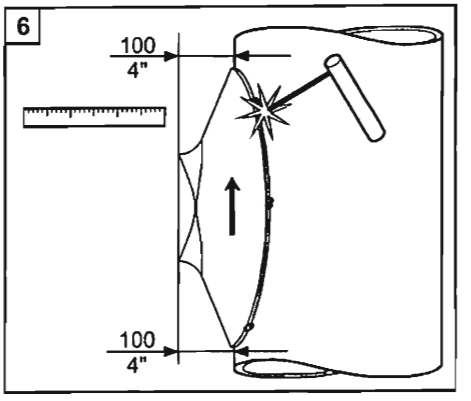


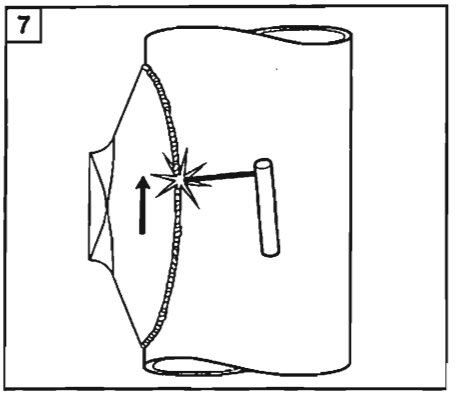


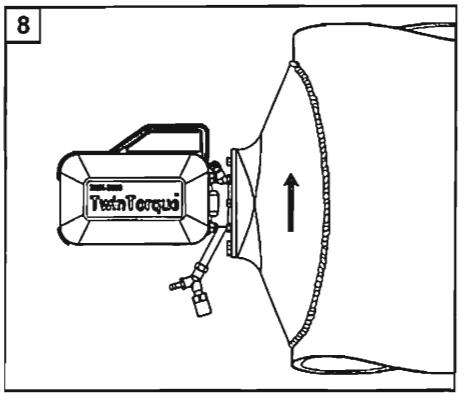


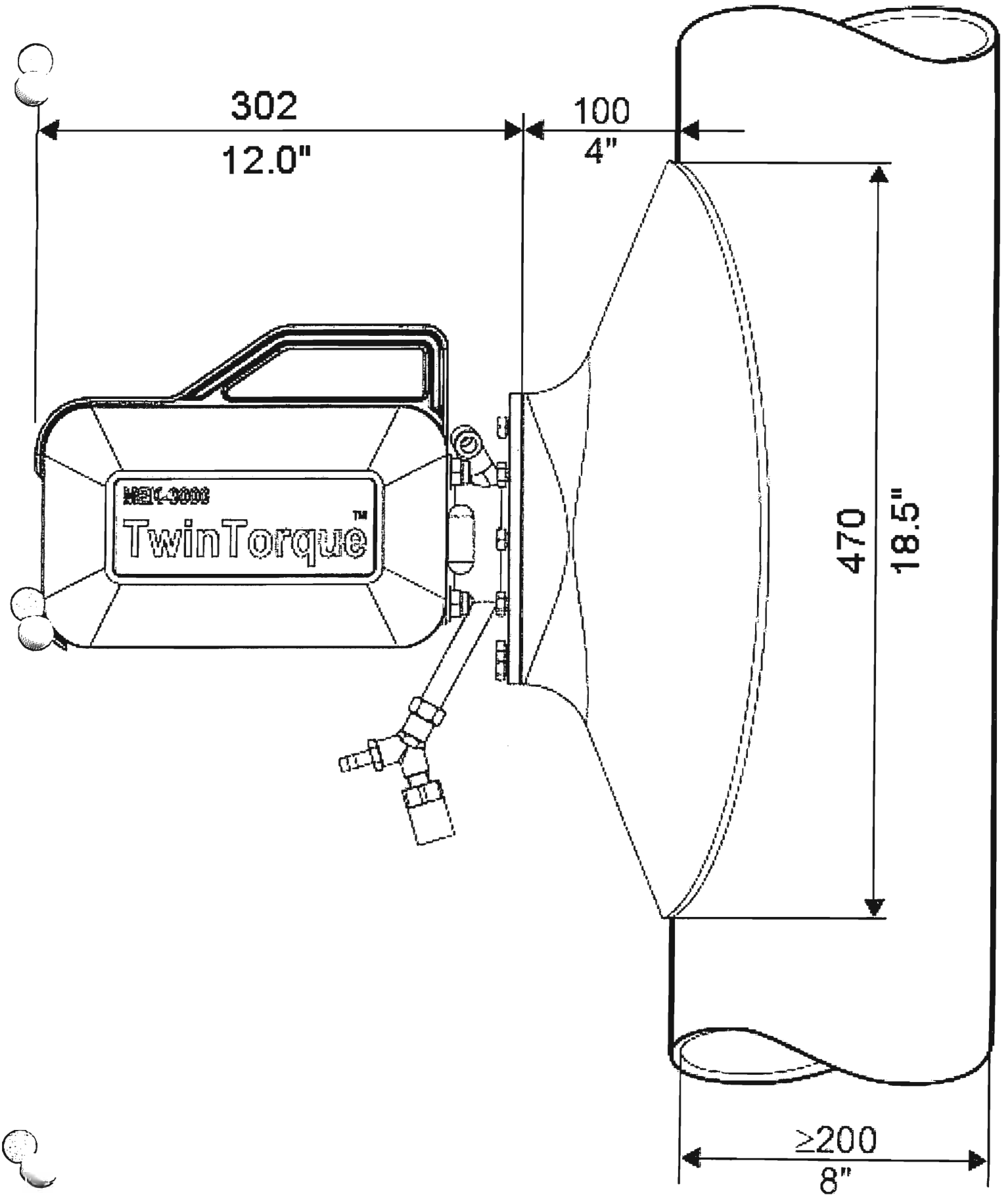











302
12.0"
100
4"
TwinTorque™
470
18.5"
≥200
8"