Correlator Operating Instructions

Version 1.0.0.1 and higher

Contents

List of Illustrations

Contact details

Company

F.A.S.T. GmbH

Boessingerstr. 36

D-74243 Langenbeutingen

Germany

Contact: Mr Tilo Behrmann

Tel: +49 – 7946 92100 25

Fax: +49 – 7946 7153

E-Mail: info@fastgmbh.de

Behrmann@fastgmbh.de

Web: www.FastGmbH.de

1 Programme Design

The following chapter offers an overview of the various functions and the most important components of the programme. First, the available menus are explained in brief (section 1.1). In section 1.2 the menu bar is described, and section 1.4 contains an overview of the main mask and the particular sections. In the final section of this chapter, there is a comprehensive overview of the additional user dialogues available.

1.1 Menus

In order to control the single functions of the programme, several menu options are available to the operator. Once the programme has been started, the menu bar offers five menu levels as shown in Illustration 1-1 below. The `File` menu level holds all the functions required to open, to save, to print, to create a new measurement, or to finish the measurement and to close the programme. Illustration 2-1 shows the expanded `File` menu. The `Process` menu level offers context-related filtering and calculation functions and user dialogues. This means that these functions are available only when the programme fulfils certain conditions concerning mode, input data, activated level, etc.. For example, a filter function is available only if a measurement has been carried out beforehand.. The `Measurement` menu level contains all the functions of the programme regarding the start and the stop of a measurement. In the `Settings` menu level, the characteristics of the programme can be changed. This especially applies to the language setting. Also, the kind of measurement section is determined through this menu level. For further details about the single menu levels and their functionalities, please refer to chapter 2. The `Help` menu level contains the information dialogue of the programme providing the user with information on the programme version and on the contact details, if it is required to contact F.A.S.T. GmbH.

Illustration 1-1: Menus

1.2 Menu bar

The menu bar under the menu provides the user with functions which can be activated through the menu as well but which require quick access as they are used frequently. Here as well, the applicable functions are context-related and thus are not available in general. If

certain functions cannot be used due to the context, these functions are shaded grey in the menu bar. Illustration 1-2 below illustrates the menu bar. For a detailed description of the single functions, please refer to chapter 2.6.

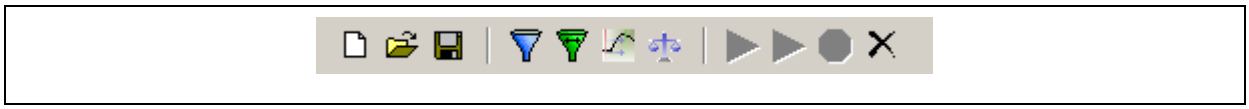

Illustration 1-2: Menu bar

1.3 User Dialogues

In order to generate any information relevant for the further calculation process, the programme offers various additional dialogues which enable the user to add and to save additional measurement-related information as a text or as a diagram. If such information has to be provided in a text format, a text dialogue can be used to draft reports (see chapter 4.1). This text can then be printed out together with the correlation and coherence diagrams. Also, a comfortable dialogue to generate and to process new kinds of pipelines is available for your convenience. This dialogue helps you to integrate new kinds of pipelines into the programme or to modify already existing kinds of pipelines. For further information on this dialogue, please refer to chapter 4.4. On the basis of the particular pipe details, the user can define the measurement sections to carry out new measurements through the dialogue as described in chapter 4.5. Sometimes it is requested for documentation purposes to put down the details of a location in a sketch. Therefore, the programme offers a dialogue (see chapter 4.2) with which sketches can be generated. This dialogue enables the user easily graphically to document certain conditions. If the programme is used by service providers who have to report to their customers, the address dialogue (see chapter 4.3) can allocate a certain service provider address. This address will be shown as the sender on the report print-out.

1.4 Main Mask

Once the programme has been started, the main mask as shown in Illustration 1-3 will appear on the screen. You can now reach all the settings and functions of the correlator. Besides, the mask also shows you the results of a particular measurement. When you want to set the filters for the correlator to be adjusted for a new measurement and to improve the results arising from this particular measurement, go to the left-hand part of the main mask. Here you also find the setting options for amplification, the averaging factor, and the activation and de-activation button for `Trans Auto`. In the lower part of the mask, the spectrums or the time signals of channel A and B as well as the input measurement distance between the diagrams

are shown. The mask sections on the right-hand side and in the middle of the mask show the displays for the correlation and coherence diagrams. Here the user can make any changes on the digital filter limits as soon as the particular measurement is finished. For detailed information on the single functions and sections of the main mask, please refer to chapter 3.

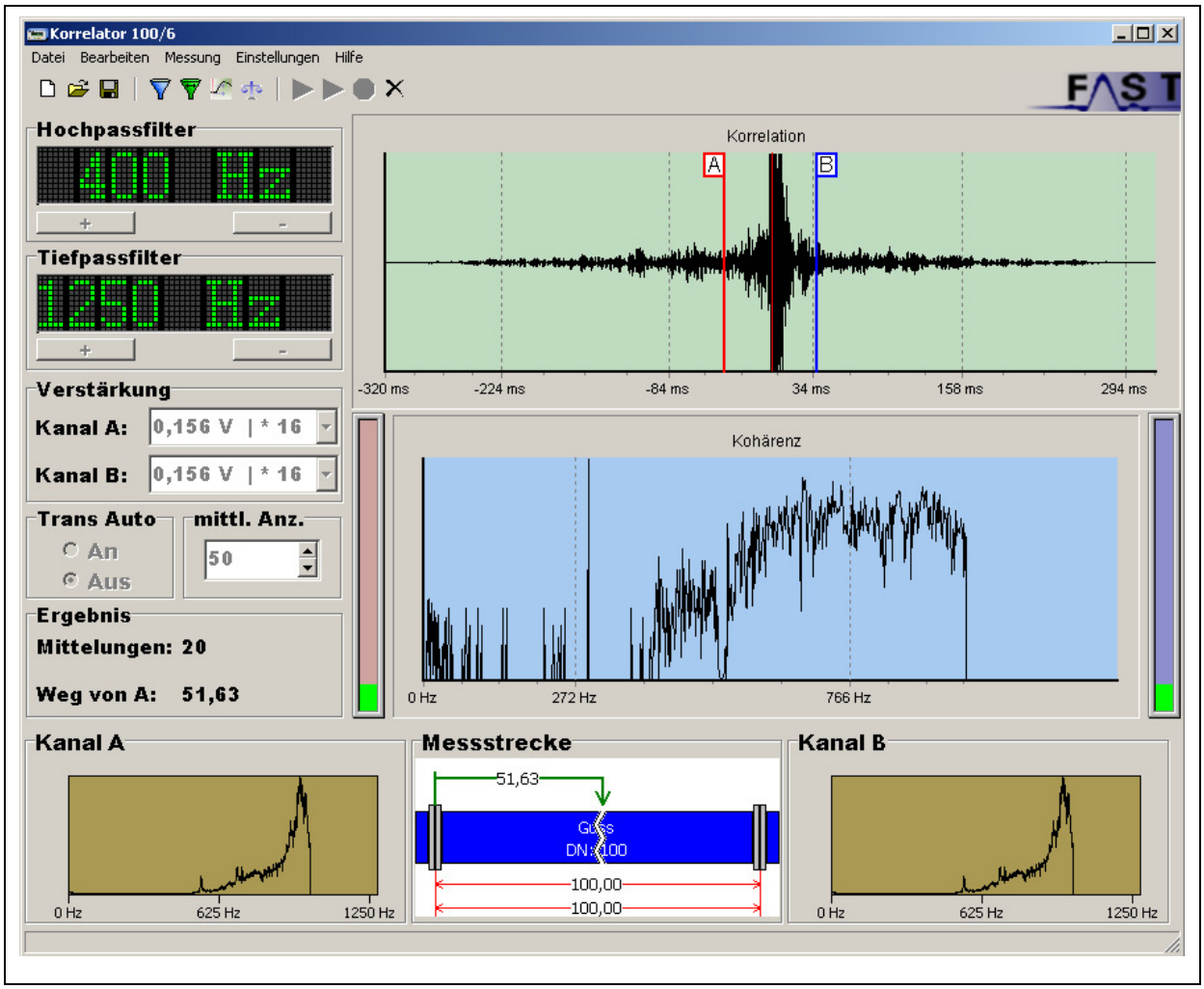

Illustration 1-3: Main mask

2 Menu Functionality

Chapter 2 is to explain the single menu levels including the particular sub-menus in detail. First, chapter 2.1 is to describe the functions related to the `Files` menu. Chapter 2.2 then deals with the `Processing` menu level. Chapter 2.3 is to describe the functions of the `Measuring` menu level, and the chapters 2.4 and 2.6 are to give information on the scope of functions of the `Settings` menu level und on the menu bar.

2.1 Files

In the `Files` menu level you will find all functions related to printing, filing, saving, and loading a measurement as well as to cancelling the programme. In order to be able to carry out a measurement, a new measurement object has to be created in the programme. This is done either by clicking on `New` (as to be seen in Illustration 2-1) or by pressing the shortcut `Strg+N`. Both procedures lead to the same result and either will help you to create a new measurement object in the programme. The programme is now capable of carrying out measurements. This "ready-to-measure" mode is indicated by an activation of the keys used to set the filters and amplification – the keys are not shaded grey any more. Moreover, the diagrams for the channels A and B (see chapter 3.9) now show the current time signal. If the measurement to be carried out has been started according to the procedure as described in chapter 2.3, the programme is now ready to start on the measurement procedure.

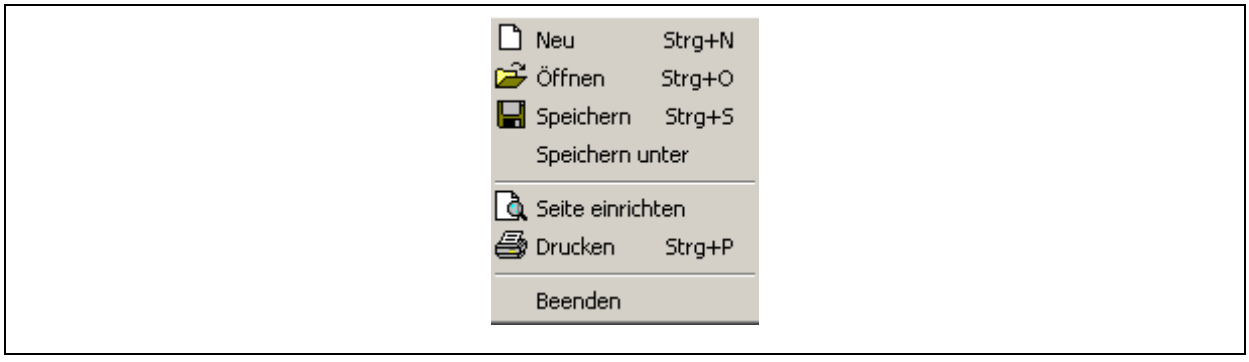

Illustration 2-1: Files menu

The next menu level enables the user either be clicking on `Open` or by pressing the shortcut `Strg+O` to open those measurement procedures which have already been carried out and saved. If any of the above options is implemented, the dialogue as shown in Illustration 2-2 opens up. Now the user can select a correlator programme file which has the ending `.kor` and load this file into the programme by clicking on the `Open` button. In contrast to an on-going measurement procedure, the analogue filter settings and the amplification factors as

well as the averaging factor for the loaded measurement cannot be changed. However, the loaded measurement can be filtered digitally again, and changes can be made on the measurement section.

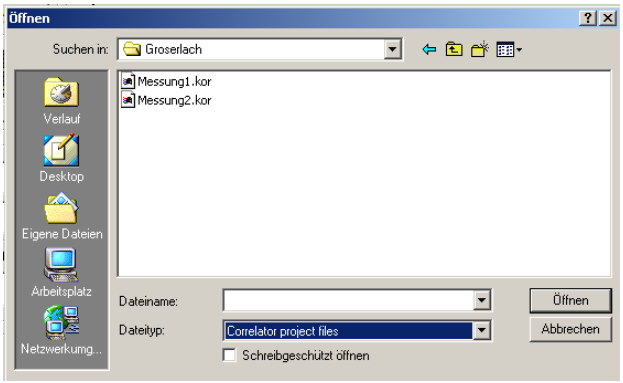

Illustration 2-2: Opening dialogue

The next two menu levels as shown in Illustration 2-1 are used to save finished measurements. The difference between `Save` and `Save as` is the different way of saving the data. When the `Save as` button is clicked on, the dialogue as shown in Illustration 2-3 will appear. When `Save` is clicked on, there will be no dialogue appearing on the screen if the measurement has already been saved at a previous point of time because the path and the file name have already been used to save the particular measurement and thus are known to the programme.

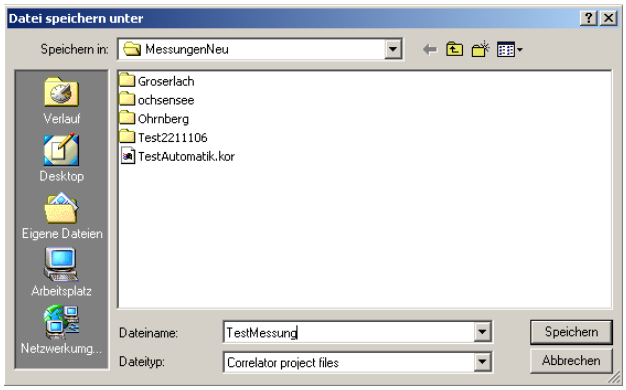

Illustration 2-3: Saving dialogue

The `Institute page` menu level is to enable the operator to select the requested paper format as well as the horizontal or vertical alignment of the print-out before the printing process is started. The report will be printed out by pressing the `Print` button. This report contains all information as input in the report (see chapter 4.1), the sketch (see chapter 4.2),

the address of the service provider (see chapter 4.3), and the measurement section (see chapter 4.5) dialogues as well as the filter setting and amplification factors, the measurement result and the correlation and coherence diagrams. Usually, the report has two pages. Pressing the `Cancel` button shuts down the entire correlator programme.

2.2 Processing

The “Processing“ menu level is a menu which is entirely dependent on the particular context. This means that all the functions hosted in this level are available only under certain conditions and in certain programme modes. The first four menu levels are available only when a measurement has been finished. For a detailed description, please refer to chapter 3.5. The final two menu levels are available as soon as a measurement object has been created, as already described in chapter 2.1.

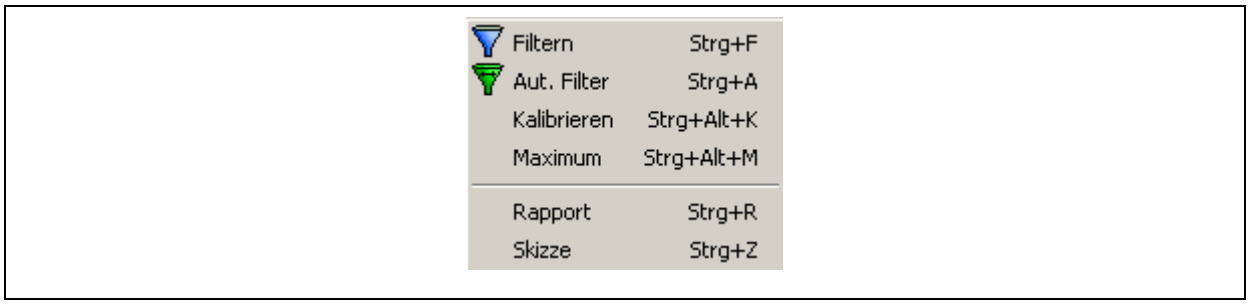

Illustration 2-4: Processing menu

With the `Filter` and `Aut. Filter` functions, the digital filters of the correlator programme can be set manually and automatically respectively. Unlike the analogue filters, the digital filters cannot be set before a measurement has been finished. Therefore, the two digital-filter functions are not available before the measurement has been finished, i.e. the digital filters are not activated before the measurement has been finished. Please note that `Filter` and `Aut. Filter` differ basically in their operation. Setting the filters manually is started either by clicking on `Filter` or by pressing the shortcut `Strg+F`. However, the filter limits have to be determined in the coherence diagram with the mouse beforehand for proper filtering purposes. The determination of these limits is described in chapter 3.7. Starting the fully automatic filtering mode is done by clicking on `Aut. Filter` or by pressing the shortcut `Strg+A`. The automatic mode does not require any preliminary work and can be started directly through the menu level or through the shortcut. Both functions lead to the same filtered correlation curve, which is displayed in the diagram as soon as the filter setting process has been finished.

The Calibrating menu level enables the user to determine the sound velocity related to a certain pipe section. This sound velocity is displayed in the Measurement section dialogue (see chapter 4.5). This function, alike the digital filter setting function, cannot be activated before the measurement has been finished. For a detailed description of the sound velocity calibrating process for a pipe section, please refer to chapter 3.8.

In contrast to the menu functions mentioned so far, the Report and Sketch menu levels can be applied as soon as a measurement object has been created (see chapter 2.1). Clicking on Report or pressing the shortcut Strg+R opens the report dialogue as described in chapter 4.1. This dialogue can be used to add further information to a particular measurement procedure. Similar applies to the dialogue to be called with the Sketch menu level. Here a certain situation can be displayed graphically, and this information can be allocated when the measurement is saved. Calling the menu level can also be done by pressing the shortcut Strg+Z. Either ways lead to the same dialogue, which is described in chapter 4.2.

2.3 Measurements

With the Measurement menu, a measurement run is started. This menu as well depends on the context, and two of its functions cannot be activated before a measurement object has been created (see chapter 2.1). The other two functions can only be used when the measurement has already started or when it has been finished.

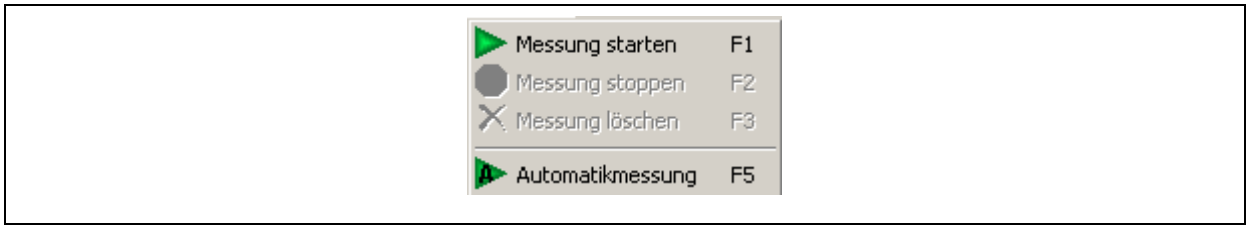

Illustration 2-5: Measurement menu

Pressing the F1 key or clicking on Start measurement starts the manual measurement process. Please note that the analogue filters, the amplification factor, and the averaging factor as well as the Trans Auto functions have to be set by the user prior to the start of the measurement. For a detailed description of the setting options, please refer to chapter 3. In contrast to the manual measuring mode, the automatic measuring mode automatically sets amplification and - when the measurement has been finished – the digital filters. The automatic measuring mode can be started either by clicking on the Automatic measurement button or by pressing the F5 key.

The Stop measurement button can be used only during the measurement process itself; it discontinues the on-going measurement process. This function as well as the other menu functions can also be started by pressing the F2 key.

The final menu level to be explained is Delete measurement. This function is available as soon as a measurement has been finished. It deletes all the information related to a particular measurement in the dialogues and in the main mask. When applied, the function resets the programme to the start status.

2.4 Settings

The Settings menu holds all the functions required to adapt the programme to the user's requirements. This especially applies to the language and pipe definition features. Furthermore, the displays of the channel diagrams for channel A and channel B can be changed, the measurement section is created, and the parameters for the GPS receiver interface are set through this menu.

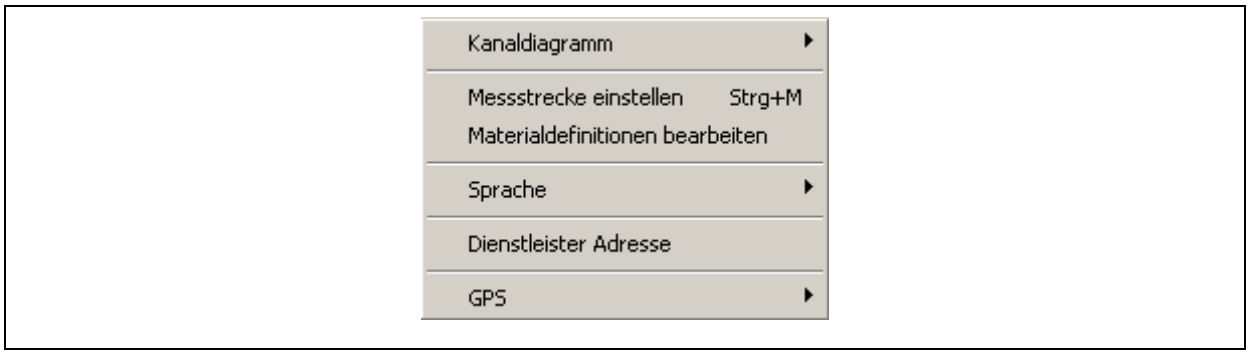

Illustration 2-6: Settings menu

The first menu level enables the operator to change the display for the channel diagrams as shown in Illustration 1-3 in the lower part of the main mask. On the one hand, the diagrams can show the current time signal of the channel, and, on the other hand, they can show the spectrum of the channel during the measurement procedure. Clicking on Channel diagram takes the user to a sub-menu which offers two options: either Time signal or Spectrum . The display mode currently activated in the channel diagrams is indicated by a tic in front of the menu level.

By clicking on Set measurement section or by pressing the shortcut Strg+M, the dialogue described in Chapter 4.5 will open. Double-clicking on the pipe schematics as shown

in the lower parts of Illustration 1-3 will have the same result. In this dialogue, the operator can combine up to seven pipe sections for the measurement.

The `Process material definitions` menu level enables the operator to integrate new kinds of pipelines into the programme or to process already existing pipe sections. In order to do so, the dialogue described in chapter 4.4 has to be opened.

If you want to change the language used for the dialogues and for the main mask, go to the `Language` menu level. The following languages can be activated if the appropriate language file has been saved in the corresponding folder of the programme:

- German
- English
- French
- Italian
- Spanish / Portuguese
- Swedish / Norwegian / Danish
- Polish

The programme features German and English as a standard. These two languages are not shaded grey in the `Language` menu level and that they are available as soon as the programme has been started. All other languages have to be installed by the operator as described in chapter 5.2. When the language is changed, all the dialogues in the programme and the report print-out are converted to the particular language. Please note that the names of the kinds of pipelines described in chapter 4.4 will not be converted automatically into another language and have to be converted separately as described in chapter 5.1.

Service providers have the option to have their corporate address printed on the report head. This can be set in the `Service provider address` menu level. If a certain address has been lodged in the dialogue, this address will be used for and printed on every report print-out until the address is changed. Concerning a detailed description of the dialogue, please refer to chapter 4.3.

The correlator programme features an interface capable of accepting GPS-related signals. Such signals are required to determine the exact position of a location. The sub-menu of the `GPS` menu level helps the operator to configurate the interface for the GPS receiver, and it also assists in carrying out a functional test for the receipt of the GPS data through the dialogue as described in chapter 4.6. For further information on how to connect the receiver, please refer to chapter 5.3.

2.5 Help

The `Help` menu provides the user with the information dialogue as described in Illustration 2-7. Press "Help" to open the illustration, which informs you about the programme version currently installed on your correlator. Furthermore, the F.A.S.T. GmbH contact details are listed on this illustration.

Illustration 2-7: Information dialogue

2.6 Menu bar

As already mentioned in chapter 1.2, the menu bar offers some functions which demand quick access to the programme due to their repeated usage. Therefore, the menu bar is divided into three sections by 2 vertical lines. This separation abstracts the first three menus: `Files`, `Process`, and `Measurements` and offers the menus' most frequently required functions.

Illustration 2-8: Menu bar

The functions available at the `Files` menu are as follows: `New`, `Open`, and `Save`. These functions are represented by the same symbols used at the menu bar of the `Files` menu.

Concerning the functionality of and the range of applications for the functions of this group, please refer to chapter 2.1.

The next group of symbols represents the functions available in the Process menu. The single functions are: Filter, Aut. Filter, Maximum, and Calibrate. These functions too, like their equivalents in the Process menu, are available only in a certain programme mode. For further information on this function, please refer to chapter 2.2.

The final group of symbols in the menu bar represents the functions of the Measurement menu. The first available function in this group is Start measurement, and the next function is Automatic measurement. However, these functions are not available permanently and thus shaded grey in the menu bar, as shown in Illustration 2-8. Availability as well as the results provided match availability and the results of the equivalent functions in the Measurement menu. For further information on this feature, please refer to chapter 2.3.

3 Main Mask

The most important information and functions are accessed through the main mask. This main mask can be divided into nine sections as described in chapter 3.1. The following chapters are to assist you in developing the measurement process with the programme. Chapter 3.2 describes the creation of the measurement section, and chapter 3.3 as well as chapter 3.4 are to provide you with information on how to set the analogue filters and amplification. The final measurement procedure is described in the chapter 3.5 and in chapter 3.6. The final chapters are to inform the operator about the options on how to rework the measurements that have been carried out.

3.1 Main mask sections of the programme

The main mask as shown in Illustration 3-1 and in Illustration 3-2 can be divided into nine sections. Some sections serve information display purposes, others are used to combine and to make available certain programme functions. In the first section, the correlation after the measurement has been finished is displayed in green. This section also shows the distance between measuring boxes A and B by means of vertical lines with various colours. The section between the lines reflects the particular measurement section currently dealt with.

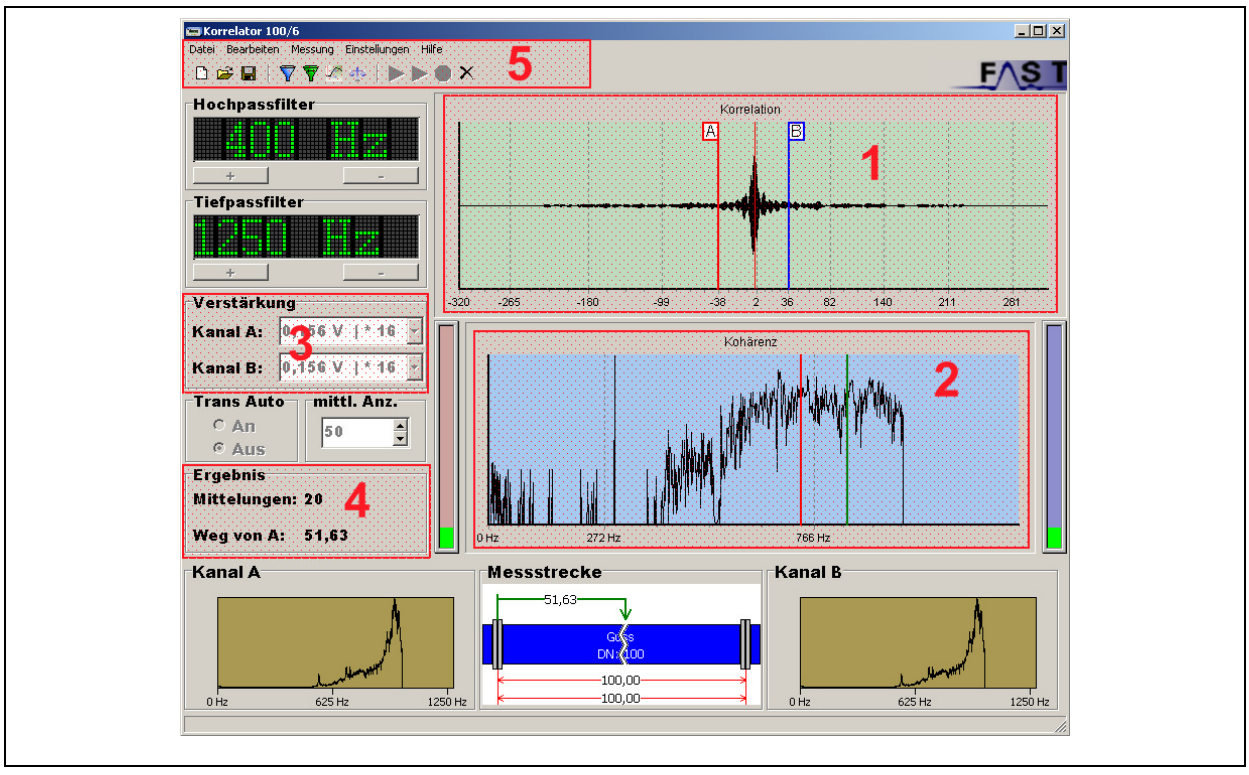

Illustration 3-1: Main mask sections 1

The maximum correlation is also displayed in this section with a small red vertical line. The programme automatically draws both this line and the correlation into the diagram when the measurement has been finished. The operator may, however, position this line in the diagram wherever he/she wants by double-clicking on it with the left mouse key. Please note that repositioning the maximum line will result in another leakage calculation. This also means that if you position the line outside the measurement section, you will either receive a zero-distance between the leakage and measuring box A or the programme will indicate the maximum pipe length. If the maximum correlation is indicated to be outside a measurement section as soon as the measurement has been finished, either the selected sound velocity is incorrect or the leakage is not located in the measurement section. In case of an incorrectly set sound velocity, the sound velocity can automatically be adapted to the pipe section through the `Calibrate` function (see chapter 3.8). Furthermore, the scale size of the correlation in the diagram can be changed through the `Image up` and `Image down` keys (similar to a zoom function).

The blue diagram as shown in section 2 shows the coherence of the current measurement procedure. In addition, the digital filters for manual digital filtering purposes can be drawn in into this diagram. If such digital filters are not applied and the operator uses the automatic filtering mode, the filter limits determined by the programme will be drawn in as soon as the calculation process has been finished. When the digital filters have been used, the correlation diagram will be updated in section 1, and the position of the leakage location will be calculated again. For further information on how to draw in and how to determine the filter limits for the manual filtering mode, please refer to chapter 3.7.

The section which is used to set the correlator, is section 3. Here the operator can change the amplification factor for the received signal for each channel separately. So the signal received by the measuring boxes A and B at the correlator can either be amplified or cushioned. For further information on how much to amplify or to cushion a signal, please refer to chapter 3.4.

In the fourth section in Illustration 3-1, the results are displayed. On the one hand, this section displays the averaged values for the particular measurement carried out, and, on the other hand, it also indicates the leakage position. Section 5 in Illustration 3-1 shows the menu functionality of the programme and has already been described in Chapter 2.

Section 6 (to be seen in Illustration 3-2) provides information on the analogue filters of the programme. These filters have to be set prior to the measurement procedure as they cannot be

changed once the measurement has been finished. One high-pass filter and one low-pass filter are available for analogue filtering purposes of the signals. For further information on the filtering process, please refer to chapter 3.3.

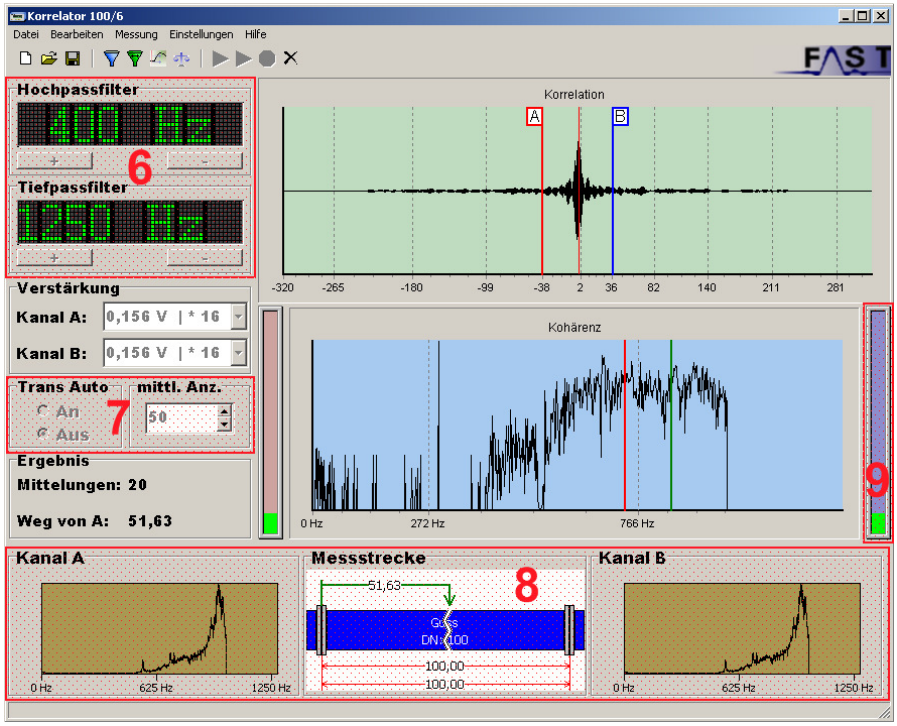

Illustration 3-2: Main mask sections 2

Section 7 shows the setting options for the `Averaging factor` and for the `Trans Auto` function. When the `Trans Auto` function is activated, the programme is capable of eliminating disturbing noises occurring during the measurement procedure and of using only such noises that are actually generated by a leakage. By raising the `Averaging factor`, the exactness of the measurement process will be increased indirectly. Each averaging process results in a measurement procedure, and the result of this measurement is added to the measurement result received previously. The more measurements are carried out, the more exact the result of the overall measurement procedure will be.

Section 8 is used to display the two channel diagrams and graphically to display the pipeline. It is also used to illustrate the leakage in the measurement section. The illustration of the channel diagrams can also show either the time signal of the channels or the spectrums of the channels (see chapter 3.9). Furthermore, the dialogue described in chapter 4.5 will appear on the screen by double-clicking on the field Measurement Section.

In order to set an amplification factor appropriate to the signals received (if required), the volume indicator in section 9 displays the volume of the time signal currently set. The red volume bar left of the coherence diagram refers to channel A, and the volume bar right of the diagram refers to channel B. If the signal is too low to be processed by the correlator, the volume bars will show a yellow bar. In this case, the operator has to increase the amplification factor for the particular channel. If, however, a red bar is displayed, the signal is excessive and cannot be processed properly by the correlator. In this case, the amplification level for the particular channel has to be reduced, if possible. A green indication with the bar being in the middle of the scale is reflects the optimum amplification factor and does not require any corrections.

3.2 Creating a measurement section

Before you start with a measurement procedure, you have create a measurement section in the programme as the programme needs to be able to calculate the distance to the leakage once it has acquired and evaluated the signals. In order to create a measurement section, you require the dialogue as described in chapter 4.5 (`Set measurement section`). Please open this dialogue and determine the particular section to be measured. You can combine up to seven pipe sections (partial sections) to one measurement section. Make sure that the partial sections have to be input originating at measuring box A. The partial sections will be displayed in the `Measurement section` field of the main mask as soon as the settings have been accepted.

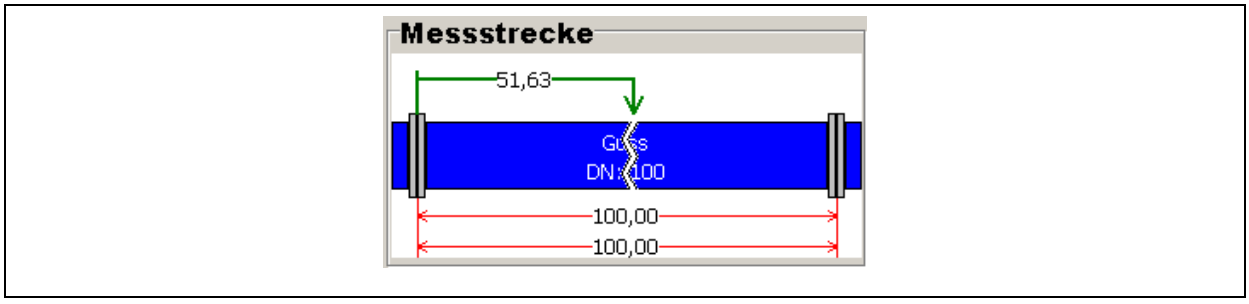

Illustration 3-3: Measurement section

The drawing in the Measurement Section illustration abstracts the underground pipe section defined by the operator. The single partial sections are drawn in one by one in blue and separated from each other with a grey flange-type line. They appear in different lengths reflecting their original lengths that have been entered by the operator. In order to provide you with a quick overview, the dimensions of the entire measurement section as well as of the partial sections are also drawn in. The dimensions are marked red and are written below the pipeline. So, coming from top, first the dimensions of the partial sections are shown, and then

the dimensions of the entire pipe section are stated. Furthermore, this section displays the result of the leakage-related calculation. The distance between the physical leak and measurement box A is always displayed above the drawn-in pipeline, and the dimensions are shown in green. The distance refers to the position of the measurement box and is indicated in metres. When you have entered all the settings for the measurement section, you can proceed by setting the analogue filters.

3.3 Setting the analogue filters

Before you start on the measurement itself, the analogue filters have to be set. The filters suppress undesired frequencies (disturbing noises). So the high-pass filter of the correlator accepts only those frequencies which are above the frequency as shown on the display. All lower frequencies are suppressed by this filter. The low-pass filter, in contrast, enables you to accept those frequencies which are below the indicated low-pass frequency and to suppress high frequencies. Therefore, you should make sure that the filter settings do not overlap each other as otherwise the programme cannot acquire any signals required to calculate the leakage. In addition, it is recommended to use a reasonably wide frequency range which contains the leakage and which can be processed by the correlator unit without any filters.

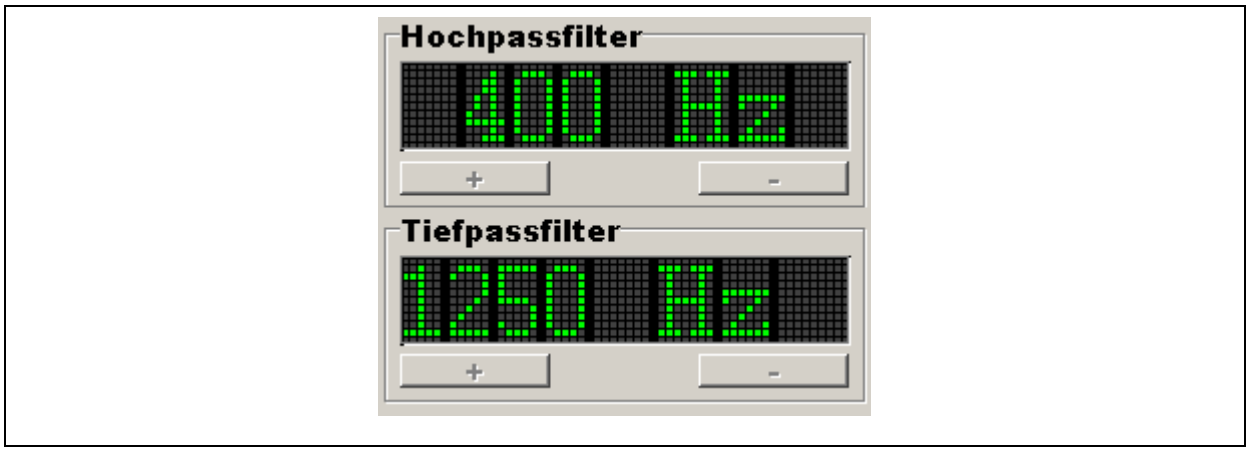

Illustration 3-4: Analogue filters

Other key factors for the appropriate setting of the filters are the pipe material and the length of the pipe section. Experienced operators are able to select the suitable filter settings on the basis of these two parameters. However, also other factors and the size of the leakage itself may have an impact on the selection of the appropriate filters. Also, when the measurement section features different pipe materials, the softest pipe material should dominate the selection criteria for the filters. So there is no general procedure on how to select which filters, but the following table is to give you some clues.

PE hard, PE soft, PVC				
distance in metre	0 - 20	20 - 50	50 - 100	> 200
HP filter	100	50	25	25
steel, cast iron				
Distance in metre	0 - 50	50 - 200	200 - 400	> 400
HP filter	400	200	100	25 or 50
asbest cementos				
distance in metre	0 - 50	50 - 200	200 - 400	> 400
HP filter	200	100	50	25

3.4 Changing amplification

Another important point to keep in mind is that the amplification factor for the particular channel has to be set before the measurement starts. If a signal for the channel is too weak or too strong, the correlator will not receive optimal information, and the measurement will be distorted.

Illustration 3-5: Amplification factors

As each pipe fracture generates its individual noise level, the programme has to be adjusted accordingly before the measurement process is started. Section `Amplification` offers the choice of five different levels of amplification to be set for the each channel separately. In order to identify and thus to set the appropriate amplification level, the two volume indicators to the right and to the left of the coherence diagram provide the operator with graphical

information on the particular signal volumes. The volume indicator on the left-hand side refers to channel A, and the volume indicator on the right-hand side refers to channel B.

The higher the bar in the volume indicators, the stronger the signal at the corresponding channels. You should select the amplification level for the channels appropriately so that the bars are displayed in green and are positioned in the middle of the level indicator. If a bar is displayed in red permanently, this means that the channel is overmodulated (= too loud) and amplification has to be reduced. If the bar is displayed in yellow, amplification is too low and thus the signal is too weak. Amplification for the particular channel needs to be increased then.

When all pre-settings (measurement section, analogue filters, amplification) have been made, you can start on the actual measurement procedure itself. Remember that you do not need to set amplification when you intend to carry out the measurement in the automatic measurement mode.

3.5 Manual measurement mode

In order to apply the correlator programme appropriately for measurements, you need to create a new measurement object in the programme. This is done by as described in chapter 2.1. The difference between operation in the automatic mode and operation in the manual mode is the course of action required to set the filters and the amplification factors for the channels. Before you can start with the manual measurement procedure, you will have to set the high-pass and low-pass filters. For further information, please refer to chapter 3.3. Once you have set the filters, it is mandatory to correct amplification for the channels A and B, if required (see chapter 3.4).

Please make sure that the signals are received with the appropriate volume. The volume indicators in the programme will help you to determine the suitable level. When all necessary settings have been done, you can start the measurement process through the menu bar (see chapter 2.6) or through the `Measurement` menu (see chapter 2.3). During the measurement process, the new correlation and the coherence will be displayed in the corresponding diagrams after each measurement run. When the number of measurement runs reaches the set averaging number (see chapter 3.1, section 7), the programme will discontinue the current measurement procedure, and you can start to rework the measurement. (see chapter 3.7 and also chapter 3.8). If it proves to be necessary to stop the measurement procedure before the set

averaging number of measurements has been reached, you can immediately leave the measurement mode by pressing the `Stop` button (see chapter 2.6).

When the measurement has been finished, the programme will immediately calculate the distance between the leak and measurement box A. This distance will be displayed in the corresponding sections of the main mask (see chapter 3.1 or chapter 3.2). If the measurement is reworked, the distance between the leakage and the measurement box A may differ from the initial result.

3.6 Automatic measurement mode

In contrast to the manual measurement mode, the automatic mode does not require that much preliminary work and reworking. Also, the automatic measurement mode automatically allocates the digital filters to the coherence when the measurement process has been finished.

When you intend to carry out a measurement in the automatic mode, you first have to create a measurement object in the programme (also see Manual Mode, chapter 2.1). When the object has been created, you only have to set the high-pass and the low-pass filters for the measurement process. Then start the measurement procedure as described in chapter 2.3 and in chapter 2.6. Before the measurement is started by the programme, however, the programme checks the settings and the amplification levels. If the programme detects any insufficiencies in the settings, it automatically adjusts the amplification factors. When the number of measurement runs has reached the averaging number, the programme stops the measurement process and proceeds with the automatic filtering process of the coherence. Calculating the filter limits may take up to ten seconds. When the filter limits have been determined, the calculated limits are drawn in into the coherence diagram and the illustration will be adapted to the correlation.

If requested, you can also manually filter the measurement results digitally when the measurement procedure is finished. Please refer to chapter 3.7 for further information. The distance between the leakage and the measuring box A is indicated in metres and is displayed as soon as the measuring and filtering processes have been finished.

3.7 Setting the digital filters

An adequate function to raise the exactness of the measurement results is digital filtering of the coherence. This filtering method enables the operator to suppress those disturbing noises

displayed in the coherence by determining an appropriate filtering range and by calculating the leakage again without any disturbing noises. The programme offers two filter options for such re-calculation purposes. The operator can either filter the results manually by determining the filter limits himself/herself, or he/she can use the automatic filtering mode. In the automatic filtering mode, the programme determines the filter limits. As this filtering technique is based on a coherence curve, digital filtering cannot be started before the measurement procedure has been finished.

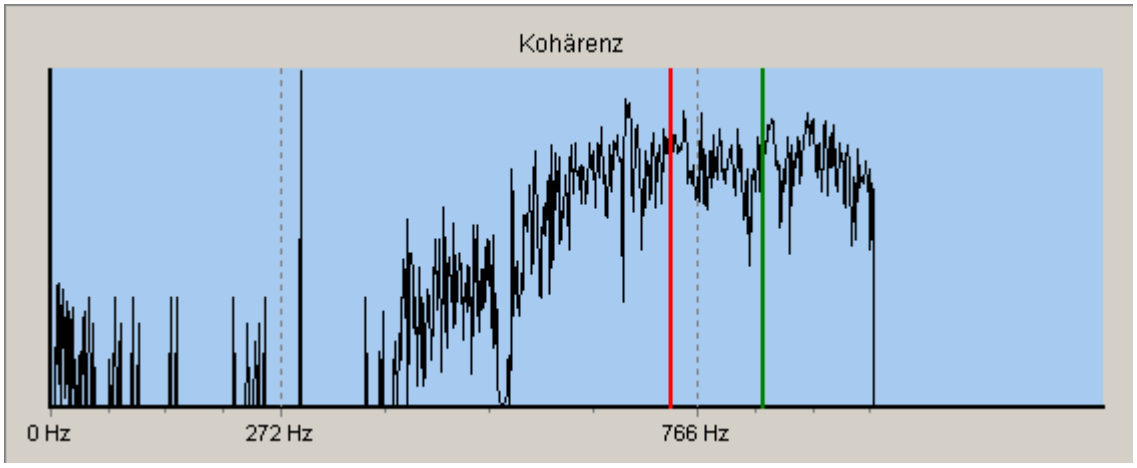

Illustration 3-6: Digital filters in the coherence

When you intend to manually filter the results, you will have to determine the filter limits before you start the function. Setting the filter limits is done in the coherence diagram of the main mask (see chapter 3.1). In order to do so, move the cursor across the diagram and click on the blue part of the diagram with the left mouse key. A red vertical line will now appear in the diagram. This line abstracts the lower filter limit for your digital filter. Repeating this process at another position in the diagram will shift the filter limit.

The upper filter limit is marked by clicking on the diagram with the right mouse key. A green line to indicate the upper limit will appear in addition to the red line, which indicates the lower limit of the digital filter. Both lines can be shifted by repeating the clicking with the particular mouse key. Whatever data is between the two lines will be used for the calculation of the leakage. The data left of the red line and right of the green line will not be considered for the leakage calculation process. Please make sure that the red line has is positioned to be left of the green line and the green line is positioned to be right of the red line so that the programme can calculate the leakage. If the positions of two lines are mixed up, the programme will issue incorrect results.

When both filter limits are set in the diagram, you can start the manual filtering process through the menu function (see chapter 2.2) or through the menu bar (see chapter 2.6). When the programme has finished the filtering process of the measurement values, it displays a new correlation in the diagram and updates the indication of the position of the leakage.

The automatic filtering mode does not require any setting of the filter limits in the coherence as the programme determines the limits itself. You only have to call the menu level (see chapter 2.2) or to call the function in the menu bar (see chapter 2.6) to filter the measurement. Please note that the automatic digital filtering process is not feasible before the measurement procedure is finished. Calculating the filter limits may take up to ten seconds, depending on the circumstances. When the calculating process for the filter limits is finished, the filter limits are drawn in the coherence diagram and adapted to the illustration of the correlation. The indication of the leakage will be updated.

3.8 Calibrating

Calibrating enables the operator to determine the sound velocity on pipe sections. Please note that the leakage does not have to be located between the two measurement boxes, i.e. not within the measurement section. If so, the correlation as shown in Illustration 3-7 will be displayed. The diagram clearly shows that the leakage must be in front of measurement box A. In such a case, the programme indicates that the distance between the leakage and measurement box A is zero. If, however, the leakage is not located outside the measurement section, such a correlation indicates that the sound velocity on the pipeline is incorrect.

In both cases, you can use the `Calibrating` function (see chapter 2.2 and chapter 2.6) to make the programme adapt the sound velocity on the pipe. When the sound velocity has been adapted, the programme shows a new correlation in the diagram. The positions of the measurement boxes have now been changed and the distance between the two boxes in the diagram has been increased. The programme shifts the location of the measurement box closer to the peak of the correlation to the peak of the correlation seen previously. Either the leakage is now exactly at measurement box A, or the distance between the leakage and measurement box A precisely corresponds to the distance between the two measurement boxes.

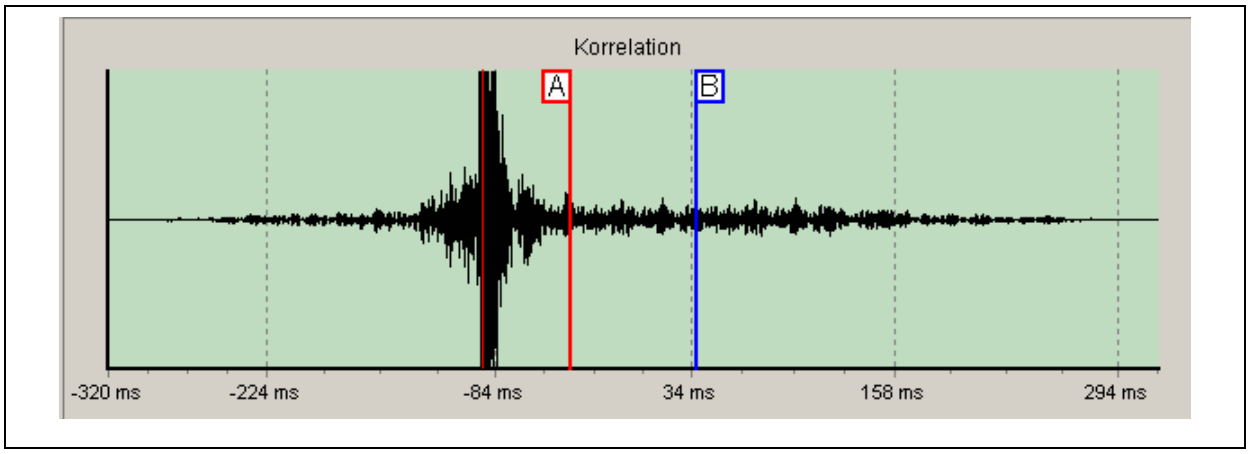

Illustration 3-7: Calibration

If you have to carry out a calibration process, proceed as described in chapter 3.5 or in Chapter 3.6 and carry out a measurement. When the result of the measurement is similar to what is shown in Illustration 3-7, you can start the calibrating process through the menu function of the `Measurement` menu (see chapter 2.3) or through the menu bar (see chapter 2.6).

3.9 Time and spectrum diagrams

This part of the programme displays the time signal or the spectrum for a particular channel. The time signal is displayed as soon as a measurement object has been created, whereas the spectrum can only be displayed during the measurement procedure itself. In the `Settings` menu at the `Channel diagram` menu level, the operator can switch between the two indication modes.

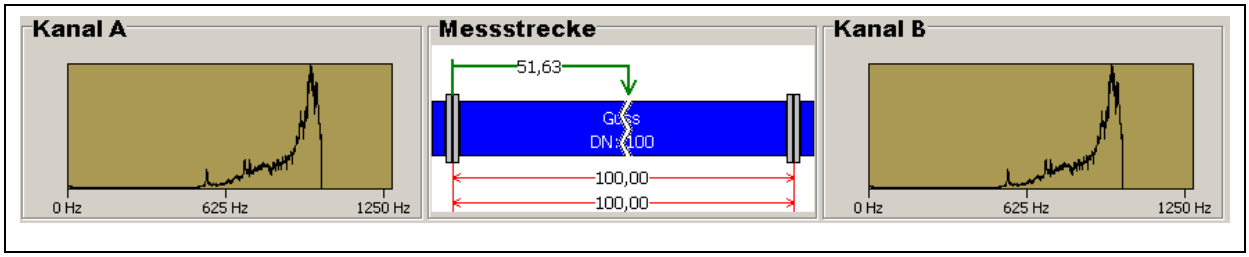

Illustration 3-8: Channel diagrams

4 User Dialogues

This chapter is to provide a detailed description of the dialogues available in the programme. The dialogues are used to add further information to the a particular measurement or to change the settings in the programme. Chapter 4.1 is to describe the options available for the `Report` dialogue which help to add certain information in a text-format to a particular measurement. Chapter 4.2 is to describe the options and the range of functions available for the `Sketch` dialogue, and chapter 4.3 is to provide you with information on the `Service provider address` dialogue. Chapter 4.4 deals with the scope of functions of the `Process material definitions` dialogue, and the chapters 4.5 and 4.6 finally are to give you an overview of the `Measurement section` dialogue and on the dialogues for the configuration of the GPS interface.

4.1 Reporting

As already briefly mentioned in chapter 1.3, additional information on this dialogue can be input to generate a report and to print out this report together with the measurement diagrams. To call the dialogue, please proceed as described in chapter 2.2. When the dialogue has been called, the input mask as shown in Illustration 4-1 will appear on the screen. This mask offers four fields for input to the particular measurement. On the left-hand side, there are the fields for `Address` and `Remarks`, and in the right-hand side, there are the fields for `Measurement points` and `Specialist`.

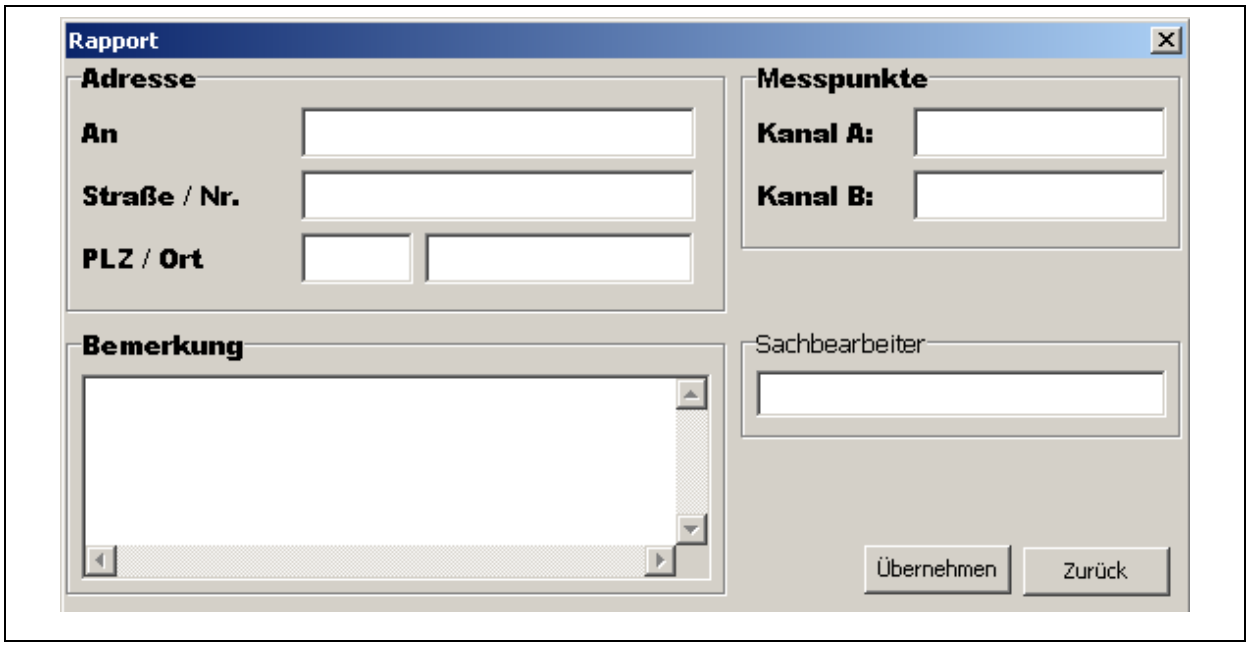

Illustration 4-1: Reporting dialogue

In the Address field, the customer's address can be lodged. This address will then be shown on the head of the report. The field for Remarks will also be printed out. However, only the first four lines will be printed out on the report to save some space. In the Specialist field, the name of the colleague who carried out the measurement can be input. The boxes of the Measurement points field are used to input a description of the location for the measurement boxes A and B. This information is also shown on the printed-out report.

If you intend to accept the input information and to allocate it to the current measurement, please press the Accept button. Please note, however, that the also measurement itself has to be saved in order to save the information permanently. If the measurement has not been saved, the information will be lost. Therefore, you will have to press the Accept button to allocate the information to the particular measurement and then press Save in the Files menu (see chapter 2.1) to save the information. If you do not want to accept the input information, press Return.

4.2 Sketches

In order to be able graphically to display certain conditions at the point of measurement, the correlator programme offers the operator a dialogue which can be applied to draw sketches and to save these sketches together with the measurement concerned. The dialogue is illustrated in Illustration 4-3 below.

When the dialogue has been called, the operator cannot draft a sketch yet. First, a new sheet has to be created through the Files menu of the Sketch dialogue, menu level New, or an image file has to be loaded through the Open menu level. The correlator programme is currently capable of processing JPG-type or BMP-type raster graphics. This means that these types of raster graphics can be loaded into the sketch dialogue through the Open menu level.

Illustration 4-2: Files menu in the sketch dialogue

If any of the above conditions has been fulfilled, the graphic can be drawn on the sheet. Furthermore, the Files menu (see Illustration 4-2) also offers the Cancel option. This option enables the operator to leave the dialogue. When the dialogue is closed by pressing on

`Cancel`, the programme will show an information dialogue and ask the operator whether the sketch is to be saved when the measurement is saved the next time. If this dialogue is confirmed by clicking on with YES, the sketch will be saved. If you click on NO, the data will not be saved. Please note that the measurement has to be saved as well if you intend to save the sketch permanently. If the measurement itself is not saved, the sketch-related data will be deleted.

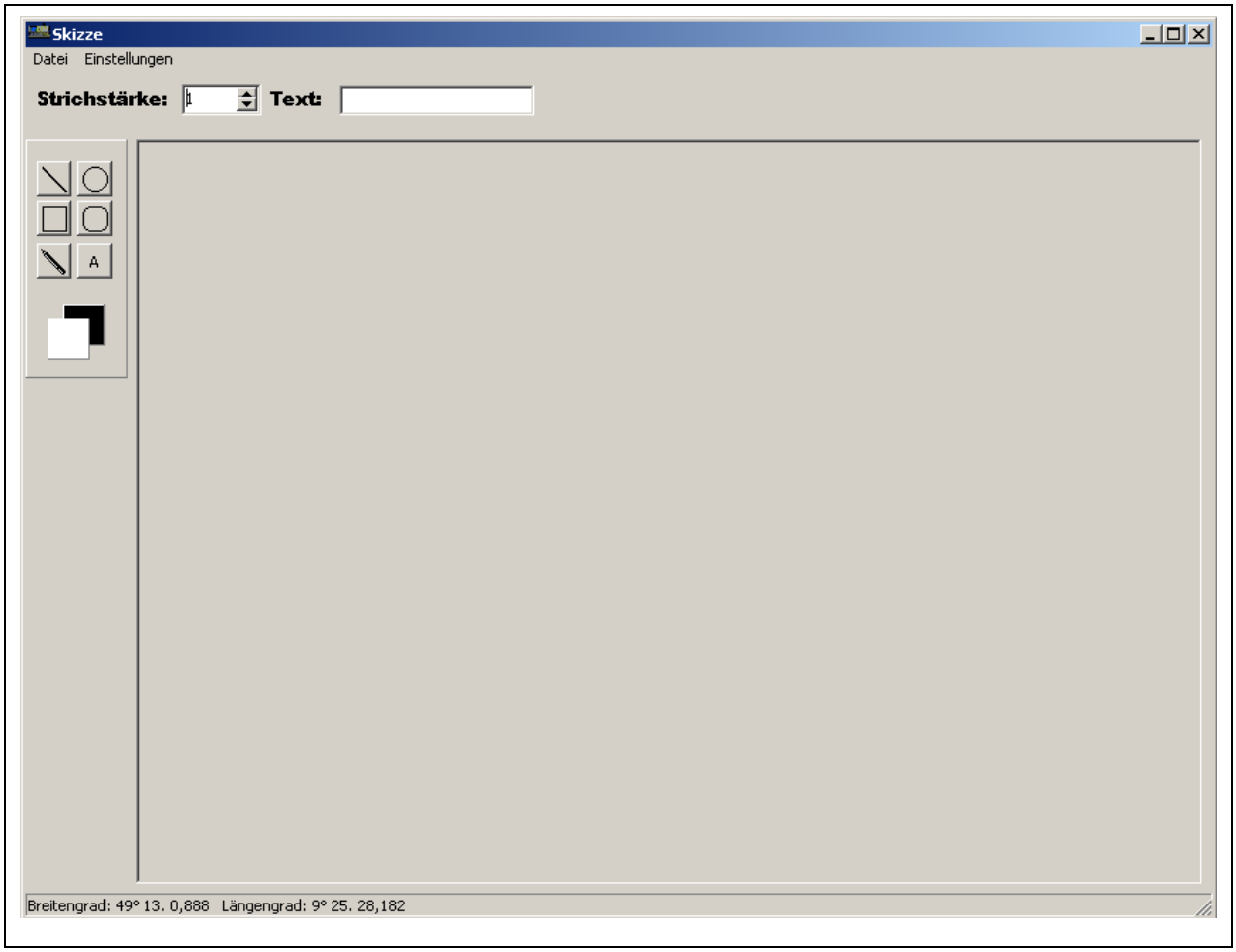

Illustration 4-3: Sketch window

The `Settings` menu provides all the functions of the `Sketch` dialogue required to change the drawing elements. So, for example, at the `Fond type` menu level, you can change all the parameters of a text to be drawn in. Both the type of fond and its size can be modified before a text is added to a graphic. Another menu level is the `Fill pattern` feature. The sub-menu offers a variety of fill patterns to draw circles, squares, etc. Another way to make lines and areas appealing is to use the `Line type` menu level. The sub-menus offer numerous options to vary the illustration of lines.

Illustration 4-4: Settings in the sketch dialogue menu

The programme offers six different drawing functions to assist the operator in this dialogue. The functions are located left of the drawing area and are represented through buttons showing the corresponding geometric character or other symbols. According to their symbols, the first four buttons are used for `Lines`, `Circles`, `Quadrangles`, and a `Quadrangle with rounded edges`.

Just click on the corresponding button and move the cursor across the drawing area. Keep the left mouse key pressed and move the mouse. Now, the desired figure is positioned on the sheet. Releasing the mouse key makes the figure remain at the particular position in the drawing area.

Another function in the `Settings` menu is `GPS Export`. This function enables the operator to export the received GPS coordinates to the Google Earth programme and to have the location indicated there. For further information on how to configurate the receipt of the GPS data, please refer to chapter 4.6 and chapter 5.3. If the programme's path to Google Earth is not filed in the correlator programme, the dialogue as shown in Illustration 2-2 will appear when the function is called. Here you will have to enter the path for the `googleearth.exe` file and to confirm the dialogue by clicking on `Open`.

4.3 Address of the service provider

Another dialogue to process information is the `Service provider's address` dialogue, which can be called through the `Settings` menu.. Here you can lodge the provider's address in the programme. This address will then be shown on the head of every report print-out. By pressing on the `Accept` button, the address will be written directly into the configuration file (see chapter 5.1) of the correlator programme. So the information contained in this dialogue can be saved in the programme independently and does not depend no any measurement. By pressing the "Return" key, the operator will delete the input and return to the main mask of the programme.

Illustration 4-5: Service provider's address dialogue

4.4 Material definitions

In order to exploit the full supportive potential of the programme when creating a measurement section and calculating the sound velocity defined for the stated pipe material, the kinds of pipelines have to be entered into this dialogue beforehand. The installation file already contains the most common seven types of pipelines and their particular sound velocities for various pipe diameters. So if you intend to process these seven types of pipelines or add some new kinds to the programme, you can do this through this dialogue. As can be seen in Illustration 4-6, the dialogue is separated into two sections: the left-hand section is used for the kinds of pipelines, and the right-hand section deals with the particular sound velocities and the pipe diameters.

In the left-hand section, the operator can create or delete certain kinds of pipelines by clicking on the section with the left mouse key. A context menu will open and will offer two menu levels: one to create a new kind of pipeline and another to delete the selected kind of pipeline.

When you intend to create a new kind of pipeline, open the context menu and select the first menu level to open a window where you can enter the name of the new type of pipeline. If you want to confirm the dialogue or to accept the kind of pipeline in the `Material definitions` dialogue, press the `OK` button. Click on the `Cancel` button to reject the entered data. When the input has been confirmed by pressing the `OK` button, the new material definition will be shown in the field on the left side of the dialogue. If you want to delete a certain material definition, mark the definition concerned and call again the context menu by clicking the right-hand mouse key. Select the second menu level. The marked pipeline definition is now deleted. Please note that the pipeline definition has now been irreversibly deleted and cannot be restored by the programme.

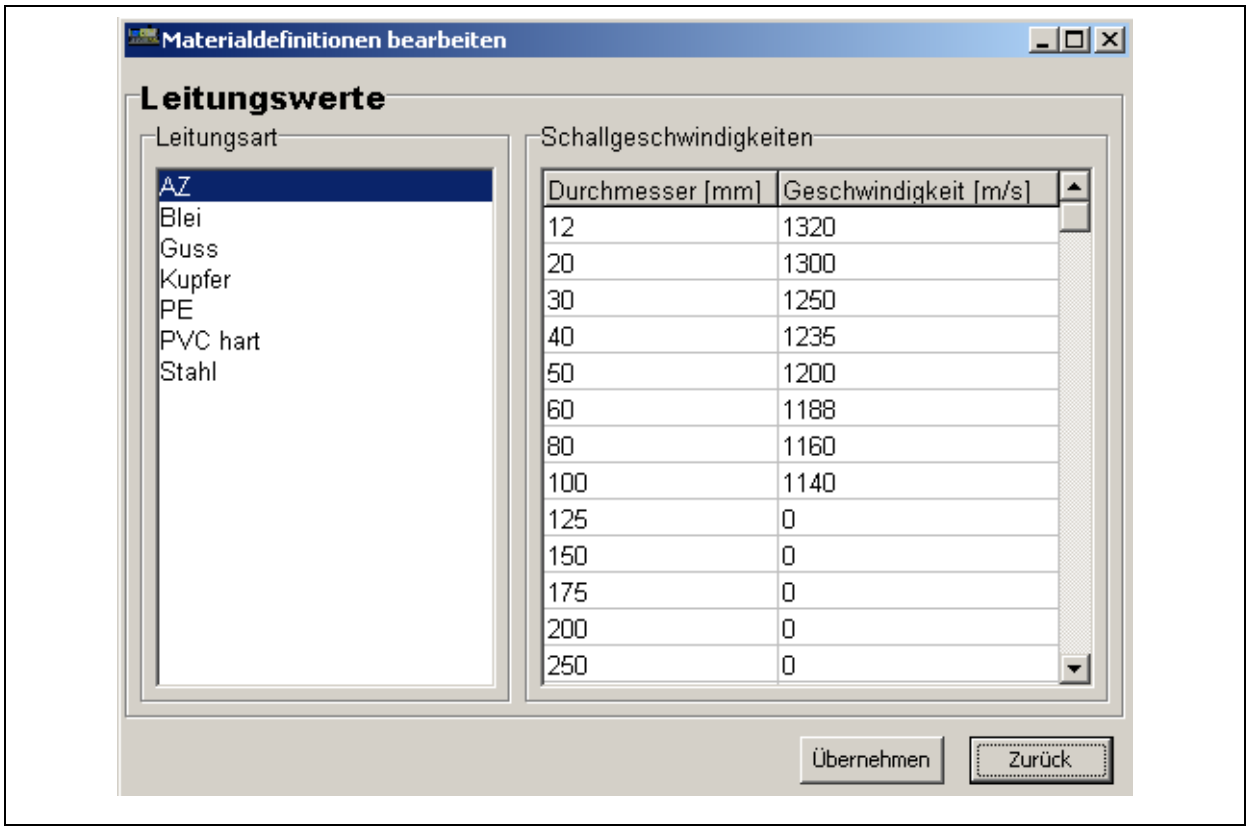

Illustration 4-6: Pipeline definitions

As mentioned at the beginning of this chapter, the field on the right-hand side is used to process sound velocities and pipe diameters of the particular marked kind of pipeline. When a particular type of pipeline has been marked, it can be processed by a single click on the particular value. The values of both the diameter and the sound velocity can be varied unrestrictedly.

When you have done all the changes, these changes can be integrated into the programme by clicking on the `Accept` button. If you do not want to maintain the changes made, press `Return` and you will go back to the main mask, the data will not be saved.

Note: The pipeline type will not be translated when the dialogue language of the programme is changed as the types of the pipelines are saved in a separate file. Concerning the translation of the names of the types of pipelines, please refer to chapter 5.1.

4.5 Setting the measurement section

The `Setting the measurement section` dialogue is used when the measurement section has to be entered. Go to the `Settings` menu and then to the `Setting the measurement section` menu level to open the dialogue. In this dialogue, you can enter up

to seven different partial measurement sections of a pipeline to be checked. One line containing the information on `Material`, `Length`, `Dimension`, and `Sound velocity` corresponds to one partial section of a pipeline. All four boxes need to contain some information as otherwise the entire line will not be considered for the calculation of the measurement results.

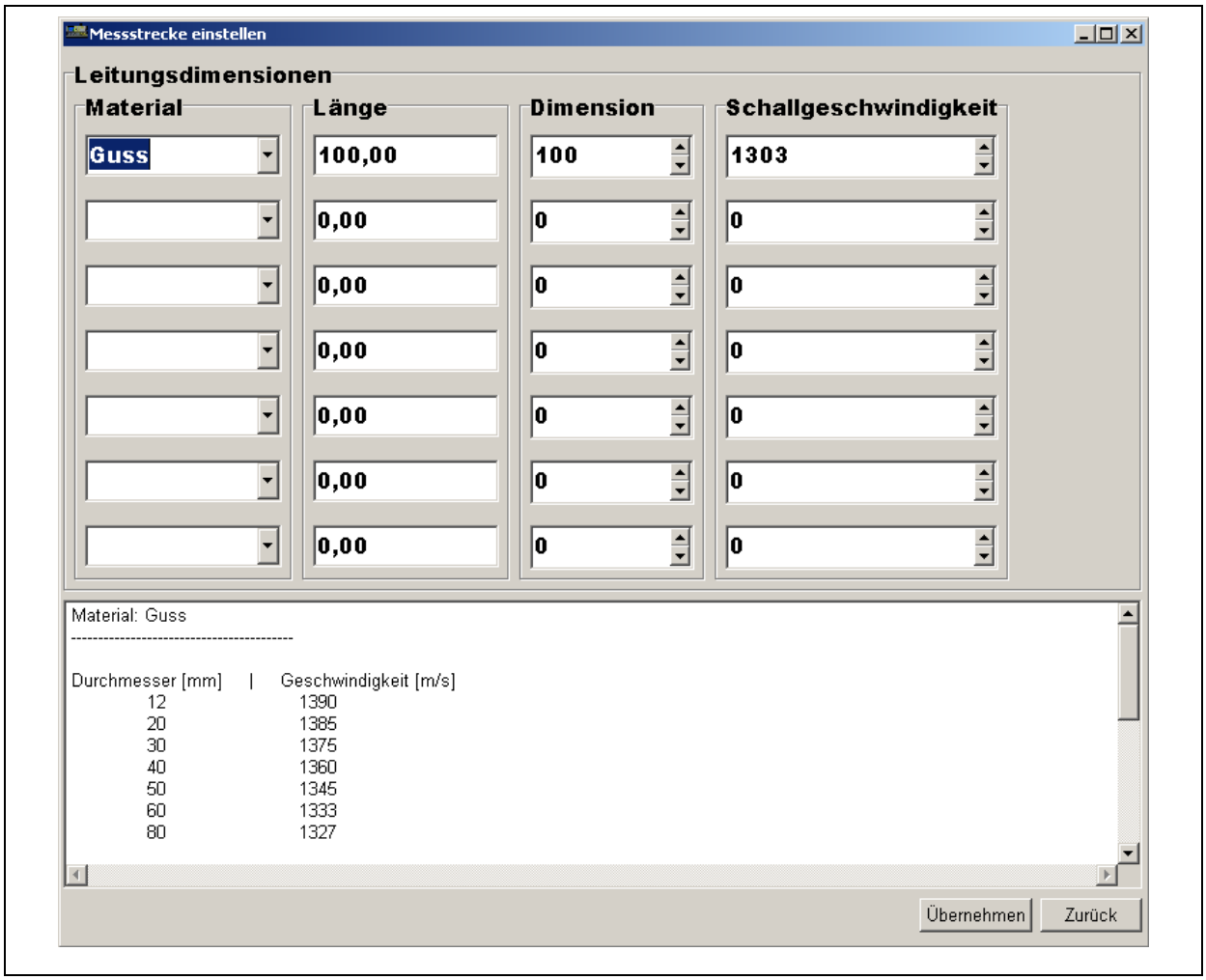

Illustration 4-7: Material selection

If you want to enter the data related to a certain partial measurement section, first select the material in the selection box in the `Material` field. This selection box contains all types of pipelines which have been created in the `Material definitions` dialogue (see chapter 4.4). So the programme will automatically determine the sound velocity if some information has been entered into the `Length` and `Dimension` fields. Of course, you can also modify the sound velocity later by pressing the arrow keys at the `Sound velocity` field or by entering a certain value directly into the box. If you want to enter the data related to several partial measurement sections, just repeat the process in the next line(s).

Press Accept at the lower part of the mask so that the programme can accept the settings you selected. The measurement section is saved now and will be displayed in the Measurement Section (see Illustration 1-3) of the main mask. When the Setting the measurement section dialogue is called again, the data you have entered will be displayed in the dialogue. Click on Return if you do not want to save the information you have entered. You will now go back to the main mask without having created a measurement section.

4.6 GPS interface

In order to be able to receive and to process GPS data, certain settings have to be made to the programme, and the GPS receiver has to accept the programme requirements. This paragraph is to describe the configuration of the programme required to process the GPS data. Chapter 5.3 is to inform you about the technical requirements the GPS receiver has to meet in order to be used for a data exchange via GPS.

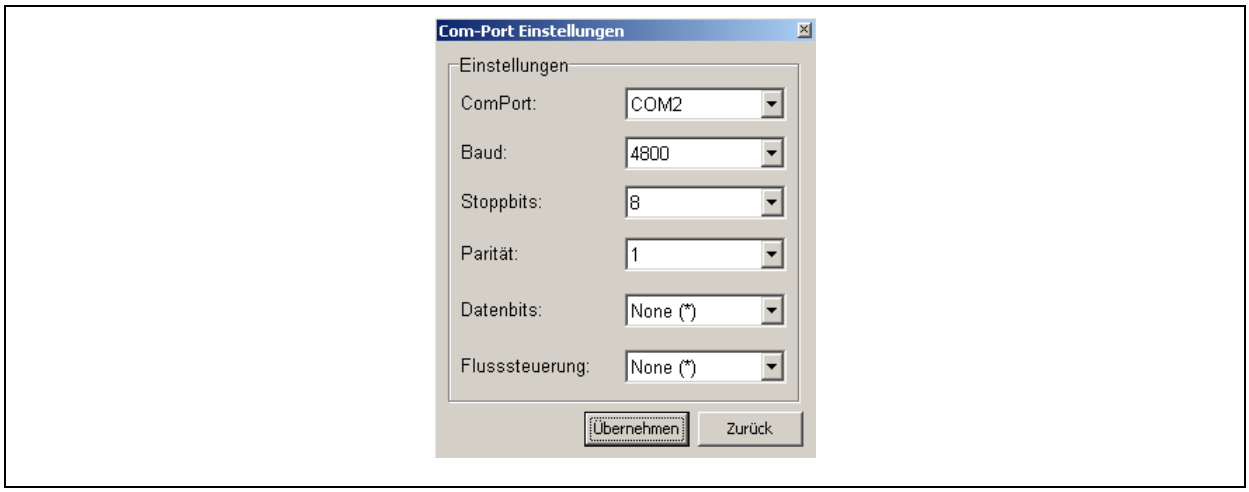

Illustration 4-8: Com-Port settings

As already explained in chapter 5.3, communication with the programme is made through the serial interface. The interface can be either a real serial interface or a virtual serial interface. Both types of interfaces have in common that the communication parameters have to be determined prior to the start of the communication process. Through the GPS menu level of the Settings menu you will reach a sub-menu which will provide you at the first menu level with the dialogue shown in Illustration 4-8. In this dialogue, all the parameters of a serial interface can be set. The settings required for the interface are stated on the packaging of the receiver. When you have configurated all the parameters of the interface, you can save the settings in the programme by clicking on the Accept button. Pressing the Return button will

delete the settings made and take you back to the main mask of the programme without having saved the parameters.

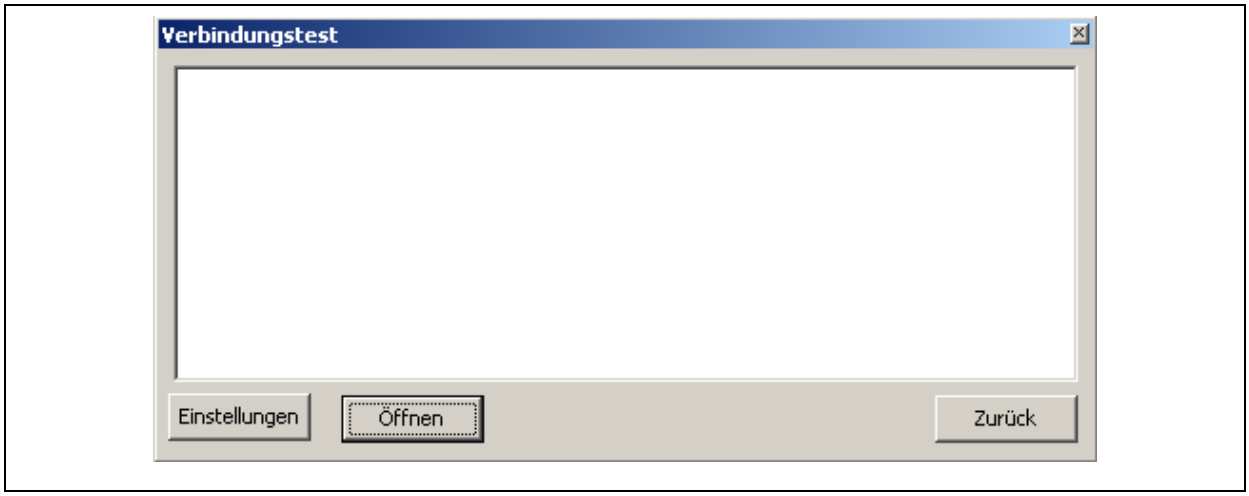

Illustration 4-9: Testing the connection

When you have adjusted the interface, you can test the radio reception quality through the second menu level of the `GPS` sub-menu by clicking on the `Open` button which is shown in Illustration 4-9 on the left-hand side. When you use a GPS receiver which supports the NMEA 0183 protocol, the `Communication test` dialogue will issue a similar message as shown in Illustration 4-10. As soon as the message has been displayed, the programme is ready for GPS operation and can process and display the data as shown in Illustration 4-3 (lower part).

```
$GPGGA,100539.000,4913.0052,N,00925.4911,E,1,04,5.5,215.9,M,48.0,M,,0000*5E

$GPGSA,A,3,18,21,22,07,,,,,,,,,7.3,5.5,4.9*36

$GPRMC,100539.000,A,4913.0052,N,00925.4911,E,0.26,112.34,120207,,*01

$GPVTG,112.34,T,,M,0.26,N,0.5,K*64
```

Illustration 4-10: issuing the NMEA protocol

5 Technical Information

This chapter mainly focuses on the technical features of the programme. Especially the configuration files required to save the settings as well as the material definitions are described in chapter 5.1. Chapter 5.2 is to describe the creation and the processing of the language-related files which are integrated into the programme to change the information output. Finally, chapter 5.3 is to describe the technical requirements for the connection of a GPS receiver.

5.1 Configuration files

The correlator programme requires two configuration files which are created either during installation or through the initial start of the programme. The configuration file `MatDef.md`, which is created during the installation process, is the file for the material definition data. This file contains all information on the types of pipelines used in the programme and processed through the dialogue as described in chapter 4.4. Please note that when the programme language is changed, the material definitions are not translated automatically as the data is saved in a separate file. Translating the names of the pipeline definitions, however, can be made manually by opening the file `MatDef.md` with an editor and renaming the single expressions. The file is found under the following path:

- `Installationspfad/MatDef/MatDef.md`

This means: If the correlator programme was installed under the installation path `C:/Programm/Fast/Korrelator`, the file is saved under the path `C:/Programm/Fast/Korrelator/MatDef/MatDef.md`. So when you want to process the file, first open the folder which contains the MatDef.md file. Open the context menu by positioning the cursor on the file and click on the right mouse key. A context menu will appear, and you should select the first menu level (`Open`). You will then be asked which programme you want to use in order to open this file. From the list of programmes shown on the screen you can now select either the `Editor` programme or the `WordPad` programme. Click on OK to open the file. When the file has been opened, the `Editor` (or `WordPad`) shows a text similar to the one shown in Illustration 5-1.

```
[AZ]

12=1370
```

```
50=1250
...
[Guss]
12=1390
20=1385
...
[Blei]
12=1190
20=1150
...
```

Illustration 5-1: MatDef.md file data

As can be seen in Illustration 5-1, the names of the different materials are listed in square brackets, and the definitions of the particular diameters and sound velocities are listed next (`diameter=sound velocity`). When an expression has to be replaced (translated), first replace the particular expression (e.g. the German word `[Blei]`) with the new expression (`[Lead]`). We recommend to adapt the pipe diameters and the particular sound velocities through the dialogue as stated in chapter 4.4. As soon as the conversion has been finished, please save the file under the same name and path.

Another file which contains certain settings concerning the runtime of the programme is the file `Korrel.conf`. Especially the positions of the single windows, the service provider ‘s address, and the saving paths are saved in this file. So if you delete this file, the programme will be reset to the installation status. The file `Korrel.conf` can be found under the following path:

- `C:/ Dokumente und Einstellungen / aktueller Benutzer / FastGmbH / Korrelator / Korrel.conf`

5.2 Language files

The programme can feature ten different languages, as already mentioned in chapter 2.4. However, only German and English are included as a standard in the installation of the programme. The other languages are not available immediately when the programme has been

installed and are thus not selectable through the `Settings` menu. The concept of multilingual applicability is implemented in the correlator programme through certain language files, which have to be named as listed below in order to be identified by the programme.

- `german.lng`
- `english.lng`
- `french.lng`
- `italian.lng`
- `spanish.lng`
- `portuguese.lng`
- `swedish.lng`
- `norwegian.lng`
- `danish.lng`
- `polish.lng`

In addition, the location where these files are saved is determined by the programme. If a new language file is to be added to the language file pool, the new language file has to be filed in the folder `lang` of the programme. For example, of you want to add Polish, you first have to create a file with the name `polish.lng`. This file then has to be copied into the folder `lang` of the programme. The folder for the language files is located in the installation path of the correlator programme. If, for example, the programme was installed under the path `C:/Programme/Korrelator`, the folder `lang` can be found under this path. Therefore, the language file named `polish.lng` has to be copied to `C:/Programme/Korrelator/lang`.

The design of a language file also follows the requirements of the programme and has to be kept to so that the programme is able to integrate the file exactly. Illustration 5-2 shows an excerpt of the design of a language file. The first line of each language file contains the country code in square brackets. This code is absolutely necessary to integrate the file precisely. The key follows the naming of the language file: if the language file is named

norwegian.lng, the key to be hosted in the first line is [norwegian] and for portuguese.lng it is [portuguese].

```
[german]
GB HochPass=Hochpassfilter
GBTiefPass=Tiefpassfilter
GBVerstaerkung=Verstärkung
...
```

Illustration 5-2: Design of the language file

When the language file and the country code have been named correctly, the expressions to be translated can be translated into the particular language. The structure of the file is as follows:

First, the key object is stated followed by the expression to be translated. Both expressions will be separated from each other by means of an equals sign without any blank space. As shown in lines two to four in Illustration 5-2. For example, for the expression Hochpassfilter to be translated (see Illustration 5-2), GBHochPass is the key object which must not be changed, and Hochpassfilter is the expression to be translated which can be changed. To make sure that all keys are translated and none is neglected, we may recommend that you copy a language file and make the necessary changes on this copied file.

5.3 GPS receiver

Communication between the correlator programme and a GPS receiver is done through a real or a virtual serial interface under Windows. Windows provides a communication connection for the communication with external devices. This connection is not limited to a certain hardware and is treated like a serial interface. This means that the interface is available in the system as ComPort. As the correlator programme uses this ComPort (see chapter 4.6), you may use any GPS receiver which is capable of communicating through this interface. So you can use receivers which are connected with the computer via RS-232, USB, IrDA or Bluetooth as long as they are accessible through a ComPort in the system. The second requirement to be met by the GPS receiver in order to be able to communicate with the correlator programme is the transfer protocol for the GPS data. The programme processes GPS data which meets the NMEA 0183 protocol standard. So if your receiver delivers the GPS data according to this protocol through the serial interface, the programme can process the data. Especially the information of the two tags $GPGGA and $GPRMC of the NMEA

protocol are processed. The receiver has to deliver at least one of the two tags to enable the programme to extract from the GPS information. If these preconditions are met by the GPS receiver, it can be used for the data exchange with the correlator programme.