BlowerDoor GmbH
MessSysteme für Luftdichtheit

BlowerDoor GmbH
MessSysteme für Luftdichtheit
www.blowerdoor.de

🔴TEC

| A | | B |

Outside | Inside

Tarpaulin

Orifice Plate

Window

$V_{Orifice}$

$\Delta p_{Orifice}$

$\Delta p_{Window/Door}$

Δp_{Room}

BlowerDoor Fan

Window and Door Measurement System

Air permeability test of windows, doors, and building components

Table of Contents

1   Introduction

1.1   Air permeability test of windows and doors

This method allows to determine the air permeability of building components – especially windows and doors. For this test, the BlowerDoor Standard or BlowerDoor MiniFan System and a laptop computer are needed.

The test is carried out in the building where the building component is located. It is an on-site check. The air permeability of opening joints of windows and doors is defined, for example, according to "classes" in the European regulation EN 12207:2016, and it is possible to compare the results with the classifications defined by it.
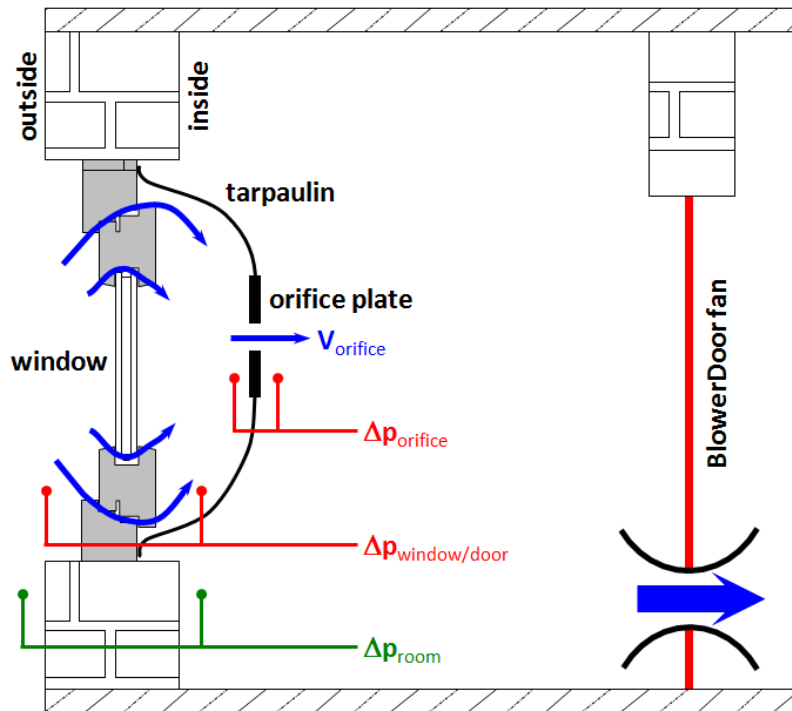
Fig. 1.1: Principle for the determination of the air permeability of a window/door.

1.2   The measuring principle

A tarpaulin with a defined orifice plate is fixed to the frame of a window/door to be analyzed. The BlowerDoor measuring fan is installed in the door of the room where the leaky component is located. The room is depressurized using the BlowerDoor fan. This depressurization causes a pressure difference in the hollow space between the window/door and the tarpaulin. The tarpaulin slowly bulges inward. As soon as the hollow space is filled with air, the measurement can be started (Fig. 1.1).

The airflow entering through the window/door joints is measured by means of a thin plate with a round orifice (defined diameter and sharp-edged) and the pressure difference between both sides of it ($\Delta p_{\text{Orifice}}$). To be able to evaluate the permeability of the joints, the corresponding pressure difference between both sides of the window/door is also measured ($\Delta p_{\text{Window/Door}}$).

For safety reasons, it makes sense to limit the pressure difference to 150 Pascal between the room and outside (Δp_{Room}).

2   Set-up and Procedure of a Measurement

2.1   Installing the BlowerDoor System

Fig. 2.1

The BlowerDoor System is installed into a door in the same room where the leaky window/door is located (see manual of BlowerDoor Standard or BlowerDoor MiniFan system).

Take care that the mounting frame is installed properly, so that the frame can resist higher pressure differences. You can test the stability of the frame by pulling on the cross bars. If the frame moves, tighten it further.

The flow rings point inward, the BlowerDoor System creates a negative pressure difference in the room.

The connection between laptop and pressure gauge DG-1000 or DG-700 (optionally with TEC WiFi Link) can be made via cable or WiFi.

2.2   Leakage detection

Fig. 2.2

Before fixing the tarpaulin, we recommend checking the component joints with a thermal anemometer at a pressure difference of 50 Pa between the room and outside (Δp_{Room}), in order to detect possible leakages and to obtain an idea of their size. After some experience, it becomes easier for the technician to choose the orifice plate with the appropriate diameter.

2.3   Attaching the tarpaulin on the component frame

To determine air permeability through building components, a tarpaulin is fixed on the window/door frame with adhesive tape.

It is important to fix the tarpaulin carefully and ensure that no unwanted leaks occur.

Fig. 2.3

2.4   Attaching the orifice plate and capillary tube to the tarpaulin
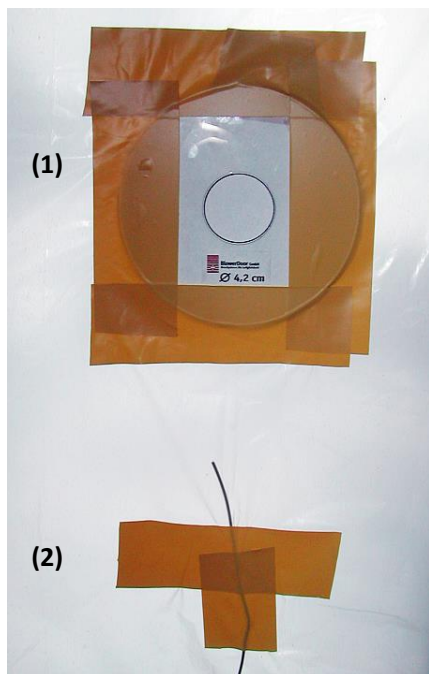
(1) An opening, slightly smaller than the outside of the orifice plate, is cut in the tarpaulin and the orifice plate selected by the technician is carefully attached to this opening with adhesive tape.

Start with an orifice plate with a larger opening, in order to prevent that the tarpaulin will rip off by a high pressure difference. Take a smaller opening if there is no pressure difference at the orifice plate.

(2) A section of a capillary tube (see figure (3)) is inserted through the tarpaulin, and the opening created is carefully sealed with adhesive tape.

In both steps, be sure that no leakages remain.

Fig. 2.4

(3) The other end of the capillary tube is connected to the pressure control device DG-700 by a hose.

Fig. 2.5

2.5 Attaching hoses to the pressure gauge

2.5.1 Attaching hoses to the pressure gauge DG-1000
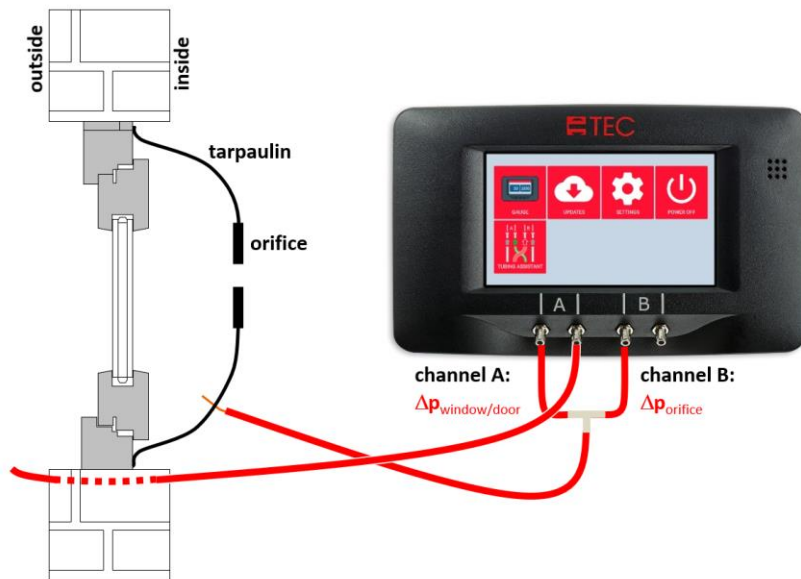
Fig. 2.6: DG-1000 hoses connections for the window and door test.

2.5.2   Attaching hoses to the pressure gauge DG-700
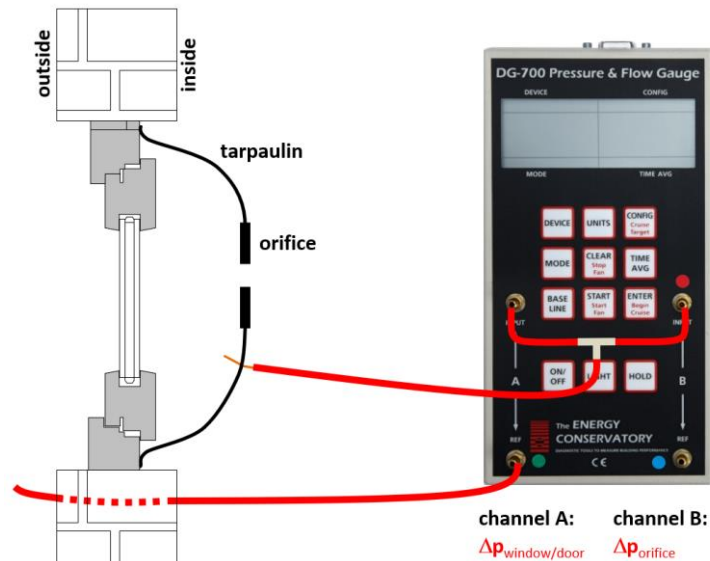
Fig. 2.7: DG-700 hoses connections for the window and door test.

2.5.3   Overview hoses connections

Channel A: → Δp Window/Door		Channel B: → Δp Orifice	
DG-1000: |A| left **DG-700:** A INPUT	The hose of the input pressure tap ends in the hollow space between the tarpaulin and the window/door.	**DG-1000** |B| left **DG-700:** B INPUT	The hose of the input pressure tap ends in the hollow space between the tarpaulin and the window/door.
DG-1000: |A| right **DG-700:** A REF (reference)	The hose of the reference pressure tap ends **outside near the leaky window**. This hose is threaded through a neighboring window or an exterior door of the house.	**DG-1000** |B| right **DG-700:** B REF (reference)	The reference pressure tap is left open.

Table 1: Hose connections for the window and door test.

2.6   Data Logging with TECLOG
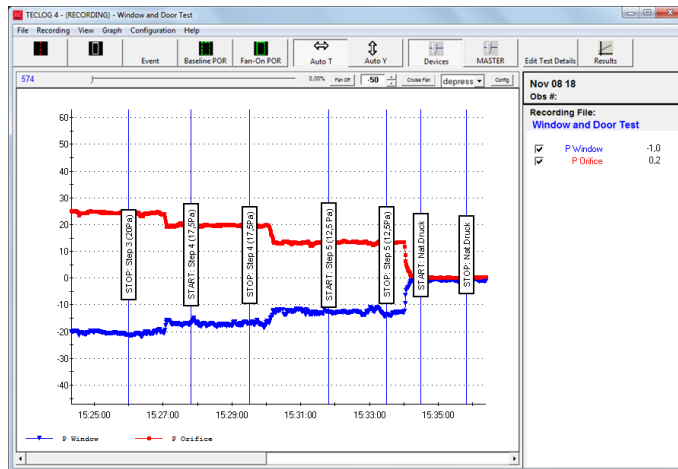
Fig. 2.8

The recording of the pressure differences ($\Delta p_{Orifice}$ and $\Delta p_{Window/Door}$) is done with the TECLOG4 software.

Each target pressure difference is achieved by slowly turning the knob on the fan speed controller to the right. Depending on the air permeability of the window/door, it takes some time for the pressure to become constant. This can be recognized when the two lines of the graph, $\Delta p_{Orifice}$ and $\Delta p_{Window/Door}$, become parallel to the x-axis and remain constant.

We recommend measuring each target pressure for at least 30 seconds.

2.7   Test Report with Excel Worksheet

Report On-Site Test
Air Permeability of Windows and Doors

BlowerDoor GmbH
Messsysteme für Luftdichtheit

| Object: | Window in kitchen |
| Test Date: | 08.03.2011 |

Boundary Conditions

Temperature Inside:	20	°C
Temperature Outside:	14	°C
Standard Temperature:	20	°C
Size of Window/Door:	2,00	m²
Length of Opening Joint:	4,00	m

Class of the Air Permeability for Window/Door

Class of Window/Door:
Class 2   EN 12207:2016

Measurement

	Input Data		Results		
Orifice Ø (cm)	Δp Window/Door (Pa)	Δp Orifice (Pa)	Δp Window/Door Baseline corrected (Pa)	Measured Airflow per m² of overall Area (m³/hm²)	Measured Airflow per m of Length of Opening Joints (m³/hm)
Baseline Pressure	1,00	-	-	-	-
3,00	-48,50	41,00	49,50	6,27	3,14
3,00	-44,80	37,00	45,80	5,96	2,98
3,00	-38,00	30,00	39,00	5,37	2,68
3,00	-30,40	23,00	31,40	4,70	2,35
3,00	-22,50	16,00	23,50	3,92	1,96
3,00	-16,30	11,00	17,30	3,25	1,62

Air Permeability related to overall Area of the Window/Door

Upper Limit of Class 2	
Pressure Difference at Window/Door Pa	max Q allowed per m² (Class 2) m³/(hm²)
100	27,0
75	22,3
50	17,0
25	10,7
10	5,8

Air Permeability related to overall Area chart — Pressure Difference at Window / Door (Pa). Legend: ● Measured airflow per m² of overall area; — max Q allowed per m² (Class 2)

Air Permeability related to the Length of Opening Joint of the Window/Door

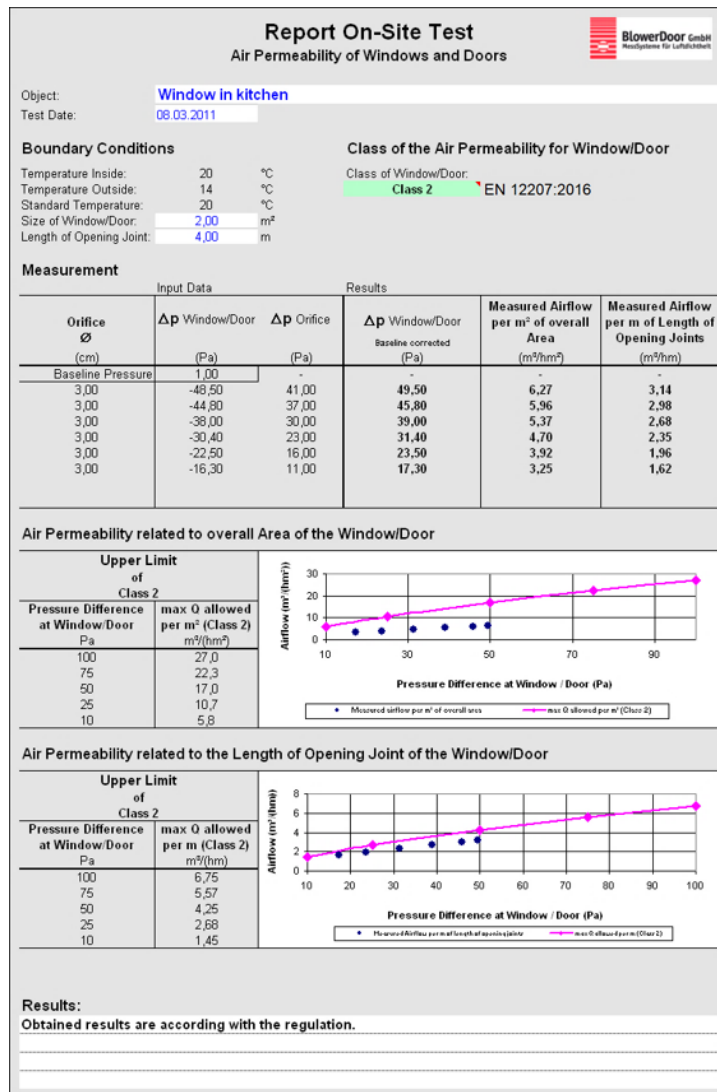| Upper Limit of Class 2	
Pressure Difference at Window/Door Pa	max Q allowed per m (Class 2) m³/(hm)
100	6,75
75	5,57
50	4,25
25	2,68
10	1,45

Air Permeability related to the Length of Opening Joint chart — Pressure Difference at Window / Door (Pa). Legend: ● Measured Airflow per m of length of opening joint; — max Q allowed per m (Class 2)

Results:
Obtained results are according with the regulation.

Fig. 2.9

After the test is completed, the averages of each pressure step are taken from TECLOG4 and inserted manually into the Excel sheet for evaluation. With the help of the menu button *REGION SELECT TOOL* in TECLOG4, the main average values from each pressure step can be obtained.

The Excel report allows the comparison of the tested window/ door to the EN 12207:2016 classification.

3   Test Conditions, Pressure Limits and Suggestions

3.1   Weather conditions

As the measured air flows are usually small, we recommend conducting the test when there is no or very little wind in order to achieve good accuracy in the results.

3.2   Suggestions for the measuring procedure and data recording

3.2.1   Data display and recording with TECLOG

In order to be able to conduct the window and door test, it is recommended to record the data with TECLOG4 software. With help of the data logger program, the measured data are displayed graphically and digitally. At the same time, TECLOG4 saves the entire measuring process in a file. This makes it possible to control the pressure difference profiles during the measurement and relevant periods of record can be selected for the evaluation.

By recording the measuring process, the measurement can also be completely retraced later and, if necessary, used as evidence for the client.

3.2.2   Measuring procedure

The measuring procedure of the window/door consists of recording the natural pressure difference (baseline) and at least 5 pressure stages generated by the BlowerDoor. If necessary, for example when there is wind, a second baseline at the end of the test could be taken.

1.   Recording of natural pressure difference (baseline)

A natural pressure difference at the window/door can be caused by wind. The baseline is taken when the BlowerDoor System is turned off and the orifice is sealed with tape. We recommend starting the test by measuring the baseline over a period of at least 30 seconds. In unfavorable conditions (e.g. wind), this period can be extended as needed.

If there is no wind, the baseline pressure should be zero with the orifice sealed.

2.   Pressure steps: number, length, and space between them

After removing the tape from the hole of the orifice plate, each target pressure difference at the window/door is achieved by slowly turning the knob on the fan speed controller to the right. Depending on the air permeability of the window/door, it takes time to achieve a constant pressure difference at the window/door. For very airtight windows/doors, this phase will take longer than it will for leaky windows/doors. A constant pressure is reached when in the TECLOG diagram both graphs are parallel to the x-axis and remain stable. This point should be marked as the start of this period (e.g. "start period 1"). We recommend measuring each pressure stage for at least 30 seconds. In unfavorable conditions (e.g. wind), this period can be extended as needed. Before adjusting the next target pressure, mark the end of this period (e. g. "end period 1").

We recommend measuring at least five pressures stages with a pressure step size of 5 to 10 Pa. If this is impossible due to very leaky window/door joints and the provided tape could potentially separate from the frame, reduce the step size to 2 or 3 Pa.

3.3   Minimum and maximum pressure values

3.3.1   ⚠ Maximum room pressure difference in the room Δp_{Room}

For safety reasons, we recommend making sure that the pressure difference between the room and outside (Δp_{Room}) is not greater than 150 Pa.

Δp_{Room} is obtained from the sum of $\Delta p_{Orifice}$ and $\Delta p_{Window/Door}$.

$$\Delta p_{Room} = |\Delta p_{Orifice}| + |\Delta p_{Window/Door}| < 150 \text{ Pa}$$

3.3.2   Minimum and maximum pressure difference at the window/door: $\Delta p_{\text{Window/Door}}$

The window and door test should start with a pressure difference of approx. 10 Pa at the tested window/door.

$$|\Delta p_{\text{Window/Door}}| \geq 10 \text{ Pa}$$

The highest pressure values should be at least approx. 50 Pa, similar to the air tightness tests of buildings (EN 13829), however, it is possible to achieve higher values if the tape and the tarpaulin are strong enough and the pressure difference between the room and outside does not exceed 150 Pa.

3.3.3   Minimum and maximum pressure difference at the orifice plate: $\Delta p_{\text{Orifice}}$

The minimum pressure difference at the orifice must be at least 3 Pa.

$$|\Delta p_{\text{Orifice}}| \geq 3 \text{ Pa}$$

If it is not possible to reach this value with the selected orifice plate, use an orifice with a smaller opening.

With a pressure value on the orifice plate from approx. 15 to 20 Pa, the tape included in the provided measurement equipment starts to separate from the window/door frame. It is possible to achieve higher values if the technician uses a stronger adhesive tape, but other materials must be used with extreme caution, as these could damage the frame of the window/door (e.g. the paint).

3.4   Orifice plate change

The package provided contains specially manufactured orifice plates with various predefined diameters that can be attached to the tarpaulin. For larger airflows, it is also possible to fix ring E or D from the Minneapolis BlowerDoor fan instead of the orifice plate on the tarpaulin.

In some cases, it could be necessary to exchange the installed orifice plate for another with a larger or smaller diameter. We suggest this under the following conditions:

3.4.1   Exchange the orifice plate for a smaller one: Ø → ∅

Use an orifice plate with a smaller diameter if the pressure difference at the window/door is larger than approx. 10 Pascal and the pressure difference at the orifice plate is less than 3 Pascal.

> **If |$\Delta p_{\text{Window/Door}}$| > 10 Pa and |$\Delta p_{\text{Orifice}}$| < 3 Pa**
> → Use an orifice plate with a smaller diameter

3.4.2   Exchange the orifice plate for a bigger one: ∅ → Ø

Use an orifice plate with a larger diameter if the pressure difference at the window/door is less than approx. 10 Pascal and the pressure difference at the orifice plate is larger than approx. 20 Pascal.

> **If |$\Delta p_{\text{Window/Door}}$| > 10 Pa and |$\Delta p_{\text{Orifice}}$| > 20 Pa**
> → Use an orifice plate with a larger diameter

4   TECLOG Software

TECLOG software is a data logging program designed to display and record data from the differential pressure channels of the BlowerDoor measuring devices DG-1000 or DG-700. Measurement data can be tracked live on the computer, events can be marked and average values of selected measurement periods can be displayed. Parallel to the display, the data is saved in a file.

4.1   System requirements

Computer

The computer/notebook/laptop must meet the following requirements:

- Pentium 233-MHZ processor
- 512 MB RAM
- USB port, Ethernet port or WiFi (if measuring with DG-1000) as well as an Internet connection for USB port driver installation of DG-1000
- USB or RS232 port or WLAN port (if measuring with DG-700)
- The connected computer must comply with IEC 60950-1 or equivalent standards on data port electrical safety isolation.

Operating system

TECLOG4 and drivers run on computers, notebooks, or laptops with the full version of the following operating systems:

- Windows 7
- Windows 8
- Windows 10

For the test report:

- Microsoft Excel version 2007 or newer.

4.2   Installing TECLOG software

- Older versions of TECLOG must be uninstalled before installing TECLOG 4.

- Before installing TECLOG4 software, close all other programs including the virus scanner on your computer.

- Start the installation by double-clicking on the installation file **TECLOG4version.exe** and follow the installation instructions.

Unless you choose a different directory, **TECLOG4** is archived as follows:
C:/Programme/Energy Conservatory/TECLOG4

4.3   Opening TECLOG software

TECLOG4
Fig. 4.1

To start TECLOG4 use the icon on your desktop, or use the Windows interface as follows:
→ *START* → *PROGRAMS/APPS* → *ENERGY CONSERVATORY* → *TECLOG4*

4.4   Configuring default settings

Before using TECLOG4 the specific country settings have to be defined and saved as default settings.
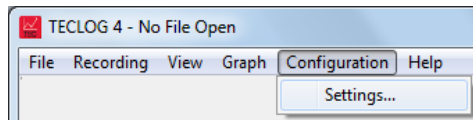
Fig. 4.2: Menu in TECLOG4

After opening TECLOG4, the start page can be seen (Setup Mode/Inactive Mode). Open *CONFIGURATION SETTINGS* window:

Menu: → *CONFIGURATION* → *SETTINGS*

In the *CONFIGURATION SETTINGS* window, the desired settings can be made in the bottom at the right:

Fig. 4.3: Loading default settings (Europe)

Click on the *RESTORE FACTORY SETTINGS (EUROPE)* button, activate the check box in front of *SAVE AS DEFAULT CONFIGURATION* by setting the check mark. Confirm all settings with *OK*.

This configuration will be loaded each time you open TECLOG4.

5   Setting up TECLOG Software and Performing the Test

When using TECLOG4 to record the measured data from a window and door test, the following steps are necessary to work with the software:

1. Activating measuring device and configurating channel settings (see section 5.1)

2. Start recording (see section 5.2)

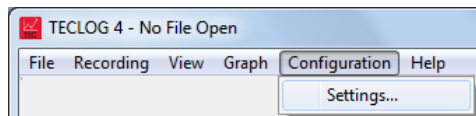## 5.1   Registering and setting up measuring device

Fig. 5.1

To register the measuring device (DG-1000 or DG-700) and configuring the differential pressure channels, open the Configuration Settings window:

→ *CONFIGURATION* → *SETTINGS*.
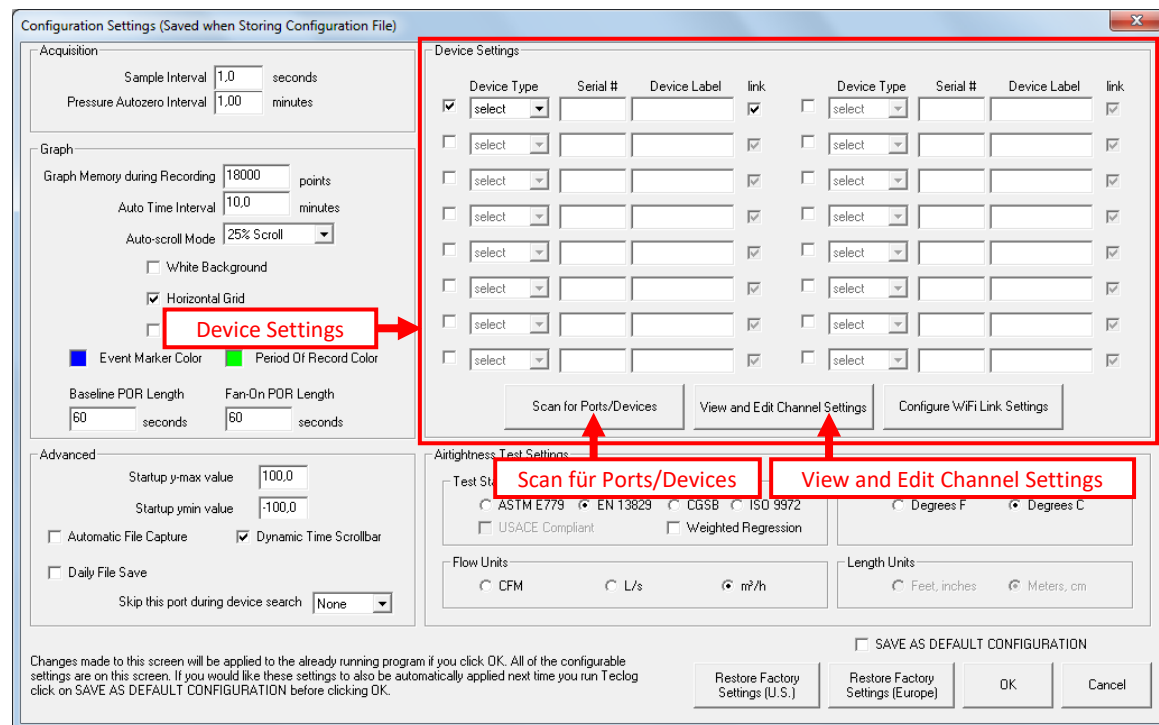
Fig. 5.2: Configuration Settings window

There are three steps to activate the measuring device and to configure the differential pressure channels:

1. Use the *SCAN FOR PORTS/DEVICES* button to check whether TECLOG4 detects the device.

2. In the group field *DEVICE SETTINGS*, enter and activate the device.

3. *VIEW AND EDIT CHANNEL SETTINGS* leads you to the window *CHANNEL SETTINGS*, where you can configure the differential pressure channels.

5.1.1   Activating the measuring devices

To activate the measuring device in TECLOG4**,** the DG-1000 or DG-700 must be connected to the computer and switched on.

After starting TECLOG4, open the *CONFIGURATION SETTINGS* window in the program's Inactive Mode:
→ *CONFIGURATION* → *SETTINGS*

1.   Testing the connection of the measuring devices with TECLOG
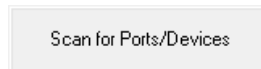
After clicking the *SCAN FOR PORTS/DEVICES* button, all ports of the computer are scanned for connected measuring devices.

Fig. 5.3

If the computer has an internal modem, the message *SKIP THIS PORT?* will be displayed.

Confirm by clicking *YES*. The modem will no longer be considered in device searches.
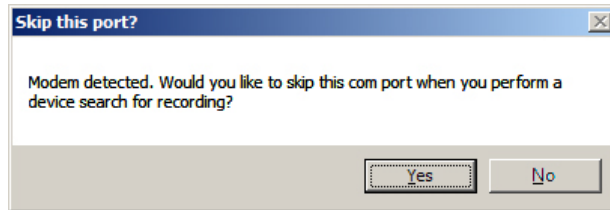
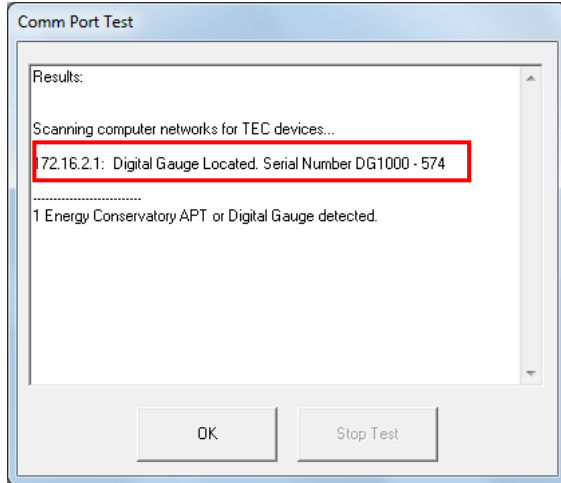*Fig. 5.4: Message window Skip this port?*

After the scan, properly connected devices are displayed in the *COMM PORT TEST* window.

They are listed with the assigned COM port number (if using a DG-700 via USB) or the network number (if a DG-1000 is connected or a DG-700 via WiFi), the measuring device type and the serial number.

Exit the window by clicking on *OK*.

Fig. 5.5: Comm Port Test

If a measuring device do not appear in the list, check the following:

- Is the device switched on?
- Is the measuring device connected to the computer?
- Is a COM-port configured for DG-700 in the Windows Device Manager?
- Are the drivers (e.g. for the DG-700 or USB/serial-adapter) installed correctly?
- If the Bluetooth function of your laptop is active, it must be switched of.
- Check all and then repeat the scan by clicking on the *SCAN FOR PORTS / DEVICES* button.

2.   Entering device information

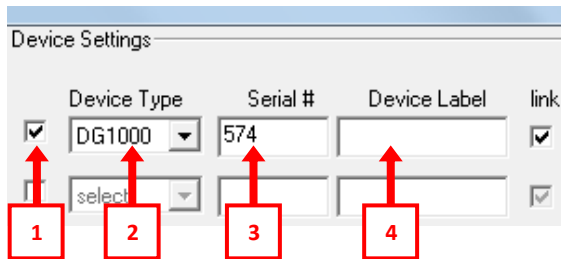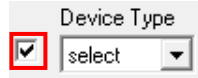All connected measuring devices are activated in the group field *DEVICE SETTINGS*.

1. Activate the measuring device.
2. Select the device type (DG-1000 or DG-700).
3. Enter the serial number of the device.
4. Optional: Enter a label for the device.

Fig. 5.6

**1) Activating measuring devices** _____ **Input required**

Fig. 5.7

Marking the checkbox in front of *DEVICE TYPE* activates the measuring device for the test. If the checkbox is not marked, TECLOG4 will not use the device.

2) Selecting Device type and
**3) input of Serial number** _____ **Input required**
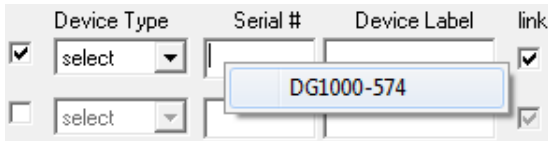
Fig. 5.8

When double-clicking on input field *SERIAL #*, a list of all the devices currently connected to the laptop and have been detected by the software will be displayed in a list so that the one you want can be selected.

Fig. 5.9
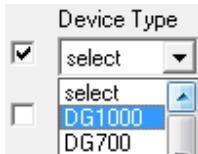
Alternatively, select the type of measuring device connected (e.g. DG-1000) in the drop-down menu *DEVICE TYPE*.
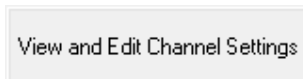

Fig. 5.10
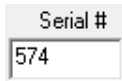
In the input field Serial #, enter the serial number of the activated measuring device.

The number is located on the back of the device and is displayed after the *SCAN FOR PORTS/DEVICES*.

5.1.2   Configuring the differential pressure channels

The differential pressure channels of the measuring devices are configured in the window *CHANNEL SETTINGS*.

Fig. 5.11

Access the Channel Settings window by clicking on the button *VIEW AND EDIT CHANNEL SETTINGS* in the window Configuration Settings.
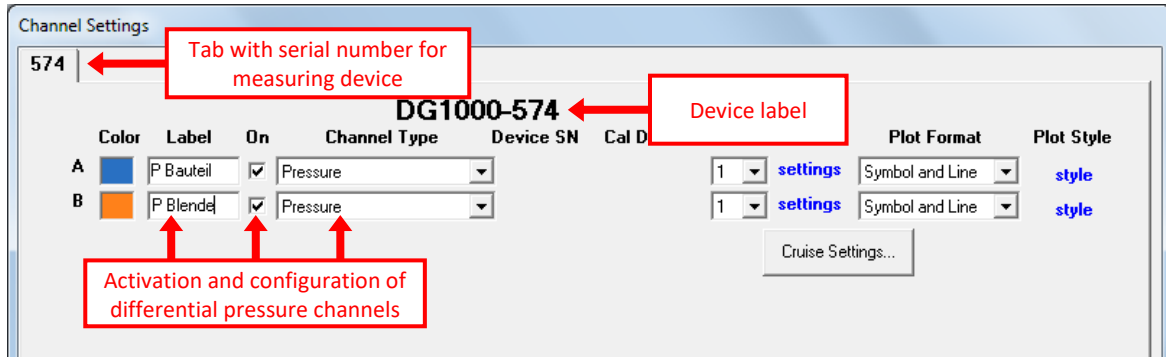
Fig. 5.12

TECLOG4 creates a separate tab for each connected measuring device. The serial number of the measuring device (e.g. DG-1000or DG-700) constitutes the tab name.

In each tab (= connected measuring device):

1.   Activate the differential pressure channels required for the measurement.

2.   Allocate the channels

1) Activating the differential pressure channel _____ **Input required**

Fig. 5.13

Activate the differential pressure channel of the measuring device by setting a check mark in the checkbox *ON*. The measured values of this channel are then recorded. If the checkbox is not marked, the measured values will not be recorded.

2) Selecting the type of differential pressure channel _____ **Input required**

Fig. 5.14

In the drop-down menu *CHANNEL TYPE*, select the channel.

3) Labeling the differential pressure channel _____ **Input useful**

Fig. 5.15

In the *LABEL* box, enter a distinct label for each channel.

To measure the air permeability of a window/door:

- **Channel A** is used to record the pressure difference of the window/door ($\Delta p_{\text{Window/Door}}$), which can be entered with an appropriate text in the *LABEL* field (e.g. P Window). The channel is activated by a check mark in the checkbox *ON*. In the Channel Type drop-down menu, select *PRESSURE*.

- **Channel B** is used to record the pressure difference at the orifice plate ($\Delta p_{\text{Orifice}}$), which can be entered with an appropriate text in the *LABEL* field (e.g. P Orifice). The channel is activated by a check mark in the checkbox *ON*. In the Channel Type drop-down menu, select *PRESSURE*.

Next, exit the *CHANNEL SETTINGS* window by clicking *OK*. Then exit the *CONFIGURATION SETTINGS* window by clicking *OK*. This will return you to the TECLOG4 home page.

5.2   Data recording with TECLOG4

⚠️ **Note:**

Please switch off the Bluetooth function of the laptop during the measurement with *TECLOG4*, otherwise the communication between *TECLOG4* and measuring device can be interrupted.

5.2.1   Start recording

After configuring the settings and closing the *CONFIGURATION SETTINGS* window, TECLOG4 will show the start window
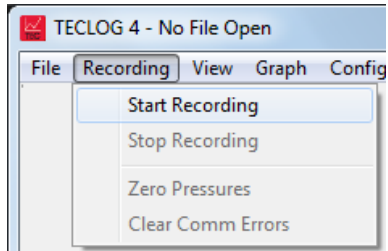
Fig. 5.16

Fig. 5.17

Start the measurement:

→ *RECORDING* → *START RECORDING*

Fig. 5.18

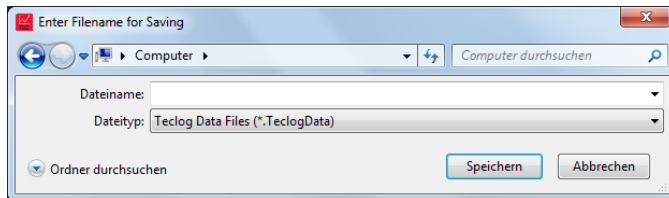TECLOG4 first scans all ports and connected devices (e.g. DG-1000, DG-700).

Fig. 5.19

Enter a file name in the window *ENTER FILENAME FOR SAVING*.

Once you start recording, all measured values are written into this file. The file is automatically assigned the ending *.TECLOGDATA*.

5.2.2   Recording a test

The measuring procedure consists of a period of natural pressure difference (baseline pressure) and at least 5 stages of pressure differences generated by the BlowerDoor system at the window/door. If necessary (e.g. in case of wind) a second natural pressure difference after the test can be measured.

5.2.2.1   Baseline pressure (natural pressure difference) before the test

First, it is necessary to measure a baseline pressure before the test, i.e. a pressure stage under natural pressure conditions. Before marking the start of baseline pressure period in the TECLOG4 diagram, do the following:

1.   Set the speed controller to **Off**

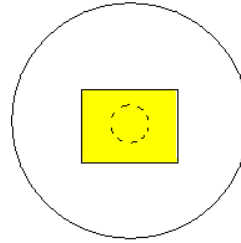2.   Cover the orifice plate with tape

Fig. 5.20

Fig. 5.21

Then mark the start time in the TECLOG4 diagram. Use the event marker *Event* from the TECLOG4 toolbar in order to mark the start time of the baseline pressure period (see point 1).

From the marked start time, record the baseline pressure for at least 30 seconds. In unfavorable conditions (e.g. in case of wind), this measurement period can be extended as needed. After at least 30 seconds, mark the end of this period with the *Event* marker (see point 2).
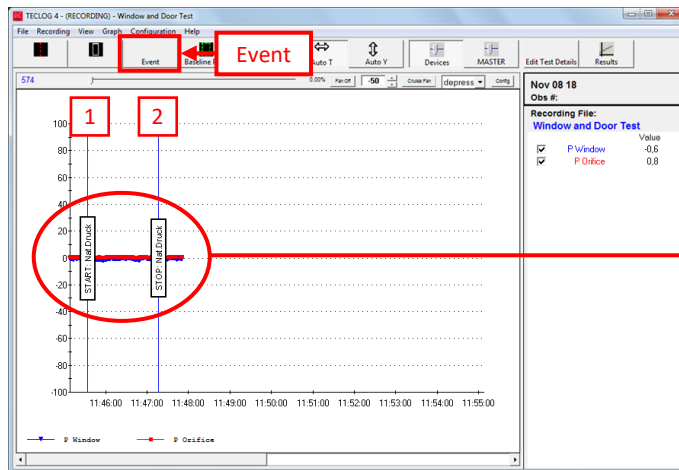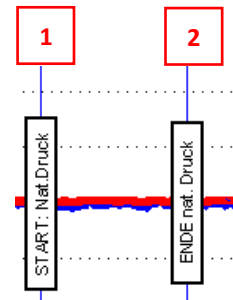

Fig. 5.22

5.2.2.2   Recording pressure steps

After measuring the baseline, begin recording the pressure stages. Before starting the pressure stages:

1. Set the speed controller to **On**

Fig. 5.23

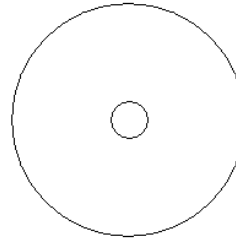2. Remove the tape from the orifice plate

Fig. 5.24

Each pressure stage is achieved by slowly turning the Speed Controller knob to the right.

Fig. 5.25

> ⚠️ **The tighter the joints are, the longer (sometimes minutes) it will take until a constant and stable pressure difference is established at the component.**
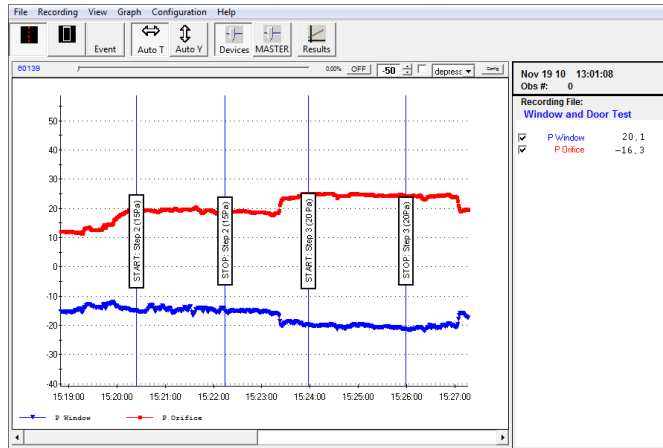
Fig. 5.26

In the TECLOG4 diagram, a stable pressure difference is detected when the graphs of the pressure differences at the window/door and at the orifice plate are parallel to the horizontal x-axis.

Mark the start time and take a period of record for this pressure stage of at least 30 seconds.

In unfavorable conditions (e.g. wind), this period of record can be extended as needed.
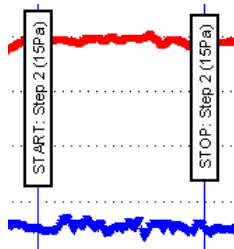

Fig. 5.27

The start and end point of each period of record for a pressure stage should be marked and named using the *EVENT* marker. The start marker is set as soon as the Δp Window/Door and Δp Orifice are parallel to the x-axis and can be marked with the target pressure stage (e.g. "START 15 Pa").

A period of record for a stable pressure stage should be at least 30 seconds. The end of this period of record is also marked with the *EVENT* button (e.g. "STOP 15 Pa").

Repeat this step at least 5 times with different pressure stages at the window/door (e.g. 10 Pa, 20 Pa, 30 Pa, 40 Pa, 50 Pa). More pressure stages increase the accuracy of the measurement.

5.2.2.3   Baseline pressure (natural pressure difference) after the test

Sometimes it can be necessary (e.g. in case of wind) to measure the baseline pressure after the test as well. Before marking the start of this period of record, wait until the hollow space between tarpaulin and window/door is no longer artificially pressurized. After switching off the BlowerDoor blower, it may take some time for the air to escape from the hollow space between tarpaulin and window/door. If there is no wind, the baseline pressure should be zero.

Before marking the start of the baseline pressure, do the following:

1. Set the speed controller to **Off**

Fig. 5.28

Fig. 5.30

Fig. 5.31

2. Cover the orifice plate with tape. (Wait until the test setup has no artificial pressure).

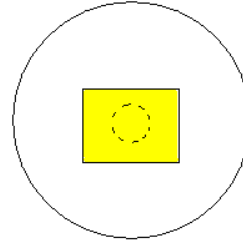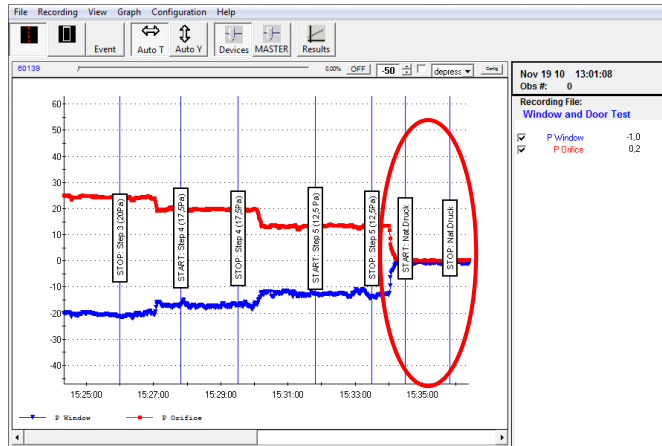*Fig. 5.29*

The period of record of the baseline pressure after the test should be at least 30 seconds.

Mark the start and the end point as shown before.

In unfavorable conditions (e.g. wind), this period can be extended as needed.
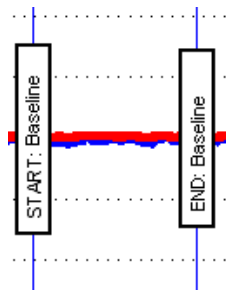
Mark the start and end points of the baseline pressure period with labels.
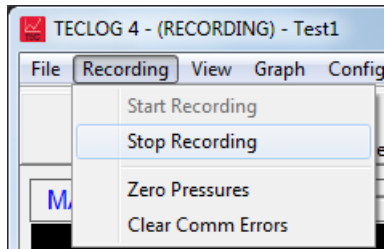
5.2.3   Stop recording

Fig. 5.32

After finishing the test, stop the data recording mode:
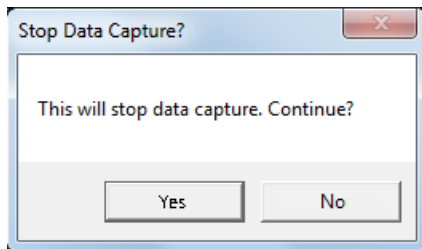
→ *RECORDING* → *STOP RECORDING*

Fig. 5.33

The message box *STOP DATA CAPTURE?* will open.

To end the measurement, click *YES*.

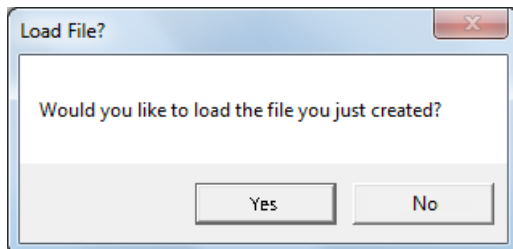To continue the measurement, click *NO*.

Fig. 5.34

The message box *LOAD FILE?* then asks if you would like to open the file you just created.

To display the measurement, click *YES*.

If you do not want to display the measurement, click *NO*.

5.2.4   Displaying the test result in TECLOG4

Upon ending the measurement, the file containing the measurement results can be displayed in the File View Mode.
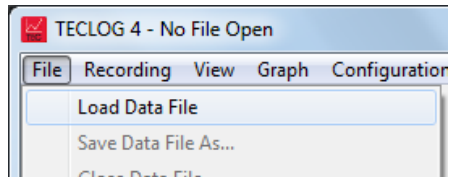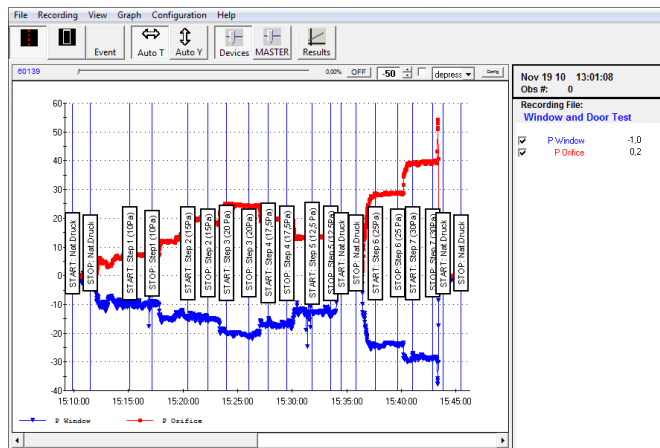

Open the file with:
→ *FILE* → *LOAD DATA FILE*

In the screen that appears, select the file you would like to open.

Fig. 5.35

The measurement is displayed in the TECLOG4 File View Mode.

Fig. 5.36

5.2.5   Statistical summary for a selected portion (period of record)

In order to create a test report (e.g. with the Excel test report from the software CD), it is necessary to obtain the averages of each period of record for the pressure stage and the baseline pressure from the TECLOG4 diagram. In both *FILE VIEW MODE* and *DATA RECORDING MODE*, the user can view summary statistics for a selected portion of the graph. First choose a period of record in the TECLOG4 diagram.

With the left mouse button, click on the *REGION SELECT TOOL* button in the toolbar.

Fig. 5.37

Fig. 5.38

In the diagram, draw up a field with the **left mouse button**. Mark one period of record from the "Start Point" to the "End Point".

With the **right mouse button**, click into the marked field.
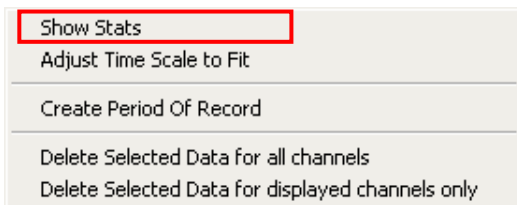
Fig. 5.39

In the context menu that appears, click *SHOW STATS.*

Fig. 5.40

These steps are repeated for all pressure levels.
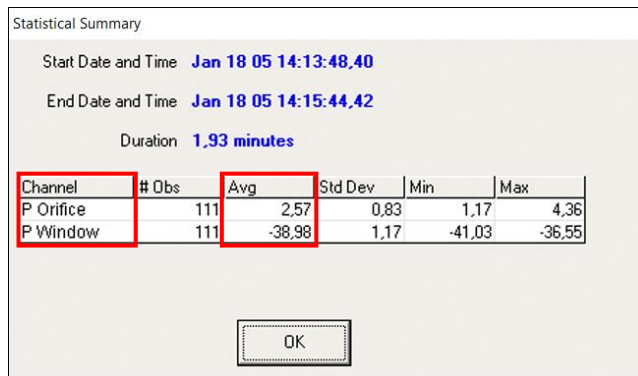
A statistical summary window will appear showing the number of observations, **the average**, the standard deviation of the observations, and the minimum and maximum values within the selected area.

Take the average of the window/door pressure and the average of the orifice pressure and insert these values in the Excel test report.

6   Test Report

A test report can be created with the Excel sheet *REPORT_WINDOW_MEASUREMENT_VERSION.XLT*.

6.1   Input in protocol

Data input for the measurement:
Text can only be entered into the white input fields.
The grey fields contain formulas and are thus write-protected.

Test Object and Customer Information

Fig. 6.1

- **Test Object:**   Data input for the tested window/door.
- **Customer Information:** Customer data input.

Climatic data (temperature, barometric pressure):

Fig. 6.2

- **Temperature Inside:**   Air temperature near the orifice is measured and entered here.
- **Temperature Outside:** Temperature outside the window/door.

- **Barometric Pressure:**   A standard barometric air pressure of 101325 Pascal is set.

Orifice Plate:

- **Air Resistance Value c_d:** This coefficient changes as a function of the shape of the orifice (sharp-edged, rounded). For the enclosed orifice plates, a value of 0,61 (0.61) is set.

Measurement (Test):

Orifice Diameter (cm)	Orifice Area (A_0) (cm²)	Δp Window/Door (Pa)	Δp Orifice (Pa)		Airflow through Orifice (m³/h)	Tolerance (%)	Airflow through Window/Door [m³/h]
———	Baseline Δp =>	1,00	———		———	———	———
3,00	7,07	-48,50	41,00		12,81	0,35	12,55
3,00	7,07	-44,80	37,00		12,17	0,07	11,92
3,00	7,07	-38,00	30,00		10,96	-0,38	10,73
3,00	7,07	-30,40	23,00		9,59	-0,12	9,40
3,00	7,07	-22,50	16,00		8,00	-0,16	7,84
3,00	7,07	-16,30	11,00		6,64	0,25	6,50
———	Baseline Δp =>	1,00	———		———	———	———

Correlation Coefficient r:		1,000	Confidence Interval	
$C_{Window/Door}$ [m³/(h Pa^n)]		1,092	max 1,13	min 1,06
$C_{Standard}$ [m³/(h Pa^n)]		1,101	max 1,14	min 1,07
n	[-]	0,62	max 0,63	min 0,62

Fig. 6.3

- **HELP on/off:**   The "*Help*" button shows an outline with the representation of the pressure differences $\Delta p_{Window/Door}$ and $\Delta p_{Orifice}$.

- **Orifice Diameter:**   Enter the diameter of the orifice.

- **Orifice Area (A_O):** A_O is the area of the opening in the orifice plate. It is automatically calculated if the diameter of the orifice is entered in the "*Orifice Diameter*" field. This column is protected and cannot be overwritten.

- **Δp Window/Door**   **Input field:** Enter the pressure difference generated at the window/door.

- **Δp Orifice:**   **Input field:** Enter the pressure difference generated at the orifice plate.

- **Baseline Δp:**   **Input field:** Enter the natural pressure difference (baseline pressure) before and after the measurement.

- **Airflow through Orifice:** The current airflow is shown in these cells. The amount of airflow depends on the pressure difference measured at the orifice plate, the size of the orifice and the Air Resistance Value (c_d).

- **Tolerance:**   When recording a series of measurements, the deviation of individual data points is represented by the compensation line.

- **Airflow through Window/Door:**
                               The airflow through the orifice in the orifice plate is adjusted to the current temperatures. The result is the current airflow through the leakages of the window/door.

6.2   Results

6.2.1   Airflow and air permeability

Results		
		Total Airflow
Pressure Difference across the Window/Door (inside - outside): **50** Pascal		12,68 m³/h +/- 10 %
		Airflow through 1m Joint
Pressure Difference across the Window/Door (inside - outside): **50** Pascal		3,17 m³/(h*m) +/- 10 %
Length of Opening Joint (Window/Door): **4,00** m		

Fig. 6.4

- **Total Airflow:**   Depending on the selected pressure difference at the window/door, the total air flow through the leakages of the window/door is shown here. The result is corrected to standard conditions (20 °C and 101325 Pa).

- **Airflow through 1 m joint:** Depending on the chosen pressure difference and the joint length, the air permeability related to the joint length is shown here.
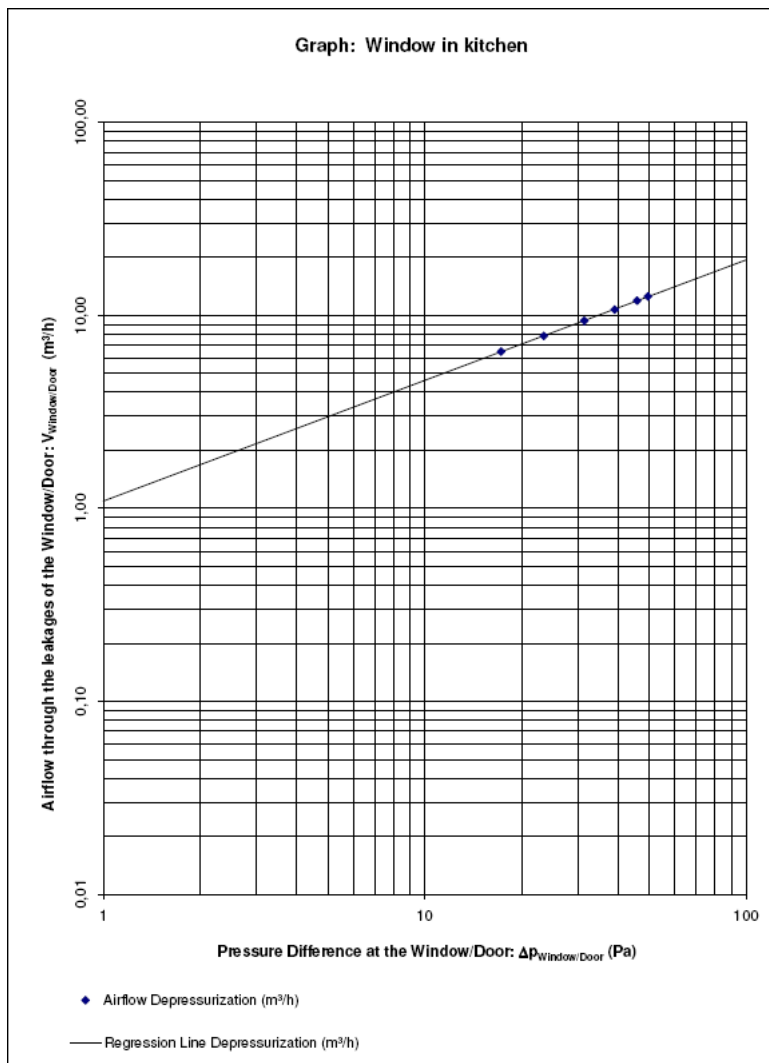
6.2.2   Graph

Fig. 6.5

The leakage curve for the window/door is represented in the worksheet graph.

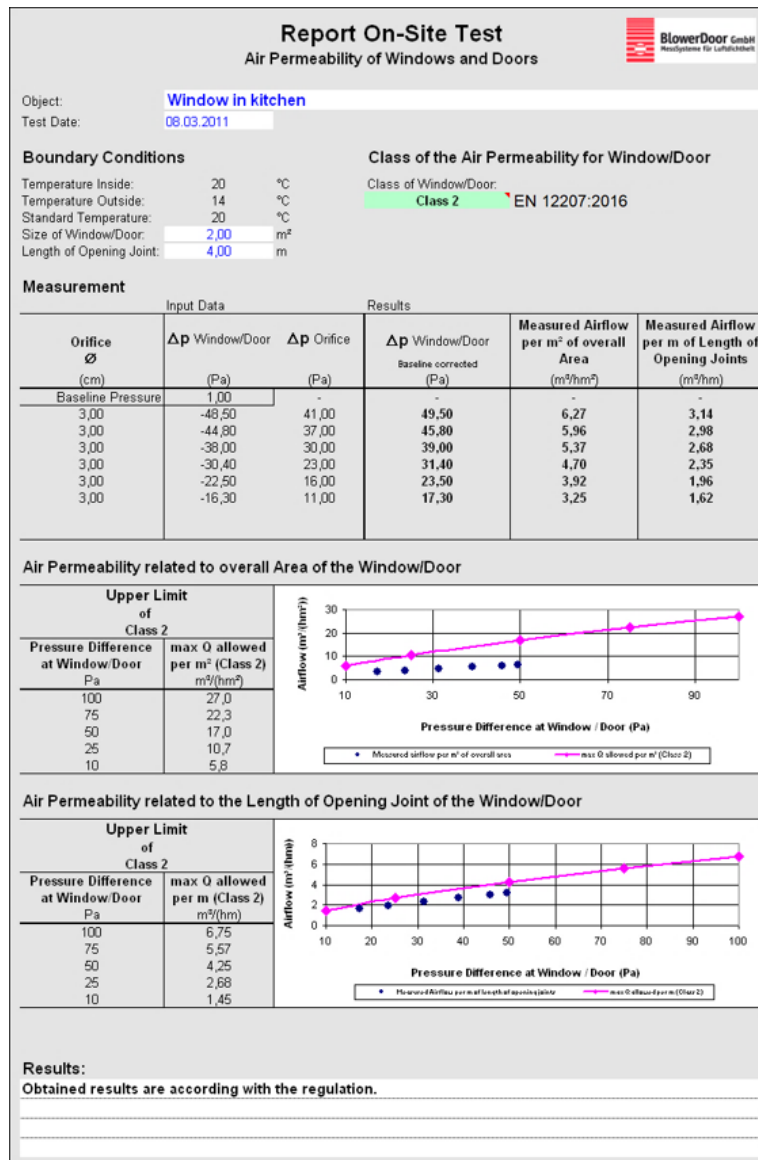### 6.2.3   On-Site test: air permeability of window/door

Fig. 6.6

By entering the size and length of the window or door joints according to EN 12207:2016, the airflow per m² area and the airflow per m of joint length are shown in the diagram.

It is possible to select a window/door class; in the diagrams, the limit of this class appears as a pink graph. Once the measurement is finished and the values from the software TECLOG4 are entered into the Excel test report (blue points), it is possible to see which class the tested window or door belongs to.

The regulation EN 12207:2016 defines four different classes, from 1 to 4. Class 1 allows a higher airflow through the window/door than does Class 4. Choose the different classes in the Excel sheet in order to determine the class to which the measured window/door belongs.

Afterwards, the class of the window/door can be compared with the regulations in your country.

7   Examples for Window Tests

Since there are no concrete parameters for selecting the ideal orifice diameter at the beginning of a window/door test, experience is a key factor. Based on the experience of BlowerDoor GmbH, four examples of window tests are presented in this chapter.

Before fixing the tarpaulin, we recommend checking the joints of the window or door with a thermal anemometer under a negative pressure difference of 50 Pa between the room and outside (Δp_{Room}), generated by the BlowerDoor-system, in order to detect possible leakages and to obtain an idea of their size.

Then the orifice plate with the selected opening is attached to the tarpaulin.

After recording the baseline pressure difference, start the measurement with a pressure difference of approx. 10 Pa at the window/door ($\Delta p_{Window/Door}$) by carefully increasing the speed of the BlowerDoor fan.

Then check if the selected orifice plate is appropriate, or if it is necessary to change it.

1. **Measurement can be started with the selected orifice plate:**
   If the pressure difference at the window/door $|\Delta p_{Window/Door}|$ is **approx. 10 Pa** and the pressure difference at the orifice plate is $|\Delta p_{Orifice}|$ **≥ 3 Pa and < 10 Pa**, the measurement can be started with the selected orifice plate.

2. **Chose an orifice plate with a larger orifice diameter:**
   The risk that the tape attaching the tarpaulin to the window/door frame will loosen is very high if the pressure difference at the orifice plate $|\Delta p_{Orifice}|$ **is between approx. 15 to 20 Pa.** So it is wise to choose an orifice plate with a bigger opening, even at pressure differences that are a bit smaller than 15 Pa.

3. **Chose an orifice plate with a smaller orifice diameter:**
   If the pressure difference at the orifice plate $|\Delta p_{Orifice}|$ is **less than 3 Pa**, the measurement is not accurate enough. Choose an orifice plate with a smaller orifice diameter.

7.1   Example 1: Very leaky window

This occurs when the joints of the window show many significant leakages, detected by hand or by the thermal anemometer at a negative pressure difference in the room at or above 50 Pa. In this case, attach the orifice plate with the largest orifice diameter to the tarpaulin.

After fixing the tarpaulin to the window frame, start the test by recording the baseline pressure. Then create the first pressure stage with the BlowerDoor fan. Increase the fan speed until a pressure difference at the window ($\Delta p_{Window/Door}$) of approx. 10 Pa is achieved.

- If the pressure difference at the orifice plate is at least 3 Pa, the measurement can be started.

- If the pressure difference at the orifice plate is greater than approx. 15 Pa, an orifice plate with a larger orifice diameter should be used. It is also possible to use ring E or D from the BlowerDoor fan and attach it to the tarpaulin instead of an orifice plate.

- If the pressure difference at the orifice plate is less than 3 Pascal, an orifice plate with a smaller orifice diameter should be used. If the pressure difference at the orifice plate is only slightly less than 3 Pa, increase the fan speed by turning the knob on the fan speed controller to the right until a minimum pressure difference of 3 Pa is achieved. In this case, the first pressure stage at the window will be higher than 10 Pa.

In the following example, the pressure difference at the orifice plate is approx. 5 Pa, when the first pressure stage at the window is approx. 10 Pa. The test could be started with the chosen setup. The pressure stages are carefully selected in intervals of 2.5 Pa.

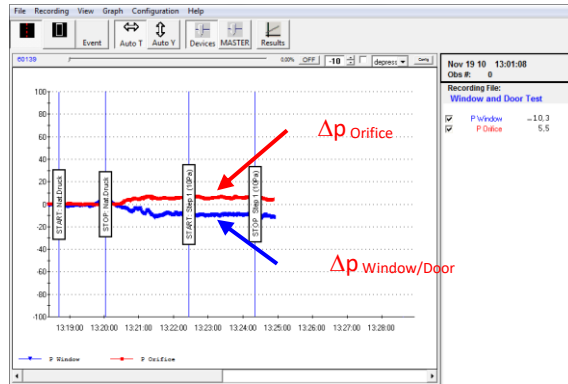## Pressure Stages

Step 1: $\Delta p_{Window/Door}$ ~ 10 Pa

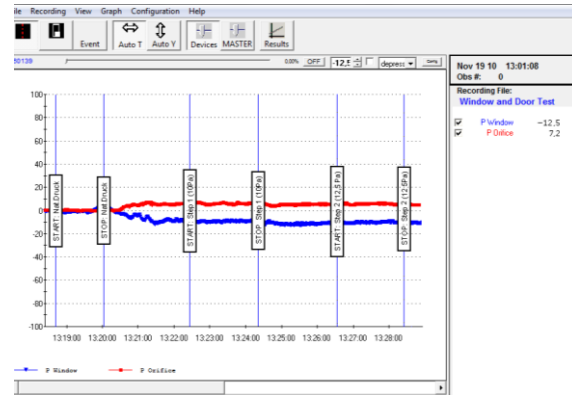
Fig. 7.1

Step 2: $\Delta p_{Window/Door}$ ~ 12,5 Pa
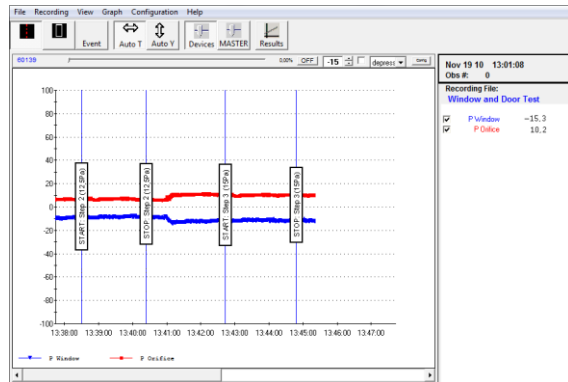

Fig. 7.2

Step 3: $\Delta p_{Window/Door}$ ~ 15 Pa

Fig. 7.3

Step 4: $\Delta p_{Window/Door}$ ~ 17,5 Pa

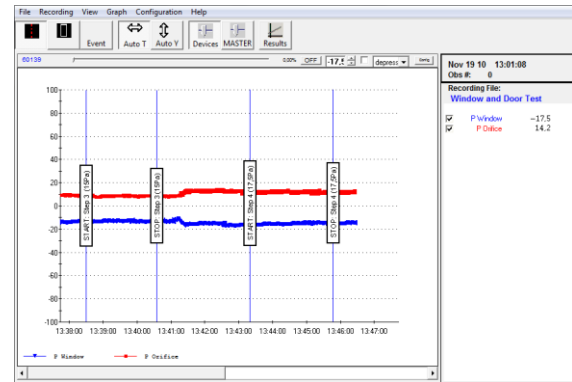*Fig. 7.4*
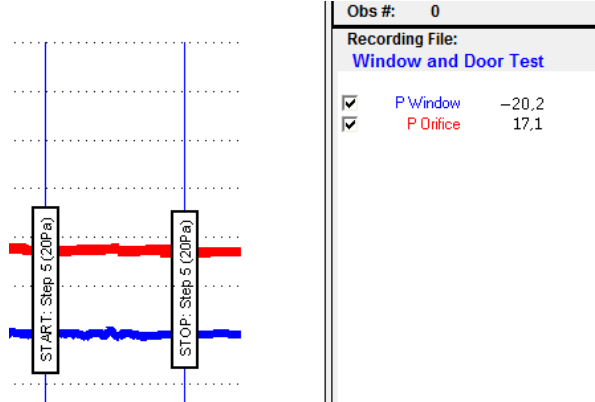
Step 5: Δp **Window/Door ~ 20 Pa**

Fig. 7.5

At approx. 20 Pa pressure difference at the window, the pressure difference at the orifice plate is approx. 17 Pa. The risk that the tape will loosen from the window frame is high. It is possible to end the test here and take a second baseline pressure after the test, if necessary (e.g. in case of wind).

Because the pressure difference at the window is only 20 Pa, it is also possible to increase the fan speed and try to take more pressure stages at higher pressure differences until the tape loosens from the frame.

Additional pressure stages until breakage of the tape

If additional pressure stages are desired, slowly turn the knob on the fan speed controller to the right, starting from the last measured pressure stage. In some cases, it is not possible to reach the recommended pressure difference of 50 Pa because the tape has separated from the frame, but further steps can still be followed.
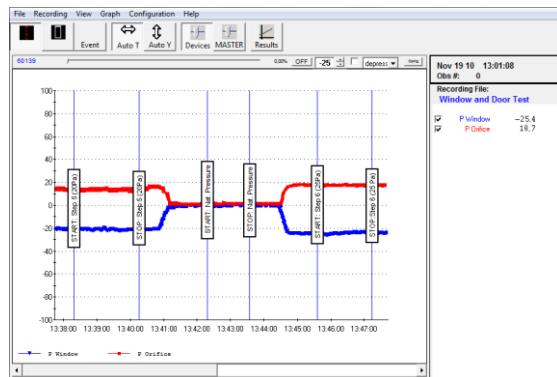
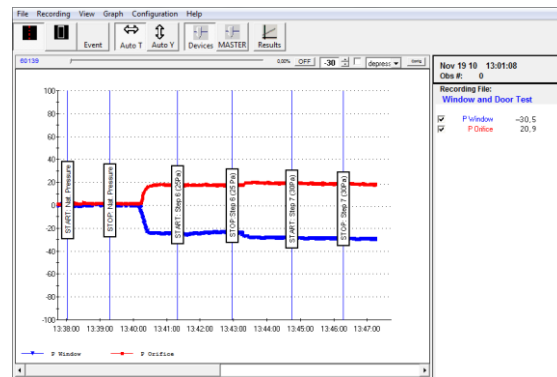**Step 6 :** Δp **Window/Door ~ 25 Pa**

Fig. 7.6

Step 7 : Δp **Window/Door ~ 30 Pa**

Fig. 7.7

The pressure stage at which the tape has separated from the frame should not be included in the Excel test report calculation. This will result in an error.

Alternative 1

If an orifice plate with a bigger diameter is available, it is possible to attach it and continue the test after sealing the previous one. If choosing this option, be very careful when fixing the new orifice plate, in order not to create leakages in the test arrangement.

Alternative 2

If the technician notices that the tape shows risk of separation from the window frame, it is also possible to reduce the fan speed. Turn the knob on the fan speed controller to the left and take values situated in the middle of the still pressure stages still being measured.

7.2   Example 2: Moderately leaky window

During the test at a pressure difference of 50 Pa, the joints of the window show some clear leakages. In this case, attach an orifice plate with a larger orifice diameter to the tarpaulin.

After affixing the tarpaulin and recording the baseline pressure, start the measurement with a pressure difference of around 10 Pa at the window ($\Delta p_{Window/Door}$).

- If the pressure difference at the orifice plate is less than 3 Pascal, an orifice plate with a smaller orifice diameter should be used.
- If the pressure difference at the orifice plate is at least 3 Pa, the measurement can be started.

The following example shows a test that runs optimally. The pressure stages are carefully selected in intervals of 5 Pa.

Pressure Stages

The test starts from around 10 Pa pressure difference at the window $\Delta p_{Window/Door}$ (step 1) and ends at approx. 50 Pa (step 9). The pressure difference at the orifice plate $\Delta p_{Orifice}$ starts at approx. 3 Pa (step 1) and ends at approx. 20 Pa (step 9).

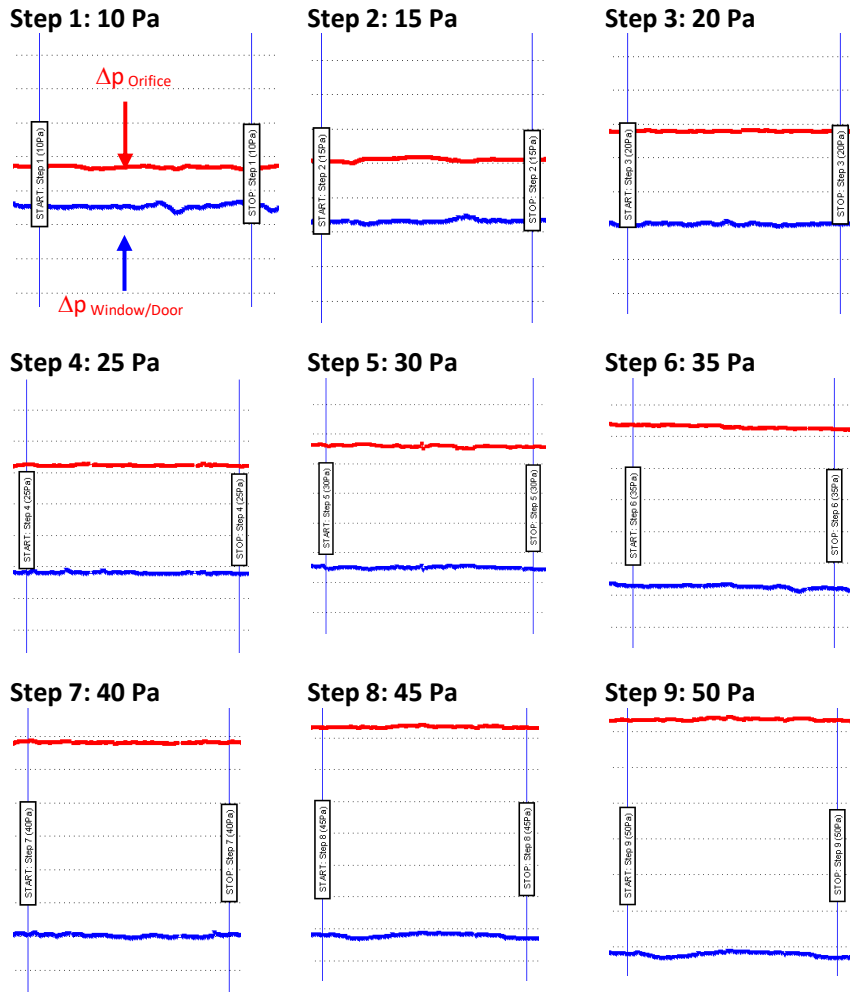**Step 1: 10 Pa**

Step 2: 15 Pa

Step 3: 20 Pa

Step 4: 25 Pa

Step 5: 30 Pa

Step 6: 35 Pa

Step 7: 40 Pa

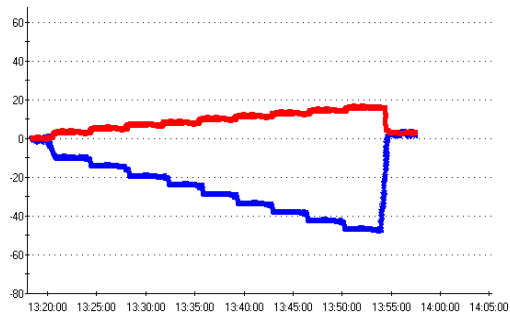**Step 8: 45 Pa**

Step 9: 50 Pa

Fig. 7.8

Complete series of measurements (without labels)

Fig. 7.9

7.3 Example 3: Window with some small leakages

During the test at a pressure difference of 50 Pa, some small leakages are detected with the thermal anemometer at the joints of the window. In this case, attach an orifice plate with the smallest diameter to the tarpaulin.

After affixing the tarpaulin and recording the baseline pressure, start the measurement with a pressure difference of approx. 10 Pa at the window ($\Delta p_{Window/Door}$).

- If the pressure difference at the orifice plate ($\Delta p_{Orifice}$) is at least 3 Pa, the measurement can be started.

- If the pressure difference at the orifice plate ($\Delta p_{Orifice}$) is greater than 15 Pa, the orifice plate should be exchanged for a larger one.

- If the pressure difference at the orifice plate ($\Delta p_{Orifice}$) is less than 3 Pascal, increase the fan speed until the minimum pressure difference of 3 Pa is achieved. In this case, the first pressure stage at the window will be higher than 10 Pa.

For a complete test try to get at least 5 pressure stages. The difference between the stages should be around 5 Pa. The maximum window / door pressure difference should be at least 50 Pa, if possible.

The following example shows this type of test.
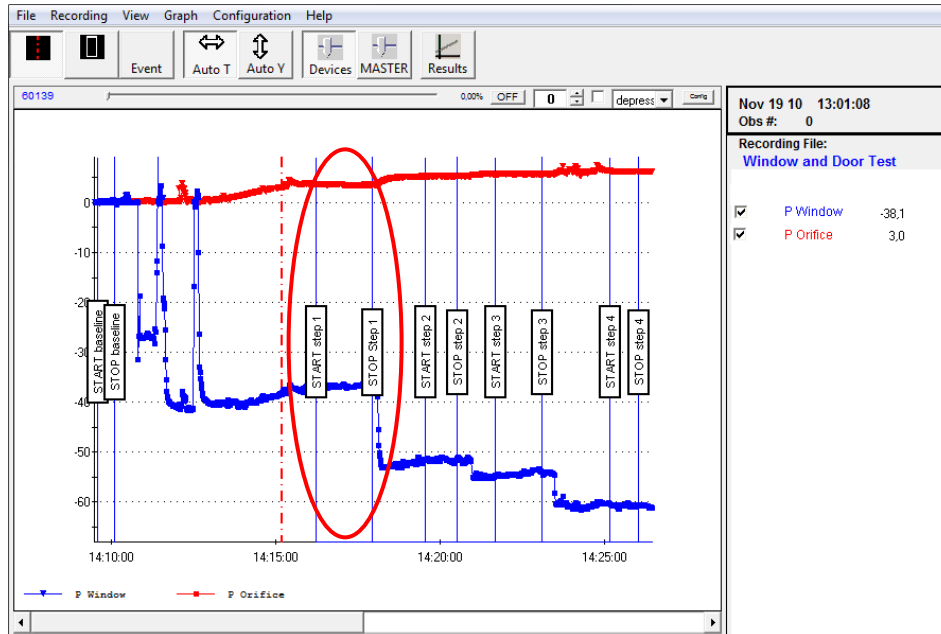
Pressure stages

Fig. 7.10

In the example, the diagram shows that a minimum pressure difference of 3 Pa at the orifice plate was reached when the first pressure difference at the window was approx. 40 Pa. The measurement was started from this pressure difference.

7.4   Example 4: Airtight window

During the test at a pressure difference of 50 Pa, no or only very small leakages were detected with the thermal anemometer at the joints of the window. In this case, attach the orifice plate with the smallest diameter to the tarpaulin.

After affixing the tarpaulin and recording the baseline pressure, start the measurement with a pressure difference of approx. 10 Pa at window ($\Delta p_{\text{Window/Door}}$).

- If the pressure difference at the orifice plate $\Delta p_{\text{Orifice}}$) is less than 3 Pascal, increase the fan speed until a minimum pressure difference of 3 Pa is achieved. In this case, the first pressure stage at the window will be higher than 10 Pa (see example 3).

- If the pressure difference at the orifice plate is from 0 to 1 Pa, even with a pressure difference at the window from 40 to 50 Pa, the window is very airtight. A test with several pressure stages may not be possible with this test arrangement.

The example in the diagram shows that the pressure difference at the orifice plate is less than 0.5 Pascal. The pressure difference at the window is 40 Pascal. The minimum pressure difference of 3 Pascal at the orifice plate cannot be achieved.
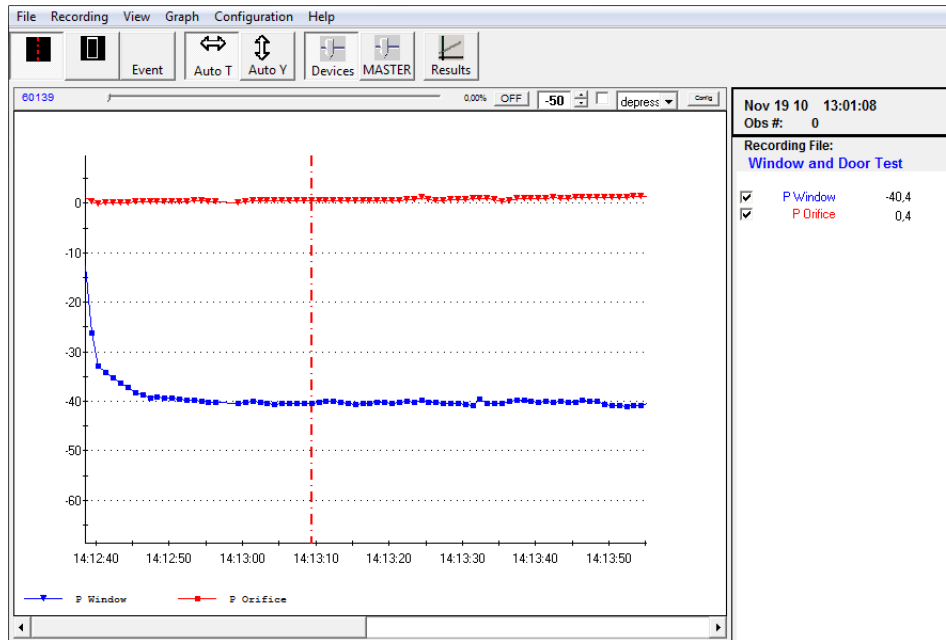

Fig. 7.11

Even by increasing the fan speed, it is not possible to reach the recommended minimum at the orifice plate.

Since the smallest orifice plate is attached to the tarpaulin, no change can be made in the installation. In this case, the airflow through the orifice is below 0.9 m³/h (at a pressure difference of 3 Pascal at the orifice plate with an orifice diameter of 1.5 cm).
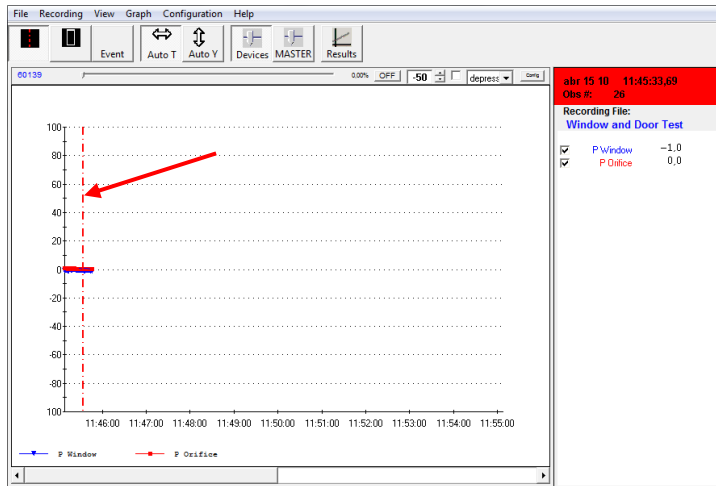
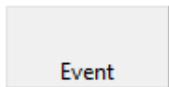## Appendix A: Event Marking in TECLOG

To mark a data point at a particular time, first click on the icon in the TECLOG4 toolbar with the red line. A dotted red line will appear in the diagram.

Fig. 7.12

Fig. 7.13

Using the left mouse button, move the line to the desired time of measurement

Then click on the *Event* button and the *Edit Event Marker* screen will appear.

Fig. 7.14

Fig. 7.15

Enter a suitable label in the Text field: e.g. START: Natural Pressure.

If the checkbox **show text on the graph** has been activated, the label is also shown on the graph.

Exit by clicking **OK**.
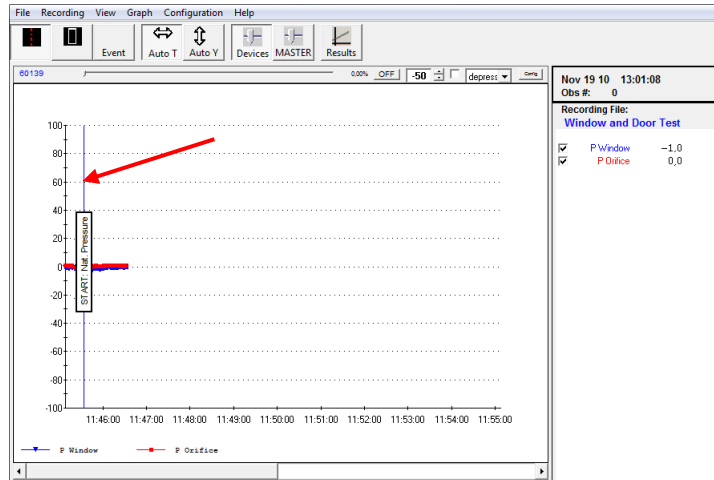
After clicking OK, a vertical blue line will be placed exactly on the dotted red line.
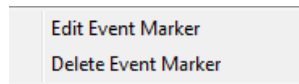
Fig. 7.16

Fig. 7.17

It is possible to delete or edit a marked point. Move the mouse over the label or the blue line. When a cross cursor appears, click the right mouse button and the context menu with *Edit Event Marker* or *Delete Event Marker* appears.

Appendix B: Airflow through the Different Orifice Plates

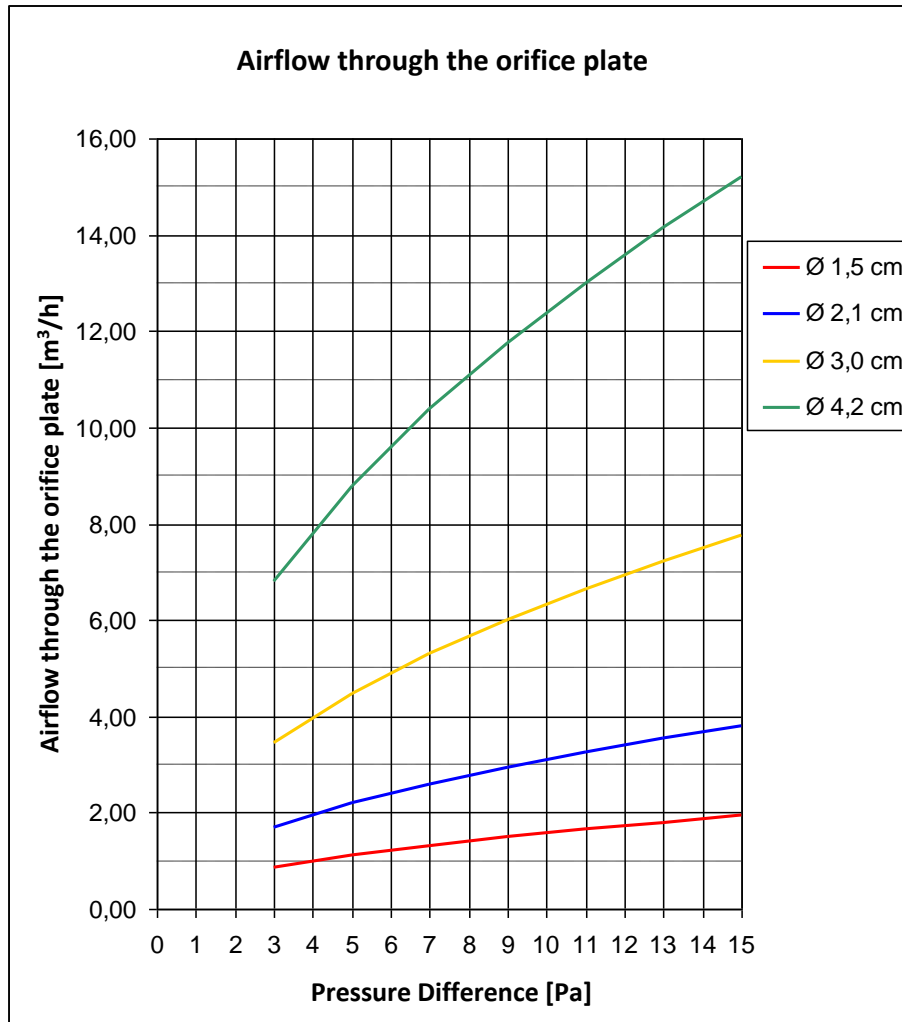**Airflow through the orifice plate**

Fig. 7.18

The flow rates for different openings of the orifice plate (diameter: 1.5 cm, 2.1 cm, 3.0 cm and 4.2 cm) are represented in the diagram as a function of the pressure difference.

Our Service Offer

Calibration of your BlowerDoor Measurement Systems

The accuracy of the BlowerDoor measuring fan incl. flow rings at 4% (rings A-C, resp. rings 1 - 4) and ± 5 % (flow rings D + E), both the accuracy of the BlowerDoor testing flow rings as well as the accuracy of the pressure gauge DG-1000 at ± 0,9% and DG-700 at ± 1 % meet the legal minimum requirements.

To maintain the high measuring accuracy of the BlowerDoor Measurement System, we recommend ensuring regular calibration according to the manufacturer's specifications: For the DG-1000 and DG-700, adjustment and manufacturer's calibration is recommended at an interval of two years. The accuracy of the BlowerDoor measuring fan should be checked by calibration every four years. A previous fan check forms part of each fan calibration. The requirements of the national legislation should be considered for pressure gauge and fan. An airtightness test of the Micro Leakage Meter is recommended every two years.

In addition to the very high quality manufacturer's calibration, BlowerDoor GmbH also offers accredited calibrations with DAkkS calibration at favorable prices. Details are available on www.blowerdoor.com. Dates and prices for leak testing of the MLM on request.

Seminars and in-house training

In addition to the extensive seminar program covering aspects of an airtight building envelope offered by the Energie- und Umweltzentrums am Deister, BlowerDoor GmbH and its contract partners also provide individual training on site or on-demand webinars. Contact us for more information!

Service at your construction site

If required, we will lend our competence to support you in conducting a BlowerDoor measurement at your construction site. Contact us for an offer tailored to your needs!

Listing in the directory of providers of BlowerDoor measurements

As a BlowerDoor testing team, your listing in our online database is free of charge. Contact us at info@blowerdoor.com if you would like an address entry, including a link to your email address and website in our directory of BlowerDoor test providers.

CompetenceCenter

All BlowerDoor testing teams receive access to our virtual Center of Competence at
www.blowerdoor.com free of charge, where we regularly provide you with news and offer interesting
information for download. Contact us if you have not yet received your client number and access data
from BlowerDoor GmbH.

Advertising material for BlowerDoor testing teams

Upon request, we support BlowerDoor testing teams with professional printable files on BlowerDoor
measurements free of charge. The material will feature your own contact data and company logo.
(View a sample at www.blowerdoor.com.) If interested, send us an e-mail with your complete address
and your company logo as a jpg file in printable resolution to info@blowerdoor.com.

Technical Support

Should you have unexpected technical problems while conducting BlowerDoor measurements, our
tech support team is available free of charge during our office hours at the following number:
+49(0)5044/975-57 (chargeable call to German landline).

Protective charge EUR 15