# User's manual

for the

# Precision thermometer

# DDM 900

(version no. 3.01 or better)



05.04.2006

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# 1. Important Safety Regulations

1. Please do read this manual **before** using the instrument for the first time.
2. Avoid **any inappropriate usage** of the instrument.
3. **All the regulations**, **warnings** and **information** in this manual have to be complied with.
4. If there are any **additional safety regulations** those also have to be stuck to.
5. The user is **not allowed to open the instrument**, as this is not necessary for an appropriate usage. Maintenance must be carried out by qualified personnel only.
6. The user has to ensure that none of the sensor or data wires are in contact with **voltage-carrying parts**.
7. The **user has to ensure** that no operating conditions occur which could lead to endangering or damage of property or personal injury.
8. Measuring results do not only depend on the correct function of the instrument but also on other circumstances (e.g. fixing of the sensors). That is why the measuring results have to be checked critically (e.g. plausibility check), before decisions are made on the basis of measuring values.
9. The user's manual has to be at the operator's disposal **at any time**.
10. **No alterations** to the instrument may be made.
11. **Never use a damaged instrument.**

## 2. Introduction

The DDM 900 is intended for temperature measurements by means of platinum-resistance thermometers (RTD). For this purpose the temperature-related resistance value of the sensor is initially measured. After that the temperature value is calculated using sensor-specific calibrating data. The DDM 900-100/25 uses Pt25- and Pt100-sensors. The DDM 900-100/1000 uses Pt100- Pt500- and Pt1000-sensors.

Normally temperature sensors are analysed using measuring methods based on ACs or DCs. The AC-method in particular offers the advantage of a far-reaching insensitiveness to irritating thermoelectric voltages. On the other hand measuring errors might occur using this method because of parasitical capacities and inductances. The DC-method, however, has the advantage of being quite insensitive to parasitical capacities and inductances and thus offers the possibility to exchange sensors relatively unproblematically. This method however could lead to incorrect measuring values because of irritating thermoelectric voltages.

In the DDM 900 switched direct currents are used to measure the sensor resistance. By comparing the results to a reference resistance which is integrated in the instrument a precise measurement of the sensor resistance is guaranteed. Thus the DDM 900 unites the advantages of the methods based on ACs with the advantages of those based on DCs. At the same time the respective disadvantages are avoided.

The conversion of the measured value of resistance into a temperature value is done with the help of sensor specific calibration tables in the instrument. These calibration coefficients do not have to be entered again into the measuring instrument after every exchange of sensors. As it is possible to store the calibration coefficients for several sensors, in many cases it will be sufficient to assign the appropriate calibration coefficients to the channel which has been connected to a new sensor. If the coefficients of a new sensor are not yet stored in the instrument, the user is able to establish them using the software which is included in the package. The complete establishment and control of the calibration coefficients is done on the PC. New calibration coefficients may easily be entered from your PC into the DDM 900 with the help of this software.

# 3. Specifications

The following specifications are only valid for a nominal operating voltage of 230V, 50Hz and an environmental temperature of 23°C.

| | |
|---|---|
| Measuring range: | -200°C up to 962°C (according to ITS-90) |
| | -200°C up to 850°C (according to DIN EN60751) |
| Resolution: | 1 mK |
| Measuring uncertainty: | Pt25, Pt100, Pt1000: 10 mK (5 mK from -50°C up to 250°C) |
| | Pt500: 15 mK (7 mK from -50°C up to 250°C) |
| Measuring channels: | 2 (10 with internal scanner or up to 81 with external scanners) |
| Sets of calibration data: | 21 (optionally up to 81) |
| Sensors: | four-conductor-technology, cable length: 2m |
| | DDM900-100/25: Pt100 and Pt25 at the same time |
| | DDM900-100/1000: Pt100, Pt500, Pt1000 at the same time |
| connectors: | Lemo 1S, quadripolar, in front panel |
| Measuring current: | switched direct current |
| | Pt500, Pt1000: about 0.15 mA, Pt100: about 0.5 mA Pt25 about 1 mA |
| Measuring time: | about 1 sec. per channel, about 0,1 sec. with reduced resolution |
| Long-term stability: | ≤ 5 mK/year (Pt25, Pt100, Pt1000) |
| Temperature coefficient: | ≤ 1 mK/°C (Pt25, Pt100, Pt1000) |
| Display: | LCD, LED backlighted, 2 lines à 16 characters, height of characters 9 mm |
| Units: | °C, °F, K, ohms |
| Interface: | RS-232, isolated from the measuring instrument |
| Baud rate: | 1200, 2400, 4800 or 9600 baud |
| Operation: | menu orientated, alternatively controllable by your PC |
| Memory: | 9000 (optionally 45000) measuring values, buffered by battery (Lithium battery CR 2032) |
| Supply: | 115 or 230 V (tolerance: -10/+6%), 50 or 60 Hz, about 15 VA |
| Fuses: | 230 V-mains: 200 mA slow-acting |
| | 115 V-mains: 400 mA slow-acting |
| Size: | 320 x 170 x 290 (width x height x depth in mm) |
| Weight: | about 8.2 kg |

Available accessories and possible extensions:

- 19” mounting kit
- external scanners
- temperature sensors
- memory expansion for up to 80 external measuring channels and 45000 measuring values
- AtpGraph, software for definition and management of sensors (windows version)
- SmartGraph, data acquisition software (ask for english version)

## 3.1 Range of goods delivered

1. DDM 900
2. Power supply cable
3. Cable for interface
4. Software for calculation and management of sensor specific calibration coefficients
5. User's manual

# 4. First operation

Please do read the safety regulations at the beginning of the user's manual. Afterwards you should check the delivery for completeness. Check the instrument for external damage. In case there are noticeable damages you mustn't use the instrument. In this case you should contact your dealer.

Please check whether the mains voltage set in the instrument corresponds with your mains supply before you connect them. You can recognize the set voltage at the back of the instrument above the mains plug. In case the set voltage does not correspond with your mains supply, you must get an expert to carry out the following steps.

1. Remove the power supply cable.
2. Open the cover above the mains plug using a small screwdriver without force. To do this insert the screwdriver into the little recess above the voltage indicator and turn slightly. (see picture 5.2)
3. Insert the screwdriver from the top into the red plastic body and pull out the fuse holder.
4. Check whether the right fuses are inserted (see chapter "Specifications"). If needed the matching fuses have to be inserted.

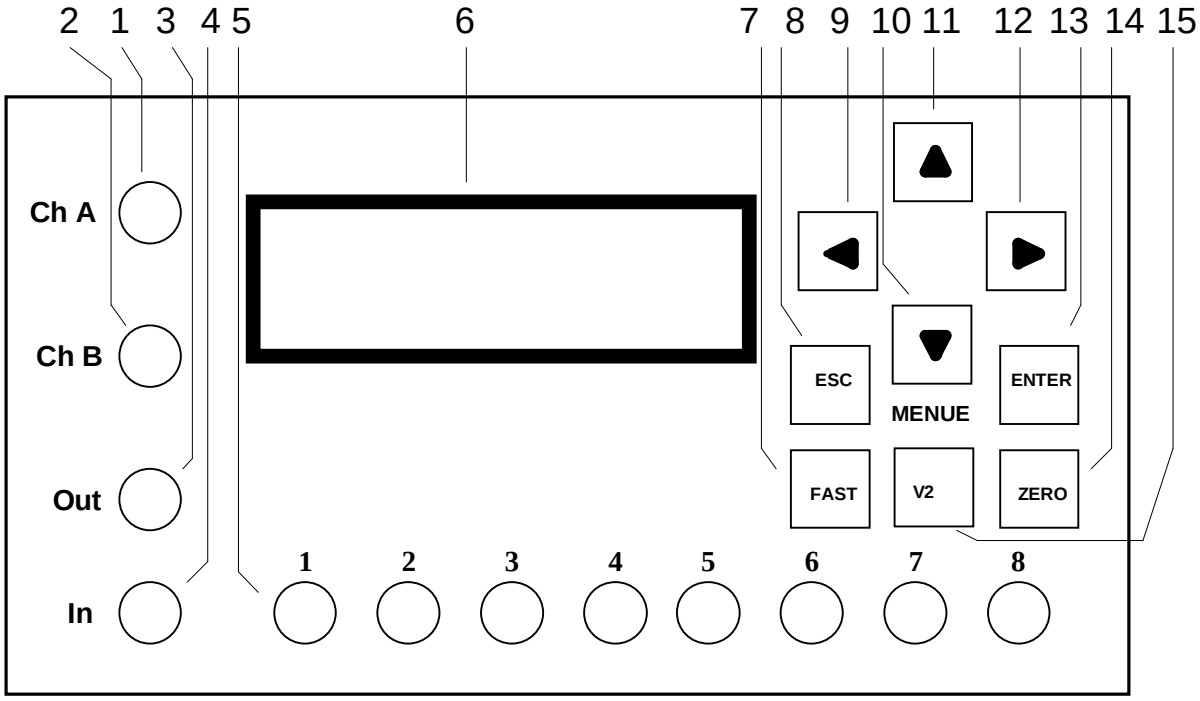
**Safety instruction: Only the prescribed fuses are to be used!**

5. Insert the fuse holder so that the desired voltage is readable (see picture 5.2).
6. Close the lid above the fuse holder.

As soon as the right voltage is chosen the instrument may be switched on. It is now in the normal operation state.

## 5. Description of the instrument

In the following the operating elements are explained.




Picture 5.1: Frontal view of the instrument

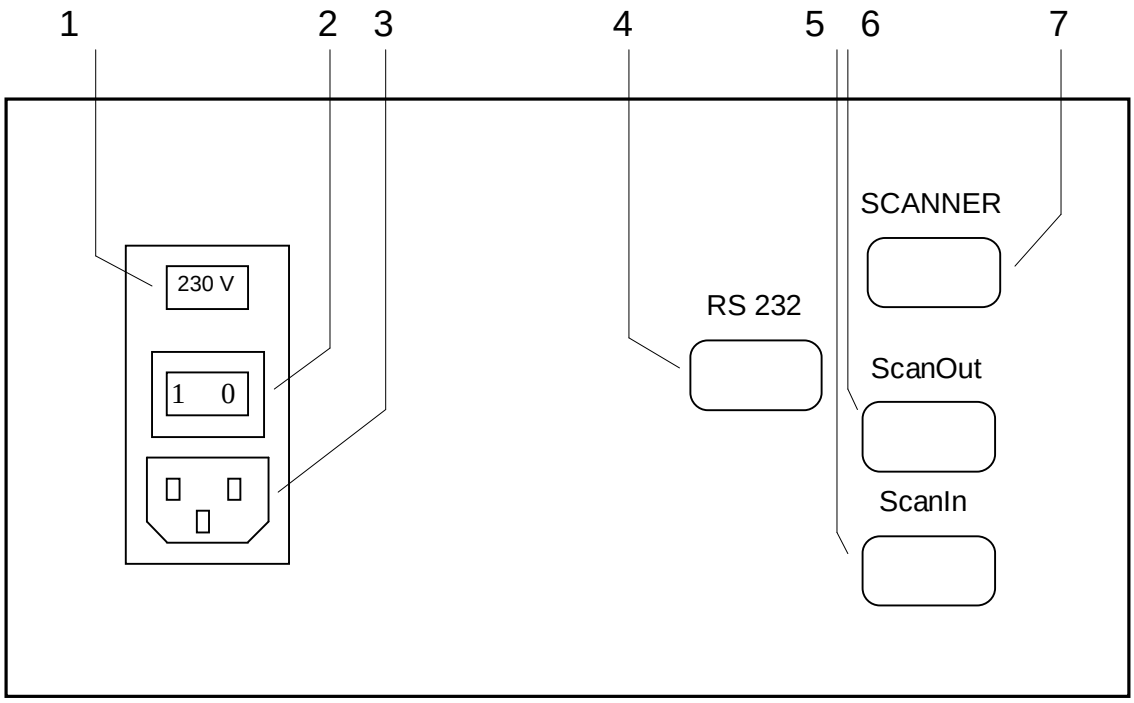
1. Measuring channel A to plug in a temperature sensor.
2. Measuring channel B to plug in a temperature sensor or an scanner (internal or external).

**Safety instruction: Only the prescribed cables are to be connected to the instrument! The operator has to ensure that no inadmissible voltages reach the instrument.**

3. ”**OUT”** is the output of an internal scanner. To use the internal scanner ”**OUT”** has to be connected with ”**Ch B”.**
4. External scanners can be connected to ”**In”.**
5. ”**1”** to ”**8”** are the connectors of an internal scanner.
6. LCD with LED backlight.
7. The button "FAST" offers faster measurements with a reduced resolution (see chapter "Specifications"). Pressing the button "FAST" once switches over to the faster mode. If

you press the button again it switches back to the normal measuring mode. In the fast mode the appropriate LED is switched on. In the normal mode it is switched off.

8. The button "escape" [ESC] is used for the menu-control only.
9. The button "arrow left" [⇐] is used for the menu-control only.
10. The button "arrow down" [⇓] is used for the menu-control only.
11. The button "arrow up" [⇑] is used for the menu-control only.
12. The button "arrow right" [⇒] is used for the menu-control only.
13. Pressing the button "enter" [ENTER] starts up the user's menu.
14. If you press the button "ZERO", the current measuring values are subtracted in any of the following measurements. This function for example is equivalent to the tare function of scales. Pressing the button again stops this function. In the "ZERO" mode the appropriate LCD/LED is switched on. In the normal mode it is switched off.
15. If you press the button "$\sqrt{2}$", the current is reduced to about 70%. Thus the self heating is reduced to about 50% and you can calculate the self heating. In the "$\sqrt{2}$" mode the appropriate LCD/LED is switched on.




Picture 5.2: Back of the instrument

Picture 5.2 shows the elements explained in the following.

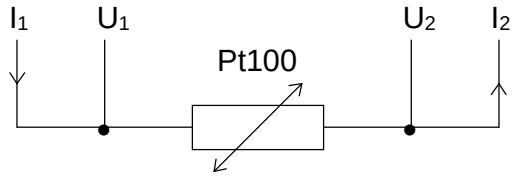
1. Display of the set supply voltage and lid of the fuse holder. (see chapter Usage of the DDM 900)
2. The on/off-button switches the supply voltage on or off.
3. Socket for the supply voltage.
4. Socket for the serial interface (RS 232)
5. Control of an **external** scanner.
6. **Internal** scanner.
7. Control of **internal** scanner.

For details about using of scanners see chapter ”Operation with scanners).

**Safety instruction: Only the prescribed cables are to be connected to the instrument! The operator has to ensure that no inadmissible voltages reach the instrument.**

## 5.1 Assignment of plugs

The plugs to connect the temperature sensors (No. 1 and 2 in picture 5.1) are constructed in a four-conductor-technology. The assignment of plugs is explained by picture 5.3.




Pin 1: $I_1$ Pin 4: $I_2$

Pin 2: $U_1$ Pin 3: $U_2$

Picture 5.3: The assignment if a temperature sensor in four-conductor-technology

The socket of the serial interface (No. 4 in picture 5.2) is assigned in the following way:

Pin 1: not connected
Pin 2: to RXD connection of a PC
Pin 3: to TXD connection of a PC
Pin 4: to DTR connection of a PC
Pin 5: earth
Pin 6: not connected
Pin 7: to RTS connection of a PC
Pin 8: not connected
Pin 9: not connected

**Safety instruction: Only the prescribed cables are to be connected to the instrument! The operator has to ensure that no inadmissible voltages reach the instrument.**

# 6. Manual Operation

Any temperature measurement with resistive sensors consists of two steps, which is due to its principle. In the first step the resistance value of the temperature sensitive sensor is taken. In the second step the measured temperature value must be calculated from the sensor's resistance value.

Due to the accuracy required for the resistance measurement three main problems occur for the manufacturer of such thermometers:

- an excellent linearity of the resistance measurements has to be guaranteed
- the measurements require a long-term stability
- to achieve the required resolution the thermometer has to be highly interference-proof

In the DDM 900 the good suppression of interference and the excellent linearity are ensured by a digital-analog converter developed especially for this thermometer. Here an integrating conversion method is used which guarantees not only an excellent suppression of hum-voltages but also a very high linearity. Due to the fact that the DDM 900 - unlike many other comparable thermometers - synchronises itself to the current supply frequency when switched on, hum-voltages can be effectively suppressed even if the mains frequency diverges from its nominal value. The excellent long-term stability is guaranteed by the measuring method as well as the usage of a high-quality hermetically sealed precision resistance.

Due to the low measuring current and the instrument's insensitivity towards thermoelectric voltages and parasitic capacities and inductances it is possible that sensors of various makes can easily be exchanged.

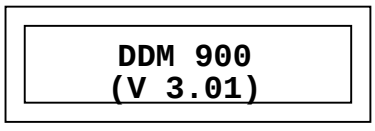
The conversion of the resistance value into a temperature value makes a completely different demand on the manufacturer. Whereas it is satisfactory for the measurement of the sensor resistance if the manufacturer ensures a sufficient precision of the measuring instrument, in many cases the user himself has to enter the sensor's coefficients, which are necessary to calculate the temperature values. Here user-friendliness is of utmost importance. This demand was already taken care of during the planning stage of the DDM 900. In the instrument the calibration coefficients required for calculating the temperature values are organized in sets of

parameters. The user is able to assign a set of parameters to a measuring channel and thus to the sensor connected to it. The assignment is carried out with the help of a menu with short and clear descriptions of the different sets. Only one set of parameters at a time can be assigned to each measuring channel. The same set of parameters however can be used for more than one measuring channel at the same time.

In addition to that the input of sensor parameters and the processing of calibration coefficients of various sensors has been transferred to a PC (see chapter "Establishing sensor specific parameters"). The user has the possibility to enter the sensors' calibration coefficients on his PC and to save them there as well. The PC software included in the package offers the processing of sensor coefficients and the input of short descriptions. Those descriptions are transmitted into the measuring instrument along with the calibration coefficients. Thus the user is enabled to assign the fitting parameters easily to a sensor as he can recognize the appropriate parameters with the help of those short descriptions and not by anonymous numbers only. Whenever temperature sensors are exchanged the user can easily enter the sensor coefficients required for the thermometer from his PC and does not have to enter them again using the instrument's keyboard. On top of that the thermometer is able to store the calibration coefficients of various sensors, so that it is not necessary to transmitt sensor data again if a sensor is changed.

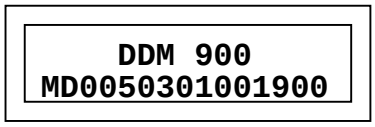
Furthermore an easy-to-learn system which is menu-controlled has been installed, which offers a lot of easily accessible functions for the user. Most of the adjustments made by the user are preserved when the instrument is switched off. Only the "ZERO"-mode and the storage of measured valued are also switched off.

After switching the instrument on it is in a standard state set by the manufacturer. Here channels A and B are activated. The measured values are displayed in °C. Unless arranged differently with the supplier for both temperature sensors the standard coefficients are set according to EN 60751. Initially when switched on the display shows the type of instrument and its version.



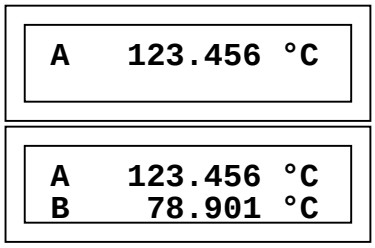

Picture 6.1: Example of the first display after switching on the thermometer

After a short time the second line changes and the instrument's number is displayed.




Picture 6.2: Example of the display of the instrument's number

After the first measurement one of the following displays might appear for example.




Picture 6.3: Examples of the display of measured values

In the following it is explained how the user might adjust the settings of the instrument.

## 6.1 Measurements with reduced measuring times

By pressing the button "FAST" a measuring mode can be activated in which the measuring times are a lot shorter. This mode is intended especially for tasks when temperature values tend to change quickly. Using an external multiplexer it still offers a high measuring rate for each channel even with a higher number of measuring channels. In this faster mode the measurements are carried out with a reduced resolution and accuracy. By pressing the "FAST" button again this faster mode is stopped.

## 6.2 Self heating compensation

Due to $P=R*I^2$ the sensor is warmed up by the measuring current. If you press the button "$\sqrt{2}$", the current is reduced to about 70%. Since the self heating is proportional to the square of the current the heating is about 50% using the reduced current. The difference of the displayed values with and without current reduction gives you 50% of the self heating.

## 6.3 Measuring temperature changes

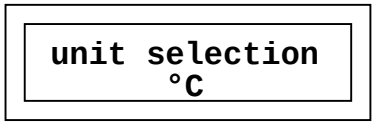
If you press the "ZERO" button the value measured last is temporarily stored. During the following measurements the content of the temporary memory is subtracted from the current measured value. This function is intended for applications used to describe changes in the values measured. Pressing the "ZERO" button again stops this mode.

## 6.4 The user menu

Further functions are available to the user by means of a user menu. This menu is started when pressing the "ENTER" button. Using the buttons "⇐" or "⇒" the user may choose an element from the main menu which are explained in the following. Afterwards the chosen menu element can be selected by pressing "ENTER". By pressing "ESC" one returns from the main menu back to the measuring mode.

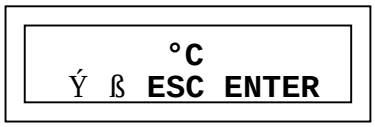
### 6.4.1 Selection of units

Firstly the element "Unit selection" in the main menu has to be clicked into with the buttons "⇐" or "⇒".




Picture 6.4: Main menu element "Unit selection"

After that this function can be activated with the "ENTER" key. Then the following will be displayed for example.

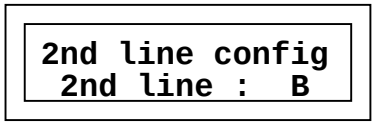



Picture 6.5: Display after activation of main menu element "Unit selection"

The instrument supports the units °C, K, °F and ohm. Using the arrows "⇑" or "⇓" the appropriate unit can be selected and can then be activated with the "ENTER" key. By pressing "ESC" you will return to the main menu without activating a new unit.

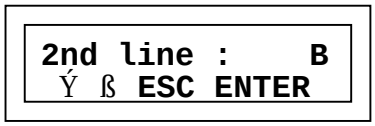
### 6.4.2 Turning differential measuring on/off

Through a configuration of the second line of the display the differential measuring is switched on or off. The thermometer is able to display the difference of the measured values of channels A and B (A - B). To do this you have to select the element "2nd line configuration" from the main menu by using the keys "⇐" or "⇒".




Picture 6.6: Main menu element "2nd line configuration"

Subsequently this selection can be activated with "ENTER", so that you will get the following display.

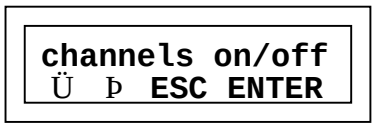



Picture 6.7: Display after activation of the main menu element "2nd line configuration"

Using the arrows "⇑" and "⇓" it is possible to choose between the display of the measuring value of channel B and the difference A - B in the second line. This function can be activated with "ENTER". By pressing the "ESC" key you will ret2urn to the main menu without making any changes.

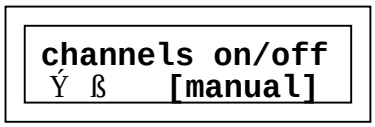
### 6.4.3 Switching channels on/off

You have got the possibility of switching measuring channels on or off. To do this you have to select "Channels on/off" from the main menu by means of the keys "⇐" or "⇒".



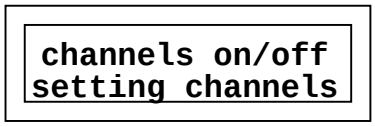

Picture 6.8: Main menu selection "Channels on/off"

Afterwards this selection can be activated with "ENTER", so that the following display will show.



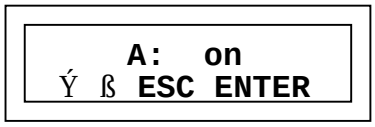

Picture 6.9: Display after activation of the main menu element "Channels on/off"

Using the arrows "⇑" and "⇓" the user first has to decide whether he wants to switch each channel on or off manually or whether all the wired channels should automatically be switched on and the unwired ones switched off by the instrument. If the automatic mode is selected the following display will appear.




Picture 6.10: Display automatic mode "Channels on/off"

If the manual mode is chosen the following will be displayed.




Picture 6.11: Display manual mode "Channels on/off"

It is now possible to chose between "on" and "off" using the arrows "⇑" and "⇓". By pressing "ESC" the old setting will be preserved. By pressing "ENTER" the selected function will be activated. This main menu element is left only when all the channels have been switched on or off manually. You ought to switch on only those channels which are actually connected to a sensor. Otherwise the measuring time will be increased unnecessarily.

### 6.4.4 Selection of sensor parameters

The selection of sensor parameters is of particular importance. Here the user has to determine which calibration coefficients are to be used for the sensor connected to each channel. In addition to the number of the set of calibration coefficients a short description (up to 16 characters) of the sensor, entered by the user himself on his PC, is shown to avoid any operational errors.

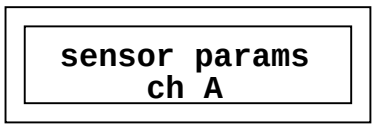
**Warning: The user has to ensure that the selected calibration coefficients belong to the sensor in use. If the user selects incorrect calibration coefficients the measured values might be wrong.**

**Note: In case the user swaps any of the connected sensors, he obviously has to swap the numbers of the parameter sets assigned to the measuring channels as well.**

At first the element "Selection of sensor parameters" has to be chosen from the main menu with the keys "⇐" or "⇒".

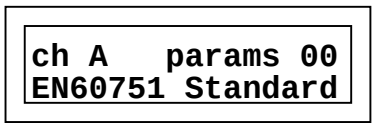

Picture 6.12: Main menu element "Selection of sensor parameters"

As soon as this element is activated with the "ENTER" key, the following is displayed.




Picture 6.13: Display after activation of "Selection of sensor parameters"

At first the measuring channel has to be selected whose sensor parameters have to be set. After that the measuring channel (A or B) is chosen with the "ENTER" key. You can leave this menu element by pressing "ESC". For the following pictures it is assumed that channel A has been selected and clicked into with the "ENTER" key.




Picture 6.14: Display when sensor parameters are set for channel A

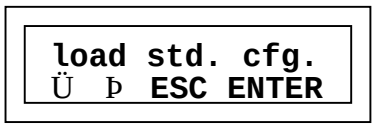
The characters "ch A" in the top left corner of the display show that the parameters for the sensor connected to channel A are to be selected. The expression "params 00" shows, that the parameter set 00 is used. The second line displays the short description for the parameter set 00, entered on the PC. With "Pt100DinStd" the manufacturer of the DDM 900 has labelled a Pt100-sensors parameter set which is described by means of the standard coefficients of EN 60751.

Using the keys "⇑" and "⇓" the number of the parameter set which is to be used can be changed. Then the according short description appears in the second line. By pressing the "ENTER" key a parameter set is assigned to a measuring channel. By pressing "ESC" the

previous menu level is reactivated without assigning a new parameter set to the selected measuring channel.

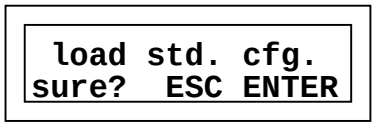
### 6.4.5 Loading the standard settings

To set the instrument back into its original status, the standard settings can be re-loaded. To do this the main menu element "load standard configuration" can be selected using the keys "⇐" or "⇒".




Picture 6.15: Main menu element "loading standard configuration"

Afterwards this menu element can be activated with the "ENTER" key, so that the following display will appear.




Picture 6.16: Display after activation of "Loading standard configuration"

Pressing "ESC" you can leave this level of the main menu again. If you press "ENTER" the standard configurations are loaded. In doing so the unit is set back to °C; channels A and B are switched on; the differential measurement A - B is deactivated as are the "FAST"-mode and the "ZERO"-mode.

### 6.4.6 Starting a record of measuring values

The instrument offers the possibility of storing measured values in a battery-powered memory (see "Specifications" for size of memory). By starting up a record the value memory is set back and measurements are started anew. As it is possible to store measured values, the measurements can be stored without a permanent connection of the instrument to your PC and may be transmitted to a PC at a later time if necessary. To do this the main menu element "start new storage" has to be selected using the keys "⇐" or "⇒".

Picture 6.17: Main menu element "Start storage of measuring values"

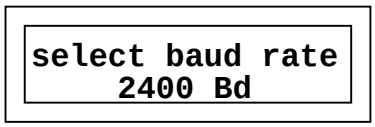
If you activate the element afterwards with the "ENTER" key, the following will be displayed.


Picture 6.18 Display after activation of "Start storage of measuring values"

You can go back to the previous level of the main menu by pressing "ESC". Pressing the "ENTER" key starts up a new series of measurements. If the thermometer is switched off, no new measured values are stored after switching it back on. Thus it is ensured that after recording a series of measurements and switching the thermometer off, no further values are added to the series right after switching the instrument back on (e.g. before the values have been transferred to the PC).

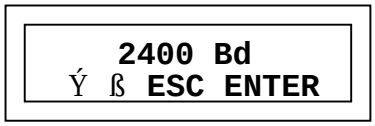
### 6.4.7 Setting the baud rate

At first the element "Select baud rate" has to be chosen in the main menu using the keys "⇐" or "⇒".




Picture 6.19: Main menu element "Select baud rate"

After that this element can be activated with the "ENTER" key, so that the following display will appear.




Picture 6.20: Display after activation of "Select baud rate"

The thermometer supports the baud rates 1200, 2400, 4800 and 9600Bd. Using the arrows "⇑" or "⇓" the appropriate baud rate can be selected and then activated with the "ENTER" key. By pressing "ESC" it is possible to return to the main menu without activating a new baud rate.

## 7. Operating the instrument from your PC

The instrument offers the possibility that nearly all of its functions can be controlled by a PC via a serial interface. To do this the RS 232-interface (see picture 5.2) of the instrument has to be linked with the matching PC connection.

**Safety instruction: Only the prescribed cables are to be connected to the instrument! The operator has to ensure that no inadmissible voltages reach the instrument.**

To ensure the current supply of the galvanically separated instruments of the thermometer's interface the PC's DTR connection has to be set to "false" (-12 V) and the RTS to "true (+12 V). For the serial transfer the following parameters are set: 8 data bits, no parity bit, one stop bit.

**Note: If you do not need a connection between the thermometer and your PC, you ought to remove the RS 232 cable, because the PC might influence your measurements.**

In the following the instructions necessary to control the thermometer by means of a PC are explained. Here the abbreviation ACK is used for an okay-message (06h) and NAK for an error-message (15h).

**Instruction code "a"** (Checking whether the instrument is ready to use)
To check whether the instrument is ready to use the PC sends the instruction code "a". The instrument will answer with "ACK" if ready.

**Instruction code "b"** (Reading the instrument's number)
To read the instrument's number the PC sends the instruction code "b". The instrument will answer with the text (16 characters), which also appears in the second line of the thermometer's display after switching it on.

**Instruction code "c"** (Recognizing the software version)

To read the number of the software version the PC sends the instruction code "c". The measuring instrument will answer with a text of 6 characters, which appears in the second line of the display right after switching the thermometer on.

**Instruction code "d"** (Recognizing the number of measuring channels)

To count the number of measuring channels the PC sends the instruction code "d". The instrument will answer with the full number of the available measuring channels, which means that it answers with "02h" if no external multiplexer is connected. If, for example, an external multiplexer with eight channels is connected the instrument will answer with "09h" as channel B is not in use because of the external multiplexer.

**Instruction code "e"** (Read size of memory)

If the PC sends the instruction code "e" the instrument will answer with the number of memory block units of 32 KB. In the basic version it thus will answer with "04h".

**Instruction code "f"** (Reading short descriptions)

To read the short information on a sensor parameter set the PC firstly sends the instruction code "f". After that it sends the number of the parameter set. The instrument will answer with the 16 character-text that also appears on the display in the manual selection of a parameter set. In case the parameter set is defect or not available the instrument will send the message "NAK".

**Instruction code "g"** (Reading the value memory)

To read the memory of the measured values the PC sends the instruction code "g". The instrument then sends the content of the value memory. Here the measured values are transmitted as decimal point numbers in the single-precision format according to IEEE.

**Instruction code "h"** (Reading the latest measured value)

To read the latest valid measuring value the PC sends the instruction code "h" and then the number of the requested channel (e.g. 0 for channel A not the ascii $30). If for this channel no measured value is available, which has not been sent to the PC yet, the instruments will send "NAK". If there is at least one value which hasn't been transmitted from the thermometer to

the PC, the measuring instrument will firstly send ACK followed by a series of bytes containing the measured value. The measured value itself follows as a decimal point number in the single-precision-format according to IEEE.

**Instruction code "o"** (Release a warm boot of the instrument)

To release a warm boot of the thermometer, the PC sends the instruction code "o". The instrument will reply with "ACK" and carry out a warm boot afterwards. With the instruction code "a" the PC then can check whether the thermometer is ready to use. After a warm boot, in contrast to a cold boot, no keys are blocked and the "ZERO"-function as well as the storage of measured values are not deactivated. Furthermore no search for external multiplexers is carried out after a warm boot.

**Instruction code "p"** (Reset of value memory and start up of storage)

To reset the value memory and start up the storage of measured values the PC sends the instruction code "p". The instrument will answer with "ACK" and start up a new series of measurements.

**Instruction code "q"** (Select baud rate))

To set the baud rate the PC sends the instruction code "q" followed by the appropriate code.
The following codes are used:

0 h for 1200 baud,
01h for 2400 baud,
02h for 4800 baud and
03h for 9600 baud.

If the PC send a different code number the instrument will answer with "NAK". In the regular case it will answer with "ACK".

**Instruction code "r"** (Switching the instrument's keys on/off)

To switch off the instrument's keys the PC sends the instruction code "r" followed by "01h". To switch it back on the PC sends "r" followed by "00h". The thermometer will answer with "ACK" in both cases.

**NOTE: In case the instrument should be controlled by means of a PC only it is recommended that the thermometer's keyboard is switched off at first, so that no configurations may be changed afterwards.**

**Instruction code "s"** (Switching the "FAST"-mode on/off)

To switch on the "FAST"-mode the PC sends the instruction code "s" followed by "01h". To switch the "FAST"-mode off the PC sends "s" followed by "00h". In both cases the thermometer will answer with "ACK".

**Instruction code "t"** (Switching the "ZERO"-mode on/off)

To switch on the "ZERO"-mode the PC sends the instruction code "t" followed by "01h". To switch the "ZERO"-mode off the PC sends "t" followed by "00h". In both cases the thermometer will answer with "ACK".

**Instruction code "u"** (Setting the unit)

To select the unit the PC sends the instruction code "u" followed by the unit and the matching code (see instruction code "h"). The thermometer will answer with "ACK" after every change.

**Instruction code "v"** (Switching the differential measurement on/off)

To switch on the differential measurement the PC sends the instruction code "v" followed by "01h". To switch it off again the PC sends "v" followed by "00h". The thermometer will answer with "ACK" after every change.

**Instruction code "w"** (Switching a measuring channel on/off)

To switch on a measuring channel the PC sends the instruction code "w" followed by the number of the channel (e.g. "01h" for channel B) and "01h". To switch off the appropriate channel "00h" is sent as a third code. If the selected measuring channel is not available, the instrument will send "NAK". Otherwise it will switch the appropriate channel on or off and send "ACK".

**Instruction code "x"** (Assignment of a parameter set)

To select a sensor parameter set the PC sends the instruction code "x" followed by the number of the measuring channel connected to this sensor followed by the number of the parameter set

to be used. The thermometer will send "NAK" if the number of the parameter set is bigger than the possible maximum. Otherwise the demanded function will be carried out and the instrument will send "ACK".

**Instruction code E3h** (Reading of the external multiplexer's version number)
To read the version number of the external multiplexer the PC sends the instruction code E3h. If no multiplexer is connected the thermometer will answer "NAK". Otherwise it will answer "ACK", read the version number of the multiplexers and send them to the PC.

**Instruction code E4h** (Reading version log number of the external multiplexers)
To read the version log number of the external multiplexers the PC sends the instruction code E4h. If no multiplexer is connected the thermometer will just answer "NAK". Otherwise the instrument will answer with "ACK", read the log version number of the multiplexers and send them to the PC.

**Instruction code F1h** (Reading whether the storage of measuring values is switched on or off)
To read whether the storage of measuring values is switched on or off the PC sends the instruction code F1h. The thermometer will send "00h" if the storage is switched off and "01h" if the values are saved.

**Instruction code F2h** (Reading the status of the keyboard)
To read the status of the keyboard the PC sends the instruction code F2h. If the keyboard is not blocked the thermometer will send "00h", if it is blocked it will send "01h".

**Instruction code F3h** (Reading the status of the "FAST"-mode)
To read the status of the "FAST"-mode the PC sends the instruction code F3h. The thermometer will send "01h" if the "FAST"-mode is activated, otherwise it will send 00h.

**Instruction code F4h** (Reading the status of the "ZERO"-mode)
To read the status of the "ZERO"-mode the PC sends the instruction code F4h. The thermometer will send "01h "if the "ZERO"-mode is activated, otherwise it will send 00h.

**Instruction code F5h** (Reading the unit)

To read the unit set in the thermometer the PC sends the instruction code F5h. The instrument will send the code of the unit (see instruction code "h").

**Instruction code F6h** (Reading the status of the differential measuring)

To read the status of the differential measuring the PC sends the instruction code F6h. The thermometer will send "01h" if the differential measuring is activated, otherwise it will send 00h.

**Instruction code F7h** (Reading the status of a measuring channel)

To read the status of a measuring channel the PC sends the instruction code F7h followed by the channel number. The thermometer will answer "01h" if the channel is switched on, otherwise it will send "00h".

**Instruction code F8h** (Reading the number of an assigned parameter set)

To read the number of a parameter set assigned to a measuring channel the PC sends the instruction code F8h followed by the number of the measuring channel. The thermometer will send the number of the parameter set.

# 8. Establishing sensor specific parameters

After the instrument has measured the sensor resistance it needs the calibration coefficients of the sensor used to calculate a temperature value from the resistance value. These parameter sets can be established on the PC and can be transmitted to the measuring instrument.

For a sufficient description of RTD´s the sensor class, the sensor tpye and the sensor coefficients are required. High alpha class sensors are described according to ITS 90-equations. Low alpha class sensors are described according to equations found in the EN60751. The sensor type ”Pt100” is a RTD with a nominal value of 100 ohms. You can direktly enter the sensor coefficients. Alternatively you can enter couples of R/T values so that the coefficients are calculated by the software. Additional to the definition of the sensor behaviour you have to set it´s temperature range so that the DDM 900 can find too small and too large temperatures. Moreover you can enter an short description of your sensor (up to 16 alphanumerical characters). This allows you a comfortable selection of the parametersets for the measuring channels at the DDM 900.

The definition and management of sensor parameter sets can be done with SEN4300 or ATPGraph.

**Note: Make copies of your parameter sets to ensure their reliability even in case of PC damages.**

## 8.1 Definition of sensor parameters with SEN4300

### 8.1.1 Installation of the DOS software

To install the DOS software for establishing sensor specific parameters (Sen4300) the program disk has to be inserted into your PC. Now the installation program INST4300 can be called on the DOS level. At first this program allows to set the user language. After that it asks in which drive a new directory for the program SEN4300 should be opened and what to call it. After that this directory file along with the subdirectory SENSDATA is created. Then the program SEN4300 is copied into the new file. In addition to that four parameter sets are copied into the subdirectory SENSDATA. The copied sets are a parameter set for temperature sensors with

the standard coefficients according to EN 60751 and a parameter set for a standard sensor according to IST 90. Both are copied for Pt100- and Pt25-sensors.
Furthermore the installation programme wants to know which of the PC-interfaces COM1 or COM2 are used for thermometer. The installation program enters the appropriate interface into the file ATP4300.CFG.

The RS232-interface of the instrument has to be connected with the appropriate PC connection used by the operator.

**Safety instruction: Only the prescribed cables are to be connected to the instrument! The operator has to ensure that no inadmissible voltages reach the instrument.**

### 8.1.2 Operation of Sen4300

Whenever a new parameter set is established a new parameter file is created by the program. Apart from the parameter set itself this file contains further data. On the one hand it contains the name of the file. Firstly this can be transmitted to the thermometer along with the parameter set, so that the user can easily find the file, in which one of the instrument's parameter sets is defined. Furthermore the parameter file contains some short information (16 bytes) which has to be entered by the user. This is also transmitted to the thermometer along with the parameter set. In the instrument it enables the user to assign a parameter set easily to a measuring channel. Besides there are five lines of information contained in the parameter file, which can be entered by the user as he wants. Afterwards the parameter file contains various calibration coefficients which have been entered by the user while establishing the parameter set. These are the basis of the actual calibration coefficients. By means of checksums the parameter files are protected against unwanted changes.

**NOTE: To keep it clear the user should proceed in the following way. The name of the parameter file consists of a maximum of eight characters. Here one can use the name or the number of the sensor for example. The 16-character description, which is also displayed on the thermometer, can be entered by the user. He ought to use a description of the sensor which allows an especially easy**

**assignment of the parameter set to the sensor. Thus it is achieved that the user easily recognized to which sensor a parameter set belongs.**

After starting the PC-program the following menu will appear.

```
<a> define sensor
<b> copy sensordata from disk to ATP4300
<c> list filenames on disk
<d> display file
<e> list sensordata at ATP4300
<f> delete sensordata at ATP4300
<x> end
```

Picture 8.1: Menu after program start

The user now has the following possibilities of operation

a) Establishing a new parameter set

b) Transmitting a parameter set to the DDM 900

c) Display of parameter files available on the hard disk

d) Looking at a parameter file on the hard disk

e) Display of parameter sets available on the thermometer

f) Deleting a parameter set from the instrument

x) Stop program

In case the user wants to delete one of his own parameter files, this can be done with the appropriate DOS-instruction.

#### 8.1.2.1 Establishing a new parameter set

After a) has been chosen from the menu the user first has to enter the name of the new parameter file. After that he can enter a short description of the sensor consisting of a maximum of 16 characters. Using this short description the user has to assign the measuring channel to the parameter set. Afterwards the user may enter another five lines of information. In those five lines he should make a note of the specialities in defining the sensor. Among other things those lines should help the user to find a certain parameter file on the hard disk of his computer. After entering the last line of information the following menu appears.

```
<a>   Industrial thermometer (low alpha, EN 60751)
<b>   Laboratry thermometer (high alpha, ITS90)
<x>   end
```

Picture 8.2: First menu when defining a new parameter file

The user now has to decide whether the temperature sensor is intended for industrial applications or for laboratory use.

The main difference between those two sensor types is shown in their alpha-value. Sensors for industrial applications have got an alpha-value of $3.85 \cdot 10^{-3}$. This kind of sensor is described in the EN 60751 for example. The laboratory reference normals made of pure platinum show an alpha-value of more than $3.9 \cdot 10^{-3}$. Those sensors are used for measurements according to the international temperature scale from 1990 [ITS 90] as interpolation instruments between the fixed points prescribed in it. If the user does not know what type of sensor it is, he can get this information from the supplier of the sensor.

#### 8.1.2.1.1 Establishing a parameter set for industrial temperature sensors

If the user selects a temperature sensor for industrial applications the following submenu appears. Here the user can select one out of three methods for establishing the parameter set.

```
<a> Standard EN 60751 coeffizients
<b> Callendar van Dusen coeffizients
<c> Callendar van Dusen couples
<x> end
```

Picture 8.3: Submenu for the definition of an industrial temperature sensor

a) Establishing a parameter set with the constants specified in EN 60751
b) Entering the coefficients according to Callendar van Dusen. The coefficients used in the EN 60751 are a special case of the Callendar van Dusen coefficients. In this point of the menu the user can determine the coefficients himself. For example if you have a sensor corresponding to EN 60751, with only its resistance value of 0°C deviating from the value prescribed in the norm, the menu point b) would have to be selected and the correct

resistance value for 0°C would have to be entered. During the input the coefficients according to the norm are automatically used if the user does not enter a different value.

c) The input of couples of values according to Callendar van Dusen enables the user just to enter the values of the temperature sensor´s calibration sheet. The program calculates the appropriate Callendar van Dusen coefficients and saves them in a new parameter file. For this procedure the user firstly has to decide whether a parameter set is to be established for positive temperatures (≥ 0°C) only or for both positive and negative temperatures.

**Positive temperatures only:**

If the parameter set is to be determined for positive temperatures only, just the coefficients $R_0$, A and B have to be calculated. To do this two to twenty observational pairs can be entered. If only two observational pairs are entered, only the coefficients $R_0$ and A are calculated. In that case the coefficient B values 0. For three or more observational pairs all three of the coefficients are determined. If more than three observational pairs are entered, the coefficients are calculated in a way that the resulting function shows a deviation as small as possible for all observational pairs. The calculation in this case is carried out using a least-square-algorithm.

**Positive and negative temperatures:**

If the parameter set is to be established for both positive and negative temperatures, all of the four coefficients ($R_0$, A, B and C) have to be calculated. To do this three observational pairs for positive temperatures (≥ 0°C) have to be entered first. After that one observational pair of a negative temperature (< 0°C) has to be entered.

After all the sensor coefficients have been entered or calculated the program asks for the temperature minimum and maximum the parameter set has to be valid for. When used the instrument will show an error message if the set temperature range is exceeded in either way. Finally the user is asked whether the established parameter set should be transmitted to the thermometer. If it shouldn't be transmitted, it is only stored in the subdirectory SENSDATA. Transmitting the parameter set to the thermometer is described in chapter 8.2.2.

#### 8.1.2.1.2 Establishing a parameter set for laboratory temperature sensors

In connection with the ITS 90 reference functions are fixed, which describe the performance of ideal platinum temperature sensors. To fit real sensors to these reference functions deviation functions are set in the ITS 90. This program allows the input or calculation of the coefficients of those deviation functions. Whereas there are only two functions (for positive or negative

temperatures) for industrial sensors, 11 areas all in all are distinguished for the laboratory sensors. This is the reason why the user first has to choose one or more temperature ranges set for the ITS 90. As it might lead to contradictions if more than one temperature range is chosen, the program only allows to combine temperature ranges which do not overlap. After the choice of temperature ranges the following submenu appears. Here the user may select one of the three methods to establish a new parameter set.

```
<a>   Use standard ITS90-coeffizients
<b>   Enter ITS90-coeffizients
<c>   Enter temperatur/resistance-couples
<x>   Abort
```

Picture 8.4: Submenu for the definition of a laboratory temperature sensor

In any case the value of the sensor resistance for the reference temperature of 0.01°C has to be entered.

a) Establishing a parameter set for a sensor ideal in the sense of ITS 90
b) Input of coefficients of the deviation function(s). Each of the above selected temperature ranges needs its own deviation function. As the different deviation functions use different coefficients, the coefficient for each one of the deviation functions, which are necessary, have to be entered.
c) The input of temperature/resistance-couples enables the user to enter the values from the calibration data of the temperature sensor. Afterwards the program calculates the coefficients of the deviation function and later saves them in the new parameter file.

After all the sensor coefficients have been entered or calculated, the program asks for the temperature minimum and maximum, which the parameter set will be valid for. The instrument will display an error message if the set temperature range is exceeded in either way. Finally the user is asked whether the newly established parameter set is to be transmitted to the measuring instrument. In case it needn't be transmitted it is saved only in the current drive of the PC. How to transmit the parameter set is described in chapter 8.2.2.

### 8.1.2.2 Transmitting a parameter set to the instrument

After selecting the menu element to transmit a parameter set the name of the parameter file is asked for. Afterwards the program reads the list of parameter sets available in the thermometer. Then the following list of parameter sets contained in the instrument is displayed on screen.

| No. in ATP. | filename | shortinfo |
|---|---|---|
| 0 | EN60751.ATP | EN60751 Standard |
| 1 | ITS90STD.ATP | ITS90 Standard |
| 2 | ---------- | ---------- |
| 3 | ---------- | ---------- |

Picture 8.5: Presentation of the thermometer's parameter sets

In picture 8.5 some of the parameter sets available in the thermometer is presented. To keep it clear only the first four elements of the table were filled in. The maximum number of parameter sets available in the instrument depends on its model version. In the basic model a maximum of 21 parameter sets is intended. In an expanded version up to 81 parameter sets can be entered. The left column shows the numbers under which the parameter set is listed. The middle column contains the name under which the matching parameter file is saved on the hard disk. In the right hand column one can find the short information. In this example numbers 2 and 3 are empty.

The user now can decide where to fill in the parameter set, which is going to be transferred to the thermometer. If he chooses a place already occupied by another parameter set this parameter set will be recorded over. When using the thermometer later on the operator can use the number set in this table to assign the respective parameter set to a measuring channel.

After the user has picked a number in the table the parameter set is transmitted to the thermometer.

### 8.1.2.3 Listing the parameter files available on the hard disk

By selecting the menu element to read all the parameter files available on the hard disk the user gets a list of all the parameter files contained in the subdirectory SENSDATA. Here only the file names and the short descriptions are displayed.

#### 8.1.2.4 Viewing a parameter file available on the hard disk

After clicking into the menu element to read a parameter file the user first has to enter the file's name. Afterwards the content of this file is displayed on screen.

#### 8.1.2.5 Viewing the parameter sets available on the instrument

To view the parameter sets available on the instrument the program reads the list of those parameter sets. After that this list is shown on screen analogously to picture 8.5.

#### 8.1.2.6 Deleting a parameter set from the thermometer

To delete one of the parameter sets available on the thermometer the program starts by reading the list of sets available and displays it on screen afterwards analogously to picture 8.5. Afterwards the user has the possibility to delete one of the parameter sets.

## 8.2 Definition of sensor parameters with AtpGraph

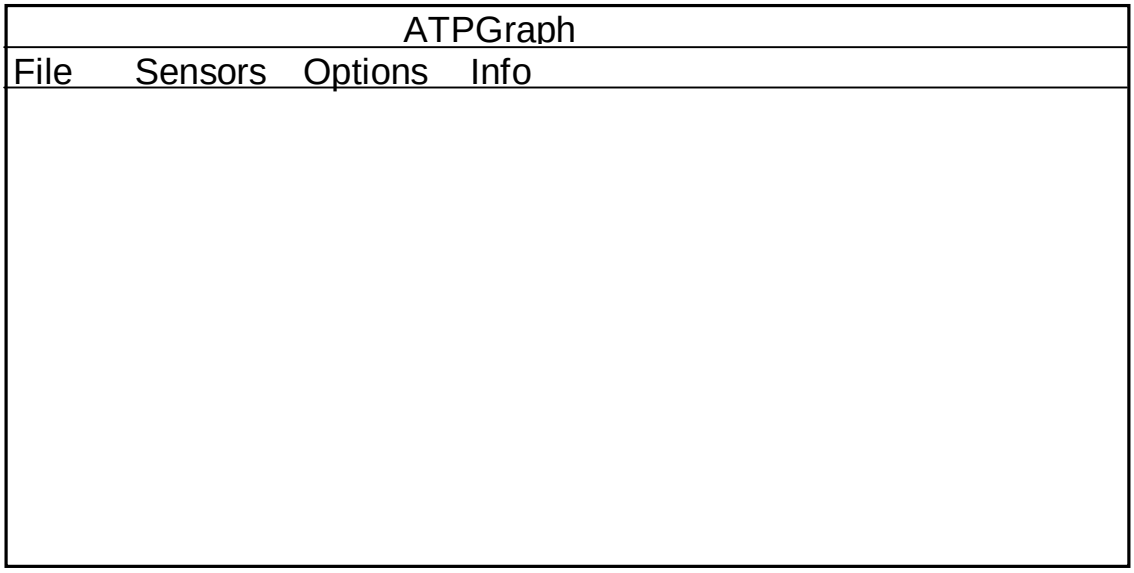
### 8.2.1 Installation of the Windows software

Copy all files form the dirctory ”WIN” of your programm disk to a diretory (e.g. DDM900) at your harddisk. Make at subdirectory named ”SENSDEFS” under the used directory. Copy the files from the directory ”SENSDEFS” of your programm disk to the corresponding subdirectory at your harddisk. Now you can start ”ATPGraph” for example with a filemanager.

### 8.2.2 Operation of ATPGraph

If you want AtpGraph to correspond (e. g. transfer sensor parameters or delete parameter sets) with the DDM 900 it has to be connected an turned on.

After starting the ATPGraph the following screen appears.

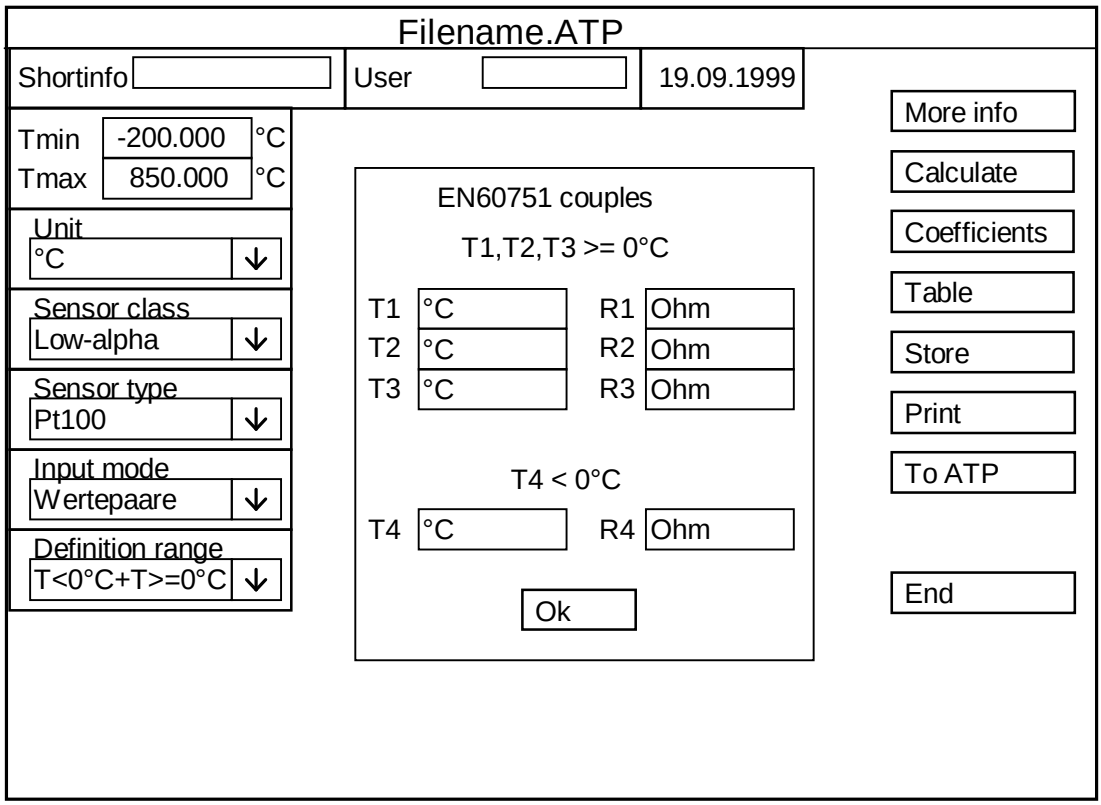



Picture 8.6 Startmenue of ATPGraph

”**Info**” gives you information about the programm version and the manufacturer. Under ”**Options**” you can select the com port and the baudrate. Under ”**File**” you can end the programm. ”**Sensors**” allows the creation of new parameter sets and the transfer to the DDM 900. Further it allows you to delete parameter sets from the DDM 900.

#### 8.2.2.1 Establishing a new parameter set

With ”**Sensors**” and then ”**New**” the follwoing screen is shown.



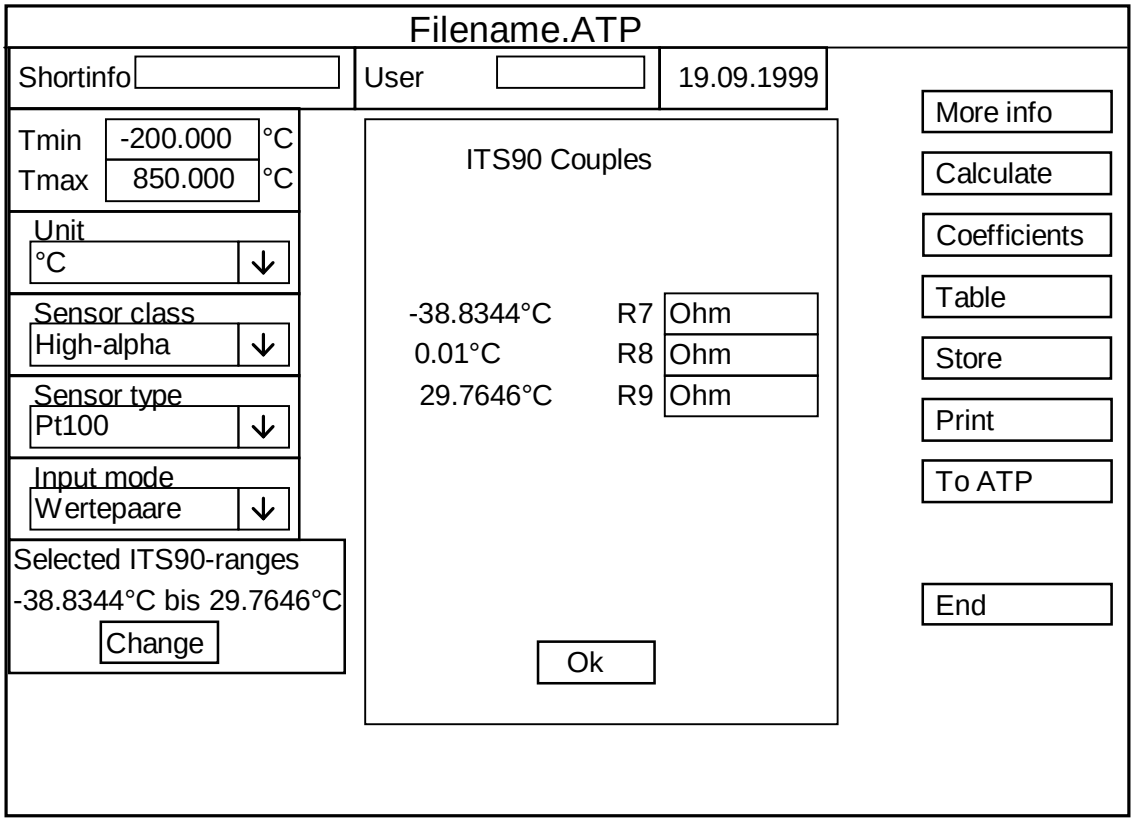

Picture 8.7 Create a new parameter set according the EN60751

Before setting the real sensor parameters you should enter some data wich is used by the AtpGraph for managing the parameter sets. First you should enter your name at the filed "**User**" to ensure you to find the creator of the parameter set. In the filed **"Short info"** you should type a short description of your sensor. This text is used in the DDM 900 to select the sensor parameters for the measuring channels (at the DDM 900 the operator has to adjust wich sensor is at what channel). For example you might note the sensors manufacturer and a calibration number in the short description. After that you should write detailled informations under **"More info"**. For example you might enter special circumstances of the sonsor and it´s parameter sets.

Now you should enter measuring range (e.g. the calibrated range) of the sensor to the fields **"Tmin"** and **"Tmax"**. The DDM 900 will use this to detect too great and too small measured temperatures. The filed "**Unit**" allows you for example to enter R/T-couples under differnet temperature scales. With **"Sensor class"** you decide wich equations are used to describe the sensor. Selecting "**high alpha**" the equations according to the ITS90 are used. For "**Low**

**alpha**"-sensors equations according to the EN60751 are used. Your choice of the **"Sensor type"** defines the measuring current used in the DDM 900 (Pt100 about 0.5 mA Pt25 about 1 mA). You can choice between different "**Input Mode**s" for entering the sensor decribing values. First you might select "**Standard**"-coefficients. In case of a low alpha sensor the values defined in the EN60751 will be used for R0, A, B and C. In case of a high alpha sensor and selecting "**standard**"-coefficients all coefficients of the IST90 defined deveation functions are set to zero. In this case only the reference polynoms of the ITS90 are used. The "**Input mode**" "**Coefficients**" allows you to enter the coefficients R0, A, B and C (acc. EN60751) or the coefficients of the deveation functions (acc. IST90) directly. Under the "**Input mode**" "**Couples**" you can enter temperatures and the corresponding resistance-values. In this case the software will calculate the coefficients of your selected equation.

If you want to enter coulpes of values for the description of a sensor according to the EN60751 you have to decide wether you use only positive temperartures or also negative temperatures. If you only use positive tempeartures you can enter up to 14 couples. The software then will find a best fitting for the coefficients using a least square algorithmn.



Picture 8.8 New parameter set according to the ITS90

If you want to use the deveation functions described in the ITS90 you first have to select the ITS90-subranges for that you want to define your sensor. You can do this by use of the switch ”**Change**” (see picture 8.8). You have to metion, that your subranges may not overlap to avoid inconsistent equations. Thus the software allows you only the selection of unlapping subranges. If you want to change the range selection you perhaps might have to unselect some ranges first.

The button **”Calculate”** starts the calculation of the sensor coefficients using the couples of values. This button will only be activated if all needed couples are entered.

**”Coefficients”** show you the results of the calculation. This button will only be activated if there are calculated coefficients.

The button **”Table”** you can see an table of values calculated with the entered or calculated coefficients. Thus this button will only be activated if all coefficients needed are aviable. You can set the start and the distance of the tables values.
Pressing the button **”Store”** will store your inputs and the parameter set in a file. Doing so the software will ask you for the filename (max 8 characters). The name you enter here later will be shown at the top of your screen. This button is activated if the sensor is completely described that means when all coefficients are aviable.

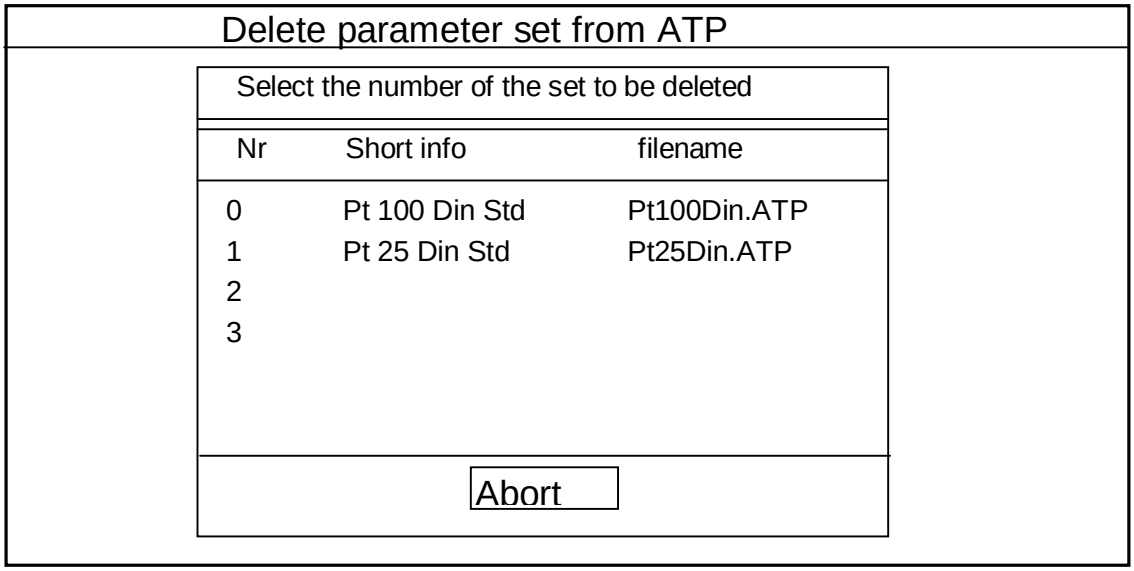
With **”Print”** you can print the sensor definition and the table at your printer or into a file. In case of printing into a file the parameter set´s filename will be used. Only the extension is changed from .atp to .prn.

The button **”To ATP”** starts the transmission of the parameter set to the DDM 900. You have to choose the place in the parameter table of the DDM 900 under which it will store the parameter set by double clicking. If you choose a occupied place the old datd wil be overwitten. You can not transmitt data to the DDM 900 before storing your inputs to disk. In this way it is ensured that there never is a parameter set in the DDM 900 which you do not have at your hard disk.

**Note: Make copies of your parameter sets to ensure their reliability even in case of PC damages.**

### 8.2.2.2 Deleting parameter sets from the thermometer

With the button ”Delete from ATP” the follwoing screen will appear.




Picture 8.9 Delete a parameter set from the thermometer

To delete a parameter set from the thermometer you have to doubleclick on it. If you should need this set later again you can transmitt it new from yout harddisk. In the most cases it will be enough to overwrite an exsisting parameter set in the thermometer with a new set without deleting it before.

# 9. Recording and presentation of measured values with SmartGraph

The program SmartGraph offers the recording, storage and graphical presentation of measured values. SmartGraph is a trademark of the Weiland-Meierhofer GmbH.

## 9.1. System requirements for the installation of SmartGraph

Hardware: You must own a personal computer with an 80386 microprocessor or better; recommended are at least 4 MB RAM and a mouse. To connect the thermometer a serial interface has to be available.

Software: MS-Windows 95 or MS-Windows 3.11 has to be installed on your computer.

## 9.2 Installation of SmartGraph

- Start up Windows
- Insert the SmartGraph floppy disk into your disk drive.
- Select the instruction "Ausführen" ("Run") from the menu "Datei" ("File") of the program-manager (Windows 3.11) or rather from the task bar (Windows 95).
- After that enter the instruction: a:\setup (only if you have inserted the disk into drive a:, otherwise you have to enter the appropriate name of the drive!) and choose "OK".
- Follow the instructions on the screen. If you take over the settings the new program group "SmartGraph" is created and the program files are copied into the subdirectory "c:\sg_atp".

As soon as the installation is completed you can find the SmartGraph program icon in the newly created program group " SmartGraph" or in the program group you have entered. (Detailed instructions on how to work with the program manager can be found in your Windows-manual. Apart from that you can always get help on the relevant active menu element by pressing the button F1.)

## 9.3 Introduction into SmartGraph

### 9.3.1 Recording measuring values

SmartGraph contains a recorder to record any measured values of the connected thermometer on your PC. For the communication with SmartGraph the baud rate of the instrument has to be set on 9600. When starting a storage SmartGraph blocks the instrument's keyboard, so that its settings (e.g. the unit) cannot be changed during a storage.

The file "Sensors.ini" contains information to describe the measured values transferred from the thermometer. This information is organized as channel description sets.

```
[Sensor2100]
Hold=Temperatur A
Name=TA
Unit=°C
Max=962
Min=-200
Dec=3
```

Picture 9.1: Example of a channel description set

At the beginning of each channel description set there is the number of the description set. The thermometer tells SmartGraph the number of the description set belonging to a measured value. The description sets 200 up to 2099 are used if the unit ohm is activated. For °C, K and °F the description sets 2100 to 2199, 2200 to 2299 and 2300 to 2399 are used. In case the differential measurement is activated on the instrument the description set numbers 2400 up to 2799 are used accordingly. If for example the unit °C is set on the thermometer and the differential measuring is deactivated, the description set with the number 2101 is used for the measured values of measuring channel B. For measured values of the measuring channel M05 the description set with the number 2106 would be used.

In the second line of the description set the measured value is described. In the example shown in picture 9.1 "temperature A" was chosen for this line. "TA" is the short name which has been set for this measuring value. For "unit" the unit "°C" was entered . The temperatures 962°C and -200°C have been set as maximum and minimum. The resolution was set to 3 decimal places. In the file "Sensors.ini" the rest of the entries were created by the manufacturer according to the above mentioned example.

Using a text editor the user can change the file "Sensors.ini". If for example the temperature of an oven is measured on the measuring channel A the user could change the description set 2100 as is shown in picture 9.2.

```
[Sensor2100]
Hold=Oven temperature
Name=TOven
Unit=°C
Max=160
Min=150
Dec=3
```

Picture 9.2: Example of a channel description set changed by the user

In the example shown in picture 9.2 the user has used application-specific descriptions. Apart from that it was fixed that a the measured values are high-lighted if the temperature falls below 150°C or exceeds 160°C.

The recorder window is opened with the instruction "Start Recorder" from the menu "Datei" ("File"). Recording intervals from 1 second up to 60 minutes can be selected. Pressing the key "Start" a record is started. The recorder window displays the most recently recorded measuring values of all channels. In addition to that the graphics and table windows are up-dated. If the thermometer has not yet measured any new values when SmartGraph makes an inquiry, no values are entered into the table at this time of record. Thus it is ensured that the time pattern determined by the recording intervals isn't broken.

If the measuring instrument recognizes that the borders set in the technical specifications of the thermometer or the borders set by the user during the definition of the sensor's calibration coefficients are exceeded, this is reported to SmartGraph. SmartGraph will then ignore the appropriate measuring values. The user can find a description of the error on the display of the measuring instrument.

### 9.3.2 Graphical and tabular presentation of the measuring values

For a graphical and tabular presentation of the measuring values one has to use the instruction "Öffnen" ("Open" in the menu "Datei" ("File").

SmartGraph will now present the measuring values graphically and tabulated in windows. These windows can be moved, enlarged or reduced to a symbol. They can overlap or be

presented one below the other. If you have used other Windows-applications before the operation will soon be familiar to you.

### 9.3.3 Analyzing and processing of measuring values

Every operation in any graphics window is also carried out in all the other graphics windows. The graphics windows thus always present the same time span. (If displayed one over the other the diagrams can be compared very well.)

To analyze the measuring values the time span can be zoomed to up to 10 seconds. As soon as you move the pointer of the mouse into the area of presentation of a graphics window it changes into a magnifying glass. To enlarge a specific area you have to put the magnifying glass over it and double-click the left mouse button. The graphics are now zoomed to the next level, keeping the selected area in the middle of the presentation. To zoom out you just have to double-click the right mouse button. Alternatively you can hold down the shift button and double-click the left mouse button at the same time.
The levels of presentation are: year, month, week, day, 6 hours, 1 hour, 10 minutes, 1 minute and 10 seconds (see also: instruction "enlarge" in the menu "edit")

Each graphics window has got image window scroll bars at the bottom to view different areas of the image. You have to click on the left or right arrow to move the graphics one step to the left or right. To leaf through the area just click on the left or right part of the scroll bars to move to the left or right.

### 9.3.4 Documentation

For printing you have to use the instruction "Drucken" ("Print") in the menu "Datei" ("File"). Here the image will be printed by the printer installed in windows with full resolution.

The content of graphics windows can be transferred into other applications (e.g. MS-Word, MS-Works or Wordperfect for Windows) using the Windows-Clipboard. For an numerical processing of measuring values the data should be saved in a text format, so that it can afterwards be read by a spreadsheet like for example Excel, etc.

- Click into the relevant window to activate it, or select it from the menu "Fenster" ("Window").

- Now select the instruction "Kopieren" ("Copy") in the menu "Bearbeiten" ("Edit").
- Change your application.
- In your new application choose "Einfügen" ("Paste") in the menu "Bearbeiten" ("Edit").

## 9.4 Description of the menu instructions

### 9.4.1 File menu

The selection of a file is done with the dialogue box "Datei öffnen" ("Open file").

- Enter the name of the respective file in the field "Name" ("name"),
- or select a file name from the list "Dateien" ("files"),
- or choose a file from another directory by selecting the appropriate directory from the list "Verzeichnisse" ("directories").

Selecting the function "Datei speichern unter" ("save as") you can save the data in a different file. Here a dialogue box appears, in which you can enter a new name for the current file. Warning: If you select a file which does already exist and if you confirm the further inquiry this file is recorded over and the old data from this file is deleted.

The menu element "Start Recorder" opens the recorder window and starts up a storage of measuring values using SmartGraph (comparable to a writer). This menu element changes into "Stop Recorder" as soon as the recording is running. Here you are asked for a file name to save the recorded values. Apart from that you can set the appropriate recording interval from 1 second up to a maximum of 60 minutes. Afterwards you click onto the "Start" button. The graphics windows display 10 minutes going back from the actual PC system time. When the right hand margin is reached in the image the graphics are moved to the left by one minute. In the recorder window the most recently recorded values are displayed. If the alarm borders are exceeded in any way the respective measuring value is written in red. The graphics and table windows are updated at the same time. Every two minutes ( or rather with each record for intervals >2 minutes) the measuring data is saved on the hard disk, so that it doesn't get lost in case of a system or power failure.

After activating the instruction "Drucken" ("print") the dialogue box "Drucken" ("printing" appears. By selecting the appropriate option you can choose what is to be printed: the table, certain graphics, or all graphics (either all arranged on one page or one page per image). Tip:

In the top right corner the image saved in the file "LOGO.BMP" is printed. You can create your own logo with the program "Paintbrush" for example.

Through the activation of the instruction "Seite einrichten" ("page setup") the dialogue box "Seite einrichten" ("page setup") appears with the following options. In "Titel" ("title") you can enter a headline printed at the top of each page (e.g. for user data). If the option "Tabelle mit Rahmen drucken" ("Print table with frame") is not activated, the table will be printed without frames and without the logo in the font set before. Thus the output rate is considerably raised, especially for matrix printers. In the option "margins" you can enter the appropriate margins in cm. (The size of page has to be set with the instruction "Drucker einrichten" ("printer setup").)

With the instruction "Drucker einrichten" ("printer setup" you can select the options of your printer. With most printers you can choose between various graphics resolutions. A higher resolution does increase the quality, but in the other hand the time needed for the printout rises. The best thing is to try different resolutions. Tip: To print single graphics windows it is best to use the page orientation "landscape"; to print all graphics at once or the table it is better to use the orientation "portrait".

### 9.4.2 Edit menu

With the instruction "Kopieren" ("copy") graphics can be copied to the clipboard.

- Either click on the appropriate graphics window with the left mouse button or select it from the menu "Fenster" ("window") so that it becomes the active window.
- Then choose the instruction "Kopieren" ("copy") from the menu "Bearbeiten" ("edit").

Now you can change your application program. In the new application select the instruction "Einfügen" ("paste") from the menu "Bearbeiten" ("edit").

Using the instruction "Vergrößern" ("enlarge") the centre of the current graphics window is enlarged to the next level. The same function is activated by the left mouse button while the pointer is over the image of a graphics window (pointer = magnifying glass); here the centre of the enlargement can be determined by the position of the magnifying glass.

Using the instruction "Verkleinern" ("reduce") the graphics window is reduced to the next level. This function is identical with a double-click of the right mouse button and the pointer = magnifying glass.

Using the instruction "Y-Bereich" (" area Y") the range of the current graphics window is changed to the set values.

Selecting the function "Alarmgrenzen" ("alarm borders") alarm borders will be added into the graphics windows. You will have to enter a minimum and a maximum for the alarm borders.

### 9.4.3 Window menu

The window menu contains instructions for the arrangement and selection of graphics and table windows. Using the instruction "Nebeneinander" ("next to each other" the windows are arranged next to each other or above one another unless they are reduced to a symbol. Using the instruction "Überlappend" ("overlapping") all the graphics/table windows which aren't reduced to a symbol are presented in scales. Using the instruction "Symbole anordnen" ("arrange symbols") the graphics/table windows reduced to symbols are arranged at the bottom of the SmartGraph window. Using the instruction "Fenster Xxx" ("window Xxx" the selected window becomes the active window. The currently active window is marked in the menu.

### 9.4.4 Options menu

Using the instruction "COM-Schnittstelle" ("COM-interface") an interface can be selected where the measuring instrument is to be connected. Note: If by mistake you have selected the interface your mouse is connected to, SmartGraph will display the message "Hardware gesperrt" ("hardware blocked") whenever you try to open the interface.

Using the instruction "Dateiformat" ("file format") you can choose between internal file format ( for fast reading and saving) and text format (readable for other programs). In the text format the data is stored separated by tabulator characters line by line, and can immediately be read in word-editing programs or spreadsheets. Many spreadsheets like for example MS-WORKS or MS-EXCEL expect a comma for the decimal point in the German version. This is why you ought to mark the respective option if you want to read the data in those programs.

### 9.4.5 Help menu

Under "Ergänzungen zum Handbuch" ("additions to the handbook") you can find the latest changes and additions which have been added after the printing of this handbook. The instruction "Inhalt" ("content") starts up the online help and displays the table of help topics. By pressing "Hilfe benutzen" ("using help") you will get an introduction into the Windows help system. Pressing "Info" ("information") you will be shown the version number and a note on the copyright of the current program version.

### 9.5 Storing the measuring data on the hard disk

SmartGraph creates the subdirectory \data additionally to the SmartGraph program directory (Unless something else was entered during the installation this directory is called c:\sg_atp). Measuring data can be saved either in the internal format (*.SGR) or in the text format (*.TXT) (see instruction "Dateiformat" ("file format") in the menu "Optionen" ("options")).

## 10. Operating the thermometer with scanners

In case two measuring channels are not sufficient, scanners may be used. The DDM 900 can be delivered with an integrated scanner with 8 channels. Extrenal scanners with 8, 16, 24 or 32 channels are aviable. The number of cascaded scanners must not be more than five. Apart from that the log numbers of the various scanners have to be identical. The number of external measuring channels is limited by the model version. In the basic model up to 21 sensor parameter sets can be stored at the same time. As a parameter set has to be available for each measuring channel, if the sensors calibration coefficients deviate from each other, the maximum number of scanner measuring channels is set to 20. With an expanded version up to 80 scanner channels can be connected. The scanners have to be connected to channel B of the thermometer. In the display of measuring values and for the settings of the instrument channel B is replaced by the external measuring channels. The instrument recognizes the connected scanners and the full number of measuring channels automatically after a cold start.

Using the deliverded cables an internal scanner has to be connected from ”**ScanOut**” to ”**B**” at the front and from ”**Scanner**” to ”**ScanOut**” at the back.

External scanners also have to be connected only using the delivered cables. If only an external scanner is used it has to be connected with it´s ”**ScanOut**” to ”**Ch B**” at the front an with it´s ”**ScanOut”** to ”**Scanner**” at the back. If an internal scanner also is in use an external one has to be connected with it´s ”**ScanOut**” to the ”**ScanIn**” of the DDM 900 at the front and with it´s ”**ScanOut**” to the ”**ScanIn**” of the DDM 900 at the back. A second external scanner (and more) can be connected with it´s ”**ScanOut**” to the ”**ScanIn**” of the first external scanner at the front and with it´s ”**ScanOut**” to the ”**ScanIn**” of the first external scanner at the back.

**Safety instruction: Only the prescribed cables are to be connected to the instrument! The operator has to ensure that no inadmissible voltages reach the instrument.**

## 11. Errors and their correction

1. After switching on the **display remains dark**.

   Proceed according to the chapter "First operation of the DDM 900". Please contact your supplier if the fault cannot be corrected.

2. **Faulty measuring** values are displayed.

   Check whether the parameter sets belonging to the sensors connected are assigned to the measuring channels (see chapter "Manual Operation").

3. The text "**Battery too low!**" appears on the display.

   The battery to buffer the thermometer's memory is empty. Have the battery changed by an expert.

   **Warning: The following work may be carried out by a trained expert only, as mains voltage may occur in the instrument.**

   - Disconnect from the mains by pulling out the plug!
   - Open the case of the instrument, by unscrewing the four upper screws in the sides of the thermometer and lift the upper lid.
   - Replace the instrument's battery (see chapter "Specifications")
   - After the replacement of the battery the parameter sets have to be re-loaded (see chapters "Establishing sensor specific parameters" and "Manual operation"). Afterwards the parameter sets and the sensors connected to the measuring channels have to be co-ordinated again. In addition to that the other settings of the thermometer have to be checked and adjusted if necessary.

4. The text "**SYSTEM FAILURE**" and a number from **1** to **4** appears on the display.

   This error cannot be corrected by the user. Please contact your supplier.

5. The text "**All chs are off!**" appears on the display.

   You have switched off all the measuring channels. You will have to switch on at least one of the measuring channels (see chapter "Manual operation")

6. The text "**Params error**" appears on the display.

   The assignment of parameter sets to the measuring channels has been changed. This can be caused by the connection or disconnection of an external multiplexer. Check whether the assignment of parameter sets to the measuring channels is still correct (see chapter "Manual operation").

7. The texts "**Sensordata Error**" and "**Deleting #**" followed by a number appears on the display.

   An error has occurred in the parameter set with the number displayed. The parameter set has been deleted. If you still need the parameter set, you have to transmit it again from your PC to the thermometer (see chapter "Establishing sensor specific parameter sets"). Check whether the assignment of parameter sets to measuring channels is correct and change them if necessary (see chapter "Manual operation")

8. The text "**Invalid Params**" appears on the display.

   A measuring channel has been assigned a number of a parameter set which doesn't exist. Correct the mistake (see chapter "Manual operation").

9. The text "**open**" appears on the display.

   The value of the connected resistance is above the resistance area which can be realized by the thermometer, or the connection line is open. Check whether the temperature sensor is connected correctly.

10. The text "**short**" appears on the display.

    The value of the connected resistance is below the resistance area which can be realized by the thermometer, or the connection line is shorted. Check whether the temperature sensor is connected correctly.

11. The text "**to great**" appears on the display.

    In case the set unit is ohm:

    The resistance value is higher than the maximum. Check whether the correct type of sensor has been used.

    In case the set unit is °C, K or °F:

    The measured temperature value is higher than the maximum. Check whether the correct type of sensor has been used or whether the measuring range has been exceeded caused by the parameter set. You will find the maximum temperature value in the appropriate parameter file on your PC (see chapter "Establishing sensor specific parameter sets").

12. The text **"to small"** appears on the display.

    In case the set unit is ohm:

    The resistance value is lower than the minimum. Check whether the correct type of sensor has been used.

    In case the set unit is °C, K or °F:

The measured temperature value is lower than the minimum. Check whether the correct type of sensor has been used or whether the measuring range has been exceeded caused by the parameter set. You will find the minimum temperature value in the appropriate parameter file on your PC (see chapter "Establishing sensor specific parameter sets").

13. The text "**range err**" appears on the display.
    This error is caused by the effects of exceeding the measuring range which can for example occur during differential measurements.
14. The text "**interface err**" and a number from **1** to **3** appears on the display.
    An error has occurred during the communication with your PC. Switch off the instrument and then switch it on again. Restart the PC program.
15. The text "**Mux-Error 1**" appears on the display.
    The external multiplexer has got an inadmissible version number , or in case more than one multiplexers are used their log version numbers are not identical. Contact your supplier.
16. The text "**Mux-Error 2**" appears on the display.
    A too high number of measuring channels has been recognized. Reduce the number of the external measuring channels or contact your supplier.
17. The text "**Mux-Error 3**" appears on the display.
    A transmitting error has occurred during the communication with the external multiplexer. Switch the instrument off and on again.

## 12. Guarantee and repairs

The manufacturer gives a twelve-month guarantee on the thermometer. The guarantee includes parts and work. The cost of transport and any damage resulting from transport in case of a repair have to be paid by the sender. The full address of the sender, a commission of repair and a description of the error have to be enclosed with any instrument sent in for repair works. The instrument has to be wrapped in such a way that it is protected from damage during transport. Before carrying out a repair the manufacturer informs the sender about the estimated cost of repairs and asks the sender to give his consent. Any costs for the return transportation and for the insurance of the repaired instrument have to be paid by the sender. The repaired instrument is sent back the cheapest possible way.

**Notes:**