

User manual
Digital Temperature Indicator
DTI 100/1000

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1 General information

This manual is only effective for following products:

DTI model 1000

DTI model 100

DTI software

The products are manufactured by:

AMETEK DENMARK A/S
GYDEVANG 32 - 34
DK-3450 ALLERØD
DENMARK
TEL.: +45 48 16 80 00
FAX: +45 48 16 80 80

2 Introduction

The DTI (Digital Temperature Indicator) system is designed for fast and traceable calibration and is ready for use. The system is portable.

Please read this manual carefully before use, to obtain maximum value of your DTI system.

The DTI is prepared for re-calibration by your local calibration laboratories, and all necessary instructions for the re-calibration is stated in this manual.

The DTI is not designed for continuously data-logging recording, since there is no guarantee for missed log values during the data-logging.

Definitions and terminology used in this manual:

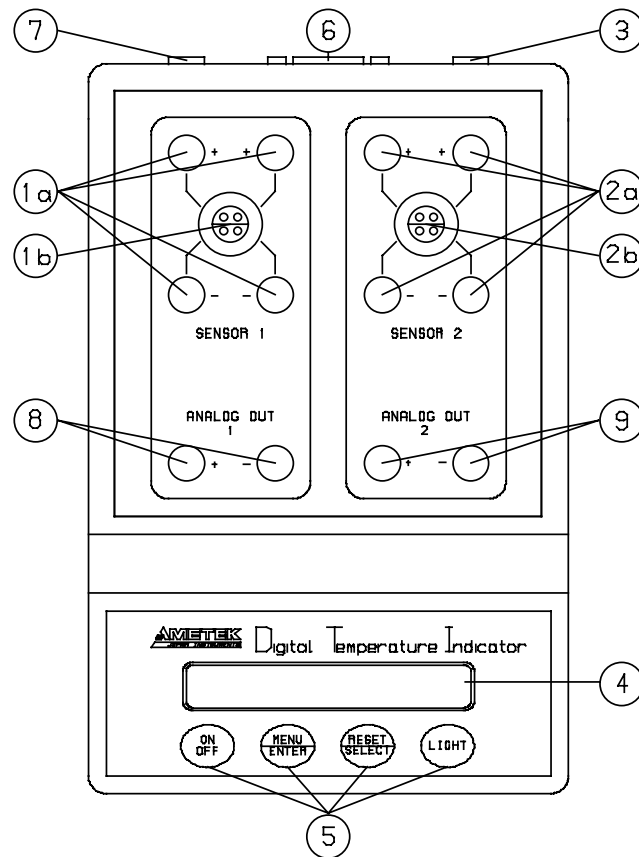
- a. Text inside <> refer to soft-keys on the DTI panel or keys on the PC keyboard. Text with big letters indicate the activated function if there are more than one function (example <ON/Off>).
- b. Display text on the DTI is shown inside rounded frames.
- c. Screen menus in the DTI software are shown inside edged frames.

WARNING:

- * Read this manual before use.
- * Do not use in hazardous area.
- * Do not connect rated voltages to earth with a maximum above 50V to the input terminals.

3 Functionality

Overview:



- 1a. Sensor1 connections.
- 1b. Sensor 1 connections, DTI 1000 only.
- 2a. Sensor 2 connections.
- 2b. Sensor 2 connections, DTI 1000 only.
3. Ground terminal for cable shields.
4. Display with 2 * 20 characters.
5. Softkeys.
6. RS232C connector.
7. Power inlet for mains adapter.
8. Analog out for channel 1, DTI 1000 only.
9. Analog out for channel 2, DTI 1000 only.

3.1 Functional description

The DTI is used for measuring inputs from two PT100 sensors in the range 0 to 360 Ω (-200 to 750°C). The two sensors are connected to the connectors in the top plate. The input signal is compared to the two internal resistor references from which the input signal can be determined.

The DTI operates with a 2*20 character display, which continuously read out the two inputs.

The input value can be shown as the actual read value for both sensors, the peak values for sensor 1 or 2, the differential value for the two sensors or as the differential peak value for the two sensors.

The input value can be shown in Ω , °C, °F or K selected by the user.

The resolution in temperature can be 0.1 or 0.01 for both models and also 0.001 for DTI 1000.

The 4th order polynomial coefficients can be inspected by the user and changed in the software program.

The DTI 1000 also has analog output which corresponds to the temperature value for the input where the signal range is from -0.5 to 3.75 volt. The gain and offset can be altered by the user in the software program. ☒

The power supply is made by eight 1.5 Volt batteries or a mains adapter (optional extra). Use only mains adapter supplied by AMETEK in order to comply with the requirements in EN50081-1 (1992) and EN50082-1 (1992).

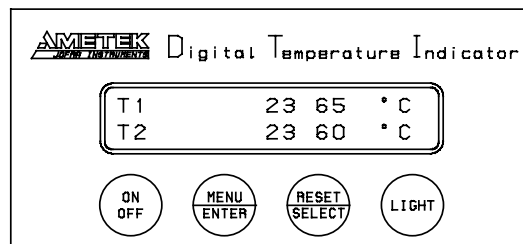
It is possible to connect the shields from the cables to the cabinet, in order to reduce the influence of noise.

Both models are supplied with RS232 and software, in order to have the possibility of saving the measured data and to recalibrate the DTI or the sensors.

☒ **Note:** If the temperature is outside the range set by gain and offset, the value of the analog output signal is undefined.

3.2 Indicators

The DTI only uses the display for all indications. The display has 2*20 characters which will swap between read-out values or menu selection when requested. Please see section 5.3.1 to 5.3.6 for possible display read-outs. Please note that the error messages will also be showed in the display, see section 7.3.



3.3 Touch pad

There are 4 soft-keys on the touch pad panel, where 2 of the soft-keys have a double function.



Switch ON or switch OFF the DTI. Please press down the key at least 0.2 seconds in order to switch on the unit.



MENU toggles between the menus: Mode/Unit/Resolution/Sensor
ENTER enters the menu function selected with the RESET/SELECT key.



RESET resets peak values for both channels.
SELECT toggles between the selected menu functions.

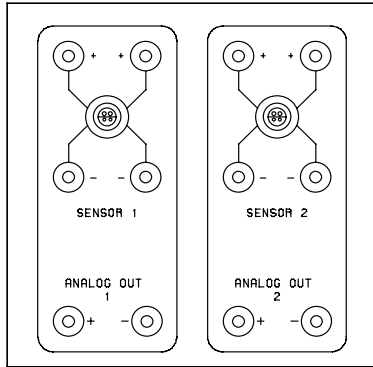


Switch on or switch off the light. The light can be activated for 10 seconds or constantly.

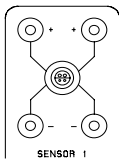
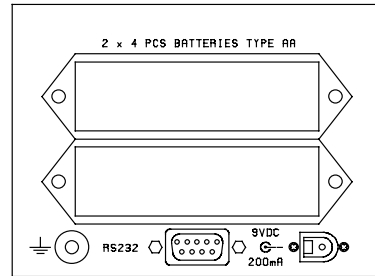
3.4 Connections

All signal cables have to be connected to the top plate (grounding on the back plate). Power and communication cables have to be connected on the back plate.

Top plate connection

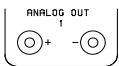


Back plate connections

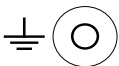


Connections for sensors, where channel 1 is shown.

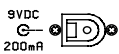
Please note that the LEMO-connector is only available on the DTI-1000 model.



Connections for analog out (channel 1 and 2) for the 2 temperature readings and only available on the DTI-1000 model.



Ground terminal for shield on the signal cables.



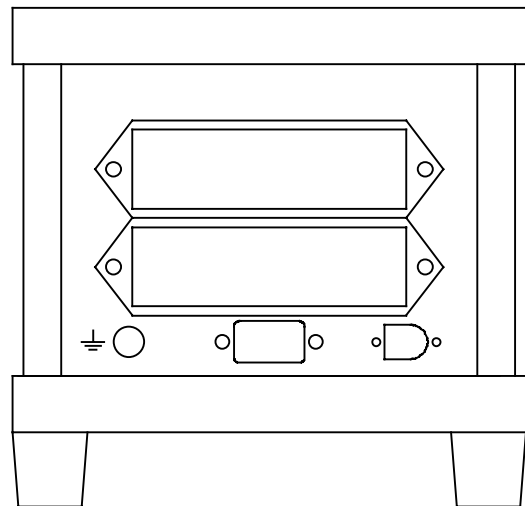
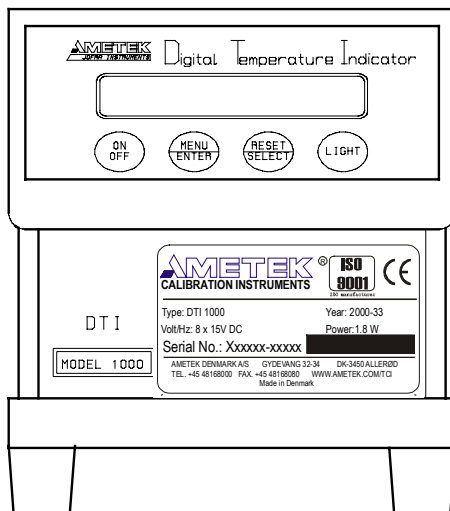
Power input for mains adapter 9VDC 200mA.



Connector for RS232C interface.

4 Labels

Sign	Meaning	Placement
Manufacturer logo	Shows name and address of manufacturer	Front plate foil
Instrument name	Unambiguous statement of the instrument name	Front plate foil Display foil
Model specification	Unambiguous statement of the instrument model	Front plate foil
Serial number	Unambiguous statement of the instrument	Front plate sticker



5 Operation

5.1 Operating area

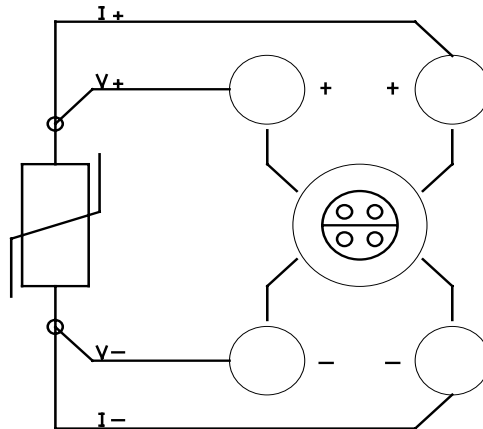
Both of the DTI models are intended for use in areas which meet the following:

Temperature range	:	0°C/32°F to 50°C/122°F
Humidity	:	0% to 90%
Protection class	:	IP20

WARNING: Do not use in hazardous areas!

5.2.1 Connection of sensors

The sensor should be connected to the terminals as shown in the figure below:

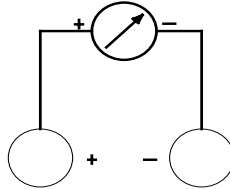


Use the ground terminal (see the figure "Overview" section 3, pos. 3) for the cable shields in order to reduce noise.

The connector type to extra connector on DTI-1000 is: LEMO FFA 1S 304 CNAC.

5.2.2 Connections for analog out (DTI 1000 only)

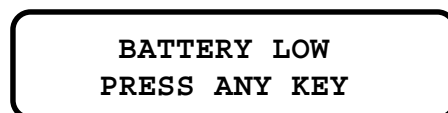
The voltage output should be connected to a measuring device as shown in the figure below:



Use the ground terminal (see the figure "Overview" section 3, pos. 3) for the cable shields in order to reduce noise.

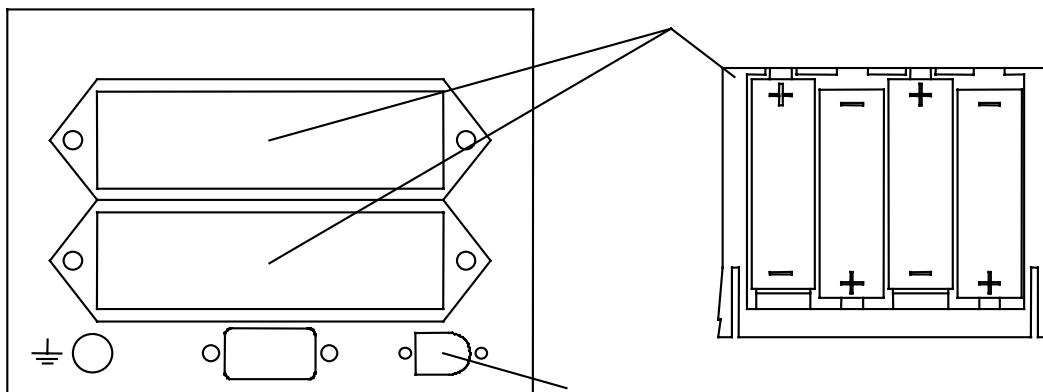
5.2.3 Power supply

The DTI is supplied with 8 1.5 Volt batteries as standard. When the battery voltage is low following message will appear:



This message will only appear one time after the DTI has been switched on, and is removed by pressing the key <Menu/Enter> or <Reset/Select>. The DTI is still able perform accurate measurements a little while longer.

The batteries are placed in the two battery holders shown in the figure below:



It is also possible to supply the DTI from a mains adapter at the connector shown in the figure above. The mains adapter can be supplied by AMETEK.

5.3.1 On / Off

Start the DTI by activating the softkey <ON/Off>. Following message will be shown in the display:

SELF-CALIBRATION
AND TESTING 1

This information states that the internal references and the sensor coefficients are checked. If the coefficients are incorrect an error message will occur which is described in section 7.3.

The next message shown in the display will be:

SELF-CALIBRATION
AND TESTING 2

In this step the A/D converter is calibrated which approximately takes 1 second. When the calibration is over following message will be shown:

SELF-CALIBRATION
AND TESTING 3

Test 3 is an internal voltage reference check, which approximately takes 4 seconds.

When all the test have succeeded, the DTI will show the model type and last calibration date in the display:

AMETEK DTI-1000
CAL. DATE 940630

After this the input values will be shown in the display in the same format, as before the DTI was shut off last time:

T1	23.65	°C
T2	23.60	°C

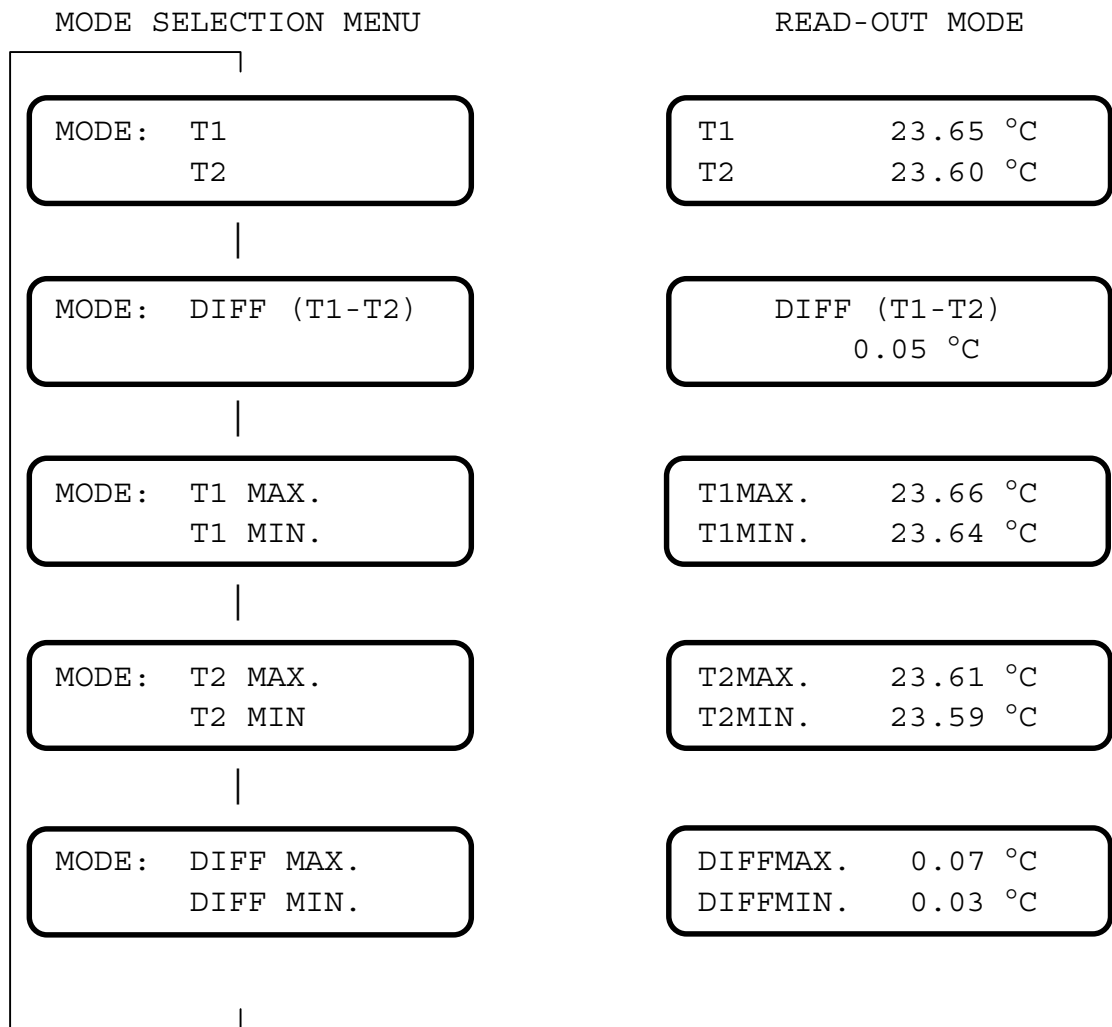
If there is no input signal or it is outside the measuring range a hyphen will be shown for that specific channel.

5.3.2 Reading

In order to change the reading, you must press the softkey <MENU/Enter> 1 time. The following message will be shown in the display:

```
MODE:  T1
        T2
```

Use the softkey <Reset/SELECT> to scroll between following types of read-out:



Use the softkey <Menu/ENTER> to select the specific read-out mode.

5.3.3 Reset

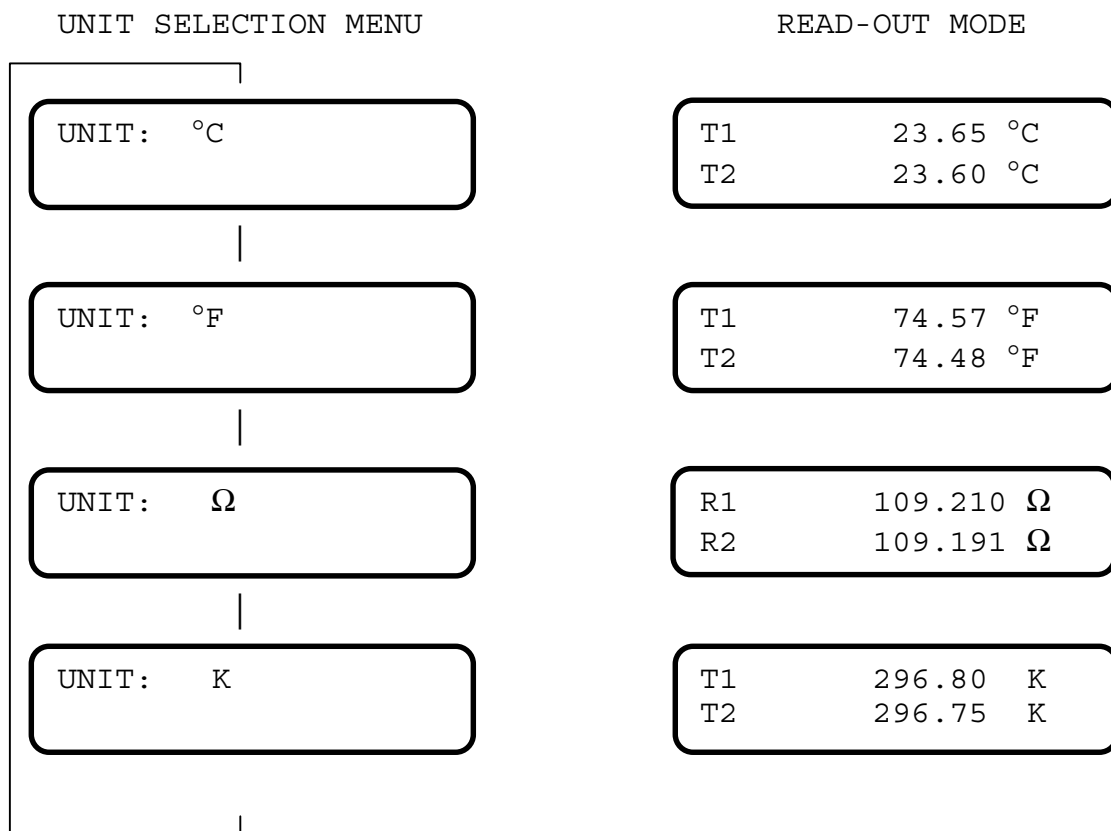
Use the softkey <RESET/Select> in order to reset the peak values in the selected difference mode.

5.3.4 Units

In order to change the unit of the read-out, you must press the softkey <MENU/Enter> 2 times. The following message will be shown in the display:

UNIT: °C

Use the softkey <Reset/SELECT> to scroll between following types of units:



Use the softkey <Menu/ENTER> to select the specific read-out unit.

Please note that read-out in Ω has one more digit than specified in the resolution set-up.

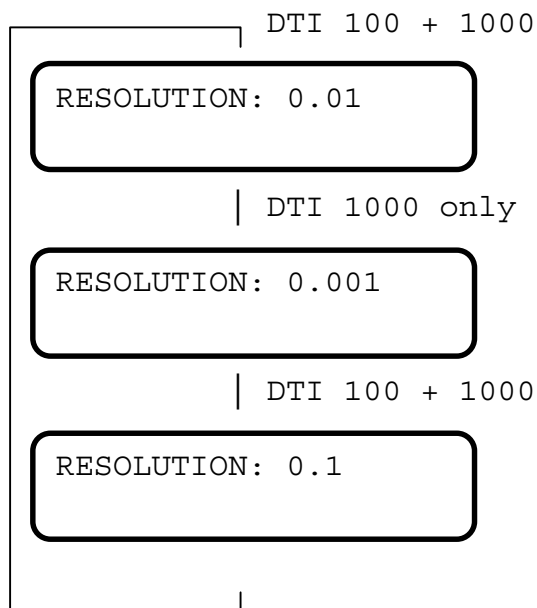
5.3.5 Resolution

In order to change the resolution on the read-out, you must press the softkey <MENU/Enter> 3 times. The following message will be shown in the display:

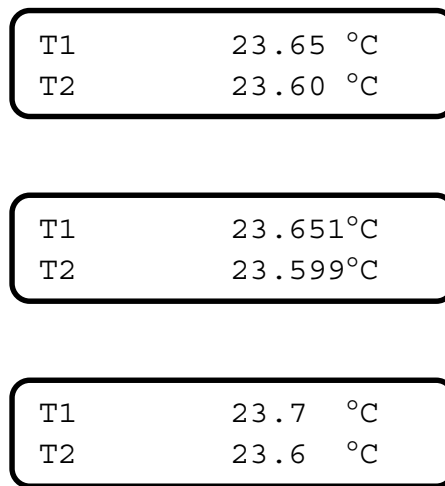
RESOLUTION: 0.01

Use the softkey <Reset/SELECT> to scroll between following types of resolution:

RESOLUTION SELECTION MENU



READ-OUT MODE



Use the softkey <Menu/ENTER> to select the specific read-out unit.

The sample period is dependent on the selected resolution which can be longer than sample rate to the display if a resolution above 0.1 is selected. The sample rates for the different resolutions are shown below:

Resolution	0.1	0.01	0.001
Sample period	1 s	2 s	10 s

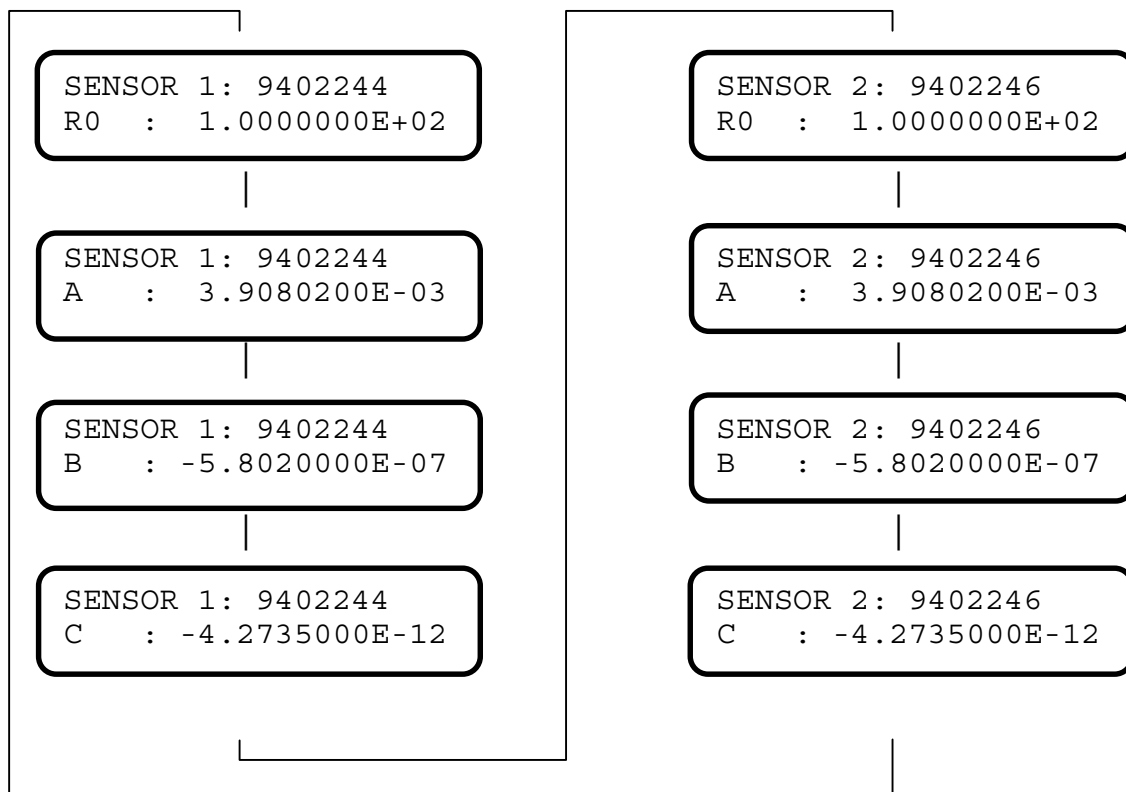
Please note that read-out in Ω has one more digit than specified in the resolution set-up.

5.3.6 Checking sensor coefficients

In order to check the sensor ID and coefficients on the DTI, press the softkey <MENU/Enter> 4 times. The following message will be shown in the display:

```
SENSOR 1: 9402244
R0 : 1.0000000E+02
```

Use the softkey <Reset/SELECT> to scroll through the coefficients:
(example with both sensors using default coefficients)



Use the softkey <Menu/ENTER> to leave this menu.

The coefficients are used in the equations:

Below 0°C: $R(t) = R_0 \cdot (1 + A \cdot t + B \cdot t^2 + C \cdot (t - 100)t^3)$

Above 0°C: $R(t) = R_0 \cdot (1 + A \cdot t + B \cdot t^2)$

5.3.7 Light

By pressing the softkey <Light> 1 time, the light will be switched on in the display for about 10 seconds. By pressing the softkey 2 times in a row the light will stay on. The light is switched off by pressing the softkey again.

6 Technical specifications

The specifications are for both DTI-100 and DTI-1000 unless otherwise specified.

Electrical data:

Measuring input:	2 channels for 4 wire PT100 sensors.
Measuring range:	0 to 360 Ω (-200 to 750°C).
Linearity:	$\pm(0.014^{\circ}\text{C} + 1 \text{ digit})$ excl. sensors at 23°C.
Calibration accuracy:	± 10 ppm (0.01°C) excl. sensors.
Temperature drift:	$\pm 0.003^{\circ}\text{C}/^{\circ}\text{C}$.
Temperature resolution	
DTI-1000:	0.1 / 0.01 / 0.001.
DTI-100:	0.1 / 0.01.
Units:	$^{\circ}\text{C} / ^{\circ}\text{F} / \Omega / \text{K}$.
Supply:	8 pcs. 1.5 V type AA batteries or 9 V mains adapter.
Battery life	
Light ON:	10 hours.
Light OFF:	50 hours.
Analog out (DTI 1000 only)	
Range:	-0.5 to 3.75 V.
Accuracy:	$\pm(2\text{mV} + 0.05\%$ of reading).
Temperature drift:	$\pm 0.3\text{mV}/^{\circ}\text{C}$
Scaling:	0°C: 0V and 5mV/°C as default. (can be changed in software)
EMC (directive 89/336/EEC):	EN50081-1 (1992) EN50082-1 (1992)

Mechanical data:

Weight:	2.2 kg.
Dimensions (H/W/D):	195 mm / 135 mm / 225 mm.
Operating conditions:	
Temperature range:	0 to 50 °C
Humidity range:	0 to 90 %
Protection class:	IP20
Storage temperature:	-20 to 60°C

7 Maintenance and display error messages

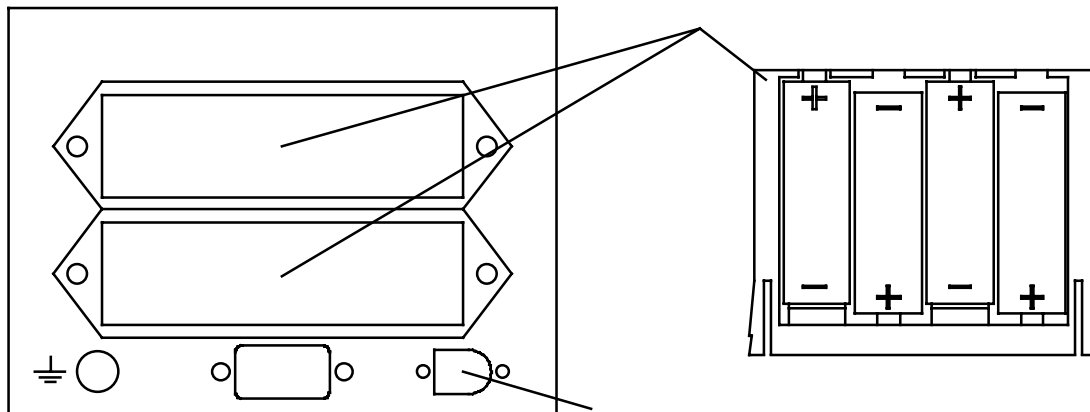
7.1 Maintenance

The DTI does not require specific maintenance before or after use. The user may carry out the following procedures him self.

Cleaning surfaces	Use alcohol or water and a soft cloth.
Re-calibrate or change coefficients for sensors	Use the software in order to re-calibrate/change the sensor coefficients (see section 8.6).
Re-calibration of DTI references or analog out	Use the calibration routines in the software to re-calibrate the DTI (see section 9 to 9.4).

7.2 Changing batteries

The batteries are placed in the two battery holders shown in the figure below. The battery holders can be pulled out by pressing the locks on both sides simultaneously.



7.3 Display and error messages

If the DTI detects an error while running, it will automatically appear in the display. Following error messages can occur:

Display message:

Meaning/Action:

BATTERY LOW
PRESS ANY KEY

Battery voltage low.
Change batteries
(section 7.2).

T1 ////.///°C
T2 ////.///°C

No sensor connected to input or measuring input
outside range.

CONSTANT ERRORS
DEFAULT VALUES

Downloaded coefficients rejected.
Check calibration.
Default sensor coefficients used are:
R0: +100.000000 A :+3.90802E-3
B : -5.80200E-7 C : -4.27350E-12
Press any key to continue

8 Software

8.1 Installation

The program must be runned in DOS. It is not recommendable to execute the program in a DOS-window under WINDOWS.

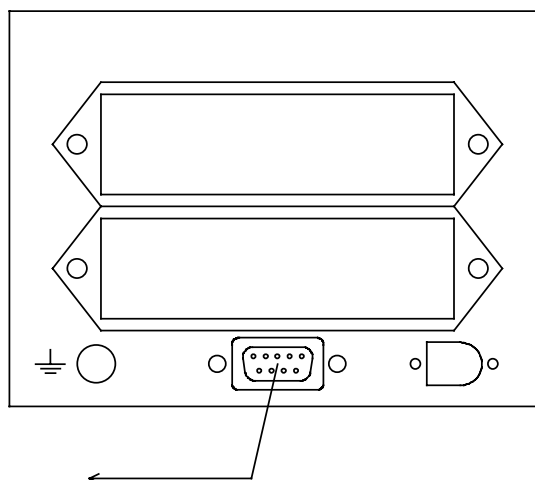
The software program can be installed on a standard PC AT with min. 640 Kb RAM, 1 3½" floppy disk, 1 hard disk, 1 RS232C COM-port, 1 parallel port and a VGA colour monitor.

1. Insert the disc in drive A (or B).
2. Type "A:" or "B:" and press <ENTER>.
3. Type "DTI_INST" and press <ENTER>.
4. Press <ENTER> to continue installation and <ESC> to leave.
5. Confirm or specify source drive for installation and press <ENTER>.
6. Confirm or specify target drive and directory for installation and press <ENTER>.
7. Select the language by using the arrow keys and press <ENTER>.
8. The program installation on the specified harddrive is now shown on the screen.
9. Press <ENTER> to leave the installation program.
10. Type "DTI" in order to start the program.

The program will consist of 1 execution file, 1 text file, 1 help text file, 1 data file for port setup and 2 batch files placed in the root and in the specified directory as the execution file. The execution file is protected to prevent erasing by a simple DOS command.

8.2 Connections

Before the program is started please connect the DTI to the PC. The RS232C connector on the DTI is shown in figure below. Use only the AMETEK cable (Part. No. 60V991) for connection.



8.3 Starting the program

1. Type "DTI" and press <ENTER> to start the program.
2. Confirm port selection with <ENTER> or change it by pressing <SPACE> and using <↑> or <↓>.
3. When the program is in contact with the DTI the "ABOUT" message will be shown on the screen. If the program can not communicate with the DTI, the message "DTI is not ready or not connected" will appear. Please check DTI and connection before trying to establish contact in the "CONNECTION" menu. Both messages will be removed by pressing any key.

The main menu consists of:

Setup	Analog out scaling (DTI 1000 only).
Measurements	Continuously measurements to screen or log-file.
Sensor	Alteration of sensor coefficients through calibration or manual entry.
Recalibrate	Showing of calibration date for the DTI.
Quit/About	Quit, info text, re-establishing of communication or altering of temperature unit.

The bottom line will show type and serial no. for the connected DTI, and the Help menu softkey <F1> which pop-up a help text for the selected menu.

8.4 Setup (Analog output) (DTI 1000 only)

The setup menu is for altering the analog output scaling for both channels where current values will also be shown:

Modify Analog fixpoints			
'Old Offset	' :	0.00	°C
'Old Gain	' :	5.00	mV/°C
'New Offset	' :	0	°C
'New Gain	' :	5	mV/°C
< ESC > aborts, press <ENTER> to accept			

Default is: Offset: 0°C = 0V Gain: 5 mV/°C

When the values have been entered into the program, download the values to the DTI, which approximately takes half a second. Please note that the analog span is limited to -0.5 to +3.75 Volt.

8.5 Measurements

The measurements menu consists of single measurement and optional setup, a continuous measurement to a log-file, and an overview menu of previous measurements.

```

Measure
Options
Datalog
Display logdata
    
```

Measure:

The measure menu shows the latest reading in the display in the read-out modes specified in the options menu. Use the <F2> softkey to reset the peak readings.

Measuring		C	Ohm
Sensor 1	:	23.651	109.2104
Sensor 2	:	23.599	109.1902
Maximum	sensor 1 :	23.660	109.2139
Minimum	sensor 1 :	23.642	109.2069
Maximum	sensor 2 :	23.608	109.1937
Minimum	sensor 2 :	23.590	109.1867
Difference	(T1 - T2) :	0.052	0.0202
Maximum	Difference :	0.070	0.0272
Minimum	Difference :	0.034	0.0132
Time since reset : 00.00:18			
< F2 > resets peak values			
< ESC > / < ENTER > to quit			

The options menu consists of the read-out modes which should be displayed in the measure menu, where the save option gives an opportunity of saving the setup as default.

OPTIONS	
Current values	: Yes
Peak Sensor 1	: Yes
Peak Sensor 2	: Yes
Sensor difference	: Yes
Peak difference	: Yes
Time since reset	: Yes
Resolution	: 0.001
Save on exit	: Yes
< Space > toggles	
< ESC > to quit	

Use space to alter the setting and the arrows <↓> / <↑> to move up and down.

8.5 Measurements, cont.

Datalog:

This menu picks up the measurements and stores them in a user specified file (with the extension DLO).

WARNING : When using an already existing file name, this file will be subjected to overwriting (destroyed).

It is possible to specify the resolution of the data in the logfile which is changed by pressing <SPACE>. Specify time (HH.MM.SS) and date (DD.MM.YY) for start and end and the time between the measurements. The specified end time has to be later than the start time in order to create the file.

Log file data	
Filename	: example .DLO
Resolution in temperature mode	: 0.001
	Use <Space> to change mode
Start time	: 12.00.00
End time	: 12.01.18
Start date	: 30-06-94
End date	: 30-06-94
Time between log	: 1 seconds
< ESC > aborts	

The measuring starts when TIME BETWEEN LOG has been entered.

Logging to file	
Status	: Log file is being created
Measured Sensor 1	: 23.651 °C
Measured Sensor 2	: 23.599 °C
Start/Current time	: 12.00.01

The program pop-up a message when the logging is over.

NOTICE: If the logging of data is started after the time indicated, the time stated in the log file is not going to indicate the actual starting time.

The contents of the file can be selected in the display logdata menu, which can be shown on the screen or printed out to a printer. The contents and format will be the same no matter if file, screen or printed paper is selected.


```

Displaying : example.DLO

"Serial number      : DTI1000 - 942600          "
"Calibrated        : 940630          "
"Reference resistors : "
"Rhigh = 360.0000 Ohm, Rlow = 50.0000 Ohm "
"Sensor 1 id       : 9401000          "
"R0 = 1.0000000e+02,A = 3.9080200e-3,B = -5.8020000e-07,C = -4.2735000e-12"
"Sensor 2 id       : 9401100          "
"R0 = 1.0000000e+02,A = 3.9080200e-3,B = -5.8020000e-07,C = -4.2735000e-12"
"Start time        : 12.00.00          "
"End time          : 12.01.18          "
"Start date        : 30-06-1994"
"End date          : 30-06-1994"
"Time between log  : 1 seconds          "
"Measuring mode    : °C"
"Resolution        : 0.001"

"  sensor 1(Ohm)  sensor 2(Ohm)  sensor 1(°C)  sensor 2(°C) "
0, 109.2104, 109.1902, 23.651, 23.599
1, 109.2100, 109.1906, 23.650, 23.600
2, 109.2104, 109.1906, 23.651, 23.600

```

In this menu it is possible to use <Page Up> / <Page Down> to scroll faster through the file.

8.6 Sensor coefficients/calibration

This menu contains the possibility to show, enter and calibrate the used coefficients for the connected sensors.

```

Show Current coefficients
Enter new coefficients
Calibrate Sensors

```

The equations for the coefficients are:

$$\text{Below } 0^{\circ}\text{C:} \quad R(t) = R_0 \cdot (1 + A \cdot t + B \cdot t^2 + C \cdot (t - 100)t^3)$$

$$\text{Above } 0^{\circ}\text{C:} \quad R(t) = R_0 \cdot (1 + A \cdot t + B \cdot t^2)$$

Show current coefficients:

In the show current coefficients menu, it is possible to show sensor 1, 2 or both sensors in turn which will be shown in the following way:

```

Sensor 1
-----
PT100 coefficients
Serial number for sensor: 048.02-01-953610

'R0': 1.000000e+02
'A' : 3.908020e-03
'B' : -5.802000e-07
'C' : -4.273500e-12

< ESC > to quit

```

Enter new coefficients:

After every download of coefficients to the DTI the user should validate that the accurate data is present in the internal memory of the DTI. This is done by:

1. Pressing <MENU/ENTER> on the DTI until the menu pops up:

CH1: "sensor number" R0 : 1.0000000e+02
--

2. Check the sensor number and coefficient A by comparing with the data on the PC.
3. Press <RESET/SELECT> in order to change to next coefficient and check.
4. Continue with this procedure until all coefficients have been verified.

In the enter new coefficients menu, it is possible to take the calculated coefficients in the calibrate sensors menu, enter the values from the keyboard or read the values from a file which has been saved earlier. Furthermore it is possible to download default coefficients if a calibration is not possible.

Please be aware of the reduced accuracy when using this procedure.

Download of
Calculated values
Values from keyboard
Values from file
Default coefficients
< ESC > aborts

Remarks:

1. When using the "Default coefficients" the IPTS-68 coefficients will be downloaded.
2. In order to use the ITS-90 coefficients, please open "Values from file" and download the file named "IEC751-90".

Calibrate sensors:

In the calibrate sensors menu it is possible to calibrate one or both sensors. The logdata is saved in separate files specified by the user before starting (extension CLO). When measuring temperatures over 0°C, it is necessary to calibrate by at least 3 temperatures. When measuring temperatures under 0°C it is necessary to calibrate by at least 3 positive temperatures and 1 negative temperature. It is recommended that the calibration temperatures are chosen so that the normal operating range lies within the temperatures which have been used for calibration.

It is possible to continue working on calibration data which has been saved in a file. This is done either by typing the name of the file in which previous calibration data has been saved in Log file setup menu or simply by pressing <ENTER> in the same menu and choose the relevant file from the list of log files.

The log file set-up automatically shows the sensor ID for the used sensor, which can be altered by the user. Enter a stable criteria, suitable for the measuring set-up. The test option is an extra protection for bad logging.

Log file setup	
Serial number for sensor 1	: 9401000
Stable time (min.)	: 5
Maximum deviation (+/- °C)	: 0.02
Stability test	: Yes
Press <Return> to accept, use arrows to move	

The logdata menu will show this information in the measuring window in the following way:

Calibrating				
Sensor 1	: Log filename	: test1.CLO		
	Stable criteria	+/-0.020 °C	during	5.0 min.
Sensor 2	: Log filename	: test2.CLO		
	Stable criteria	+/-0.020 °C	during	5.0 min.
	Temperature	Resistance		Stable
Sensor 1	0.020 °C	100.0078 OHM		NO
Sensor 2	-0.030 °C	99.9883 OHM		NO
< F2 >	Enter new logdata	< F3 >	Log True	
< F4 >	Calculate	< F5 >	Edit logdata	
< ESC >	aborts			

Following softkeys are defined:

<F2> Enter new logdata file, restarts the calibration.

<F3> Log True, enters the true temperature in °C here.

<F4> Calculates the coefficient, when there are at least 4 logs.

<F5> Edit logdata, removes unwanted log value.

<ESC> Abort, leaves the calibration routine.

Use <F3> for each temperature log wanted for calibration.

The edit logdata menu is for removal of unwanted logs where the defined softkeys are shown in it's own menu-frame:

Logdata : TEST1.CLO				
Sensor 1				
	Ohm	Read	True	Deviation
1	0.020	0.020°C	0.000°C	-0.020°C
2	100.000	100.000°C	100.000°C	0.000°C
3	199.998	199.998°C	200.018°C	+0.020°C

When the calibration points are measured use <F4> to calculate the new coefficients (C will only be shown for logs below 0°C). Leave the menu with <ESC> and enter the calculated coefficients in the menu: "Enter new coefficients".

8.7 Recalibrate (Calibration information)

This menu will show the calibration date if the program is installed on the hard disk. It is only possible to re-calibrate the DTI when the program is executed from the floppy disk. Please see section 9 for calibration.

8.8 Quit, About, Connection and Temperature unit

This menu is used for leaving the program, showing info text and re-establishing of lost connection for communication.

Quit About Connection Temperature unit

Use the Connection menu to re-establish contact to the DTI, if the communication has been aborted while running.

Use Temperature unit menu to change the unit for readout on screen and in files. The menu can be either °C (Celsius), °F (Fahrenheit) or K (Kelvin). Use the <↑> or <↓> keys to select a new unit.

In the DTI °F and K are defined as follows:

$$^{\circ}\text{F} = 9/5 \text{ } ^{\circ}\text{C} + 32$$

$$\text{K} = \text{ } ^{\circ}\text{C} + 273.15$$

8.9 Error messages

Following messages may appear in the program:

<u>Message:</u>	<u>Meaning/Action</u>
DTI is either not ready or not connected	Check cables and DTI.
No such file(s) are found	The specified files do not exist.
FATAL ERROR in DTI. Enter new PT100 coefficients manually	The downloaded coefficients can not be retrieved through the communication, try again.
Illegal coefficients in file, download is aborted for the sensor.	The calibration routine of the sensor has not been performed correctly.
Battery low, communication can continue for a while.	The battery low signal has been detected. Change battery or use mains adaptor.
Device timeout	Printer is not connected correctly to LPT1. Printer is not ready for printing or out of paper.
Previous analog data is not available	The analog scaling information cannot be retrieved through the communication, try again.

9 Calibration

WARNING:

- * The re-calibration should be performed by authorized personnel only.
- * Read section 9.1 to 9.3 before the re-calibration is started.

9.1 Recommended equipment

Following equipment is necessary for reference recalibration:

1. 50-60 Ω resistor with a traceable accuracy better than ± 10 ppm.
2. 350-360 Ω resistor with a traceable accuracy better than ± 10 ppm.
3. Digital voltmeter, range: -1 to 4 Volt DC, accuracy: better than ± 1 mV.
4. DTI Software program on floppy disk.

9.2 Starting the calibration

The calibration can only be executed from a floppy disk described in following procedure:

1. Insert the disk in the floppy drive (A or B).
2. Select the drive by typing "A:" (or "B:") <ENTER>.
3. Start the program by typing "DTI" <ENTER>.
4. Confirm port selection with <ENTER> or change it by pressing <SPACE> and using <↑> or <↓>.
5. When the program is in contact with the DTI the "ABOUT" message will be shown on the screen.
6. Select the menu "Recalibrate".

The menu now consists of three additional parts, New Cal. date, Reference resistors and Analog out.

```
Old Cal. date
New Cal. date
Reference resistors
Analog out
```

9.3 Calibration of the reference resistors

Use following procedure for recalibration of the internal reference resistors:

1. Select the menu reference resistors.
2. Enter the date format as YYMMDD.
3. Connect the two reference resistors to the sensor inputs as shown on the figure section 5.2.1.
4. Enter the value of the two reference resistors.

Determine new resistors	
Current maximum resistor :	360.000 Ohm
Current minimum resistor :	0.000 Ohm
Default resistors for DTI (0.0 Ohm & 360.0 Ohm)	No
Enter reference resistor value in sensor input 1 :	55.0000 Ohm
Enter reference resistor value in sensor input 2 :	355.0000 Ohm
< ESC > aborts, Press < Enter > to accept	

The default selection should only be used if the previous calibration went wrong.

Now the calibration will show the determination of the internal reference resistors calculated from the two connected input values:

Calculated resistor	
New maximum resistor value :	360.0180
New minimum resistor value :	49.9975
< ESC > aborts, Press < ENTER > to accept	

5. Press <ENTER> when the reading is stable ($\pm 0.0005 \Omega$).
6. Confirm the taken sample by pressing <ENTER> again. If the taken sample is at the limit of the stability criteria press <ESC> to make a new.
7. When the calibration is finished the software downloads the new reference resistor values to the DTI which will take about 1 second.
8. Check the reading of the connected references in measure menu or the display. The values must not differ more than $\pm 0.001 \Omega$ for the calibration to be accepted.

9.4 Calibration of analog out (DTI 1000 only)

Use following procedure for recalibration of the two analog outputs:

1. Select the menu analog out.
2. Enter the date format as YYMMDD.
3. Connect the voltmeter to channel 1 as shown in the figure section 5.2.2. Read the voltage and enter the measured value for channel 1.
4. Connect the voltmeter to channel 2 as shown in the figure section 5.2.2. Read the voltage and enter the measured value for channel 2.

Lowest possible voltages		
Enter - Analog output channel 1 :	-0.6	Volt
Enter - Analog output channel 2 :	-0.6	Volt
< ESC > aborts		

5. Connect the voltmeter to channel 1 again, and enter the measured signal for channel 1.
6. Connect the voltmeter to channel 2 again, and enter the measured signal for channel 2.

Highest possible voltages		
Enter - Analog output channel 1 :	3.6	Volt
Enter - Analog output channel 2 :	3.6	Volt
< ESC > aborts		

7. Enter the analog output scaling (Default: 5mV/°C, 0V=0°C).

Analog fixpoints		
Gain	: 5	mV/°C
Offset	: 0	°C
< ESC > aborts		

8. Accept the calculated output scaling factors shown on the screen.

Analog data		
Output 1 factor X'	:	4.876
Output 2 factor X'	:	4.876
Output 1 factor Y'	:	585.142
Output 2 factor Y'	:	585.142
Gain in mV/°C	:	5.000
Offset in °C	:	0.000
< ESC > aborts		
< Enter > to continue		

9. When the calibration is finished the software downloads the new scaling factors for the analog outputs to the DTI which will take about 1 second.