VAC Module Option

Measurements according to
VDI 2080/EN 12599

testo 400

Instruction Manual for Instrument and PC Software Extension

Contents

Introduction

Dear Testo Customer

You have made the right decision in choosing Testo´s VAC module. Every year, thousands of customers purchase our high-quality products. There are many good reasons for this:
1) We offer value for money: reliable quality at the right price.
2) Considerably longer guarantee periods of up to 3 years - depending on the instrument.
3) With over 40 years of specialist experience we are optimally equipped to solve your measuring task
4) Our high quality standards are confirmed by ISO 9001 certification.
5) It goes without saying that our instruments bear the CE mark required by the EU.
6) Calibration Certificates available for all relevant parameters.

Your measuring instrument is a flexible, future-adaptable system, whose operational and software range can vary depending on the installation.
By purchasing the VAC module, you have selected the first branch-specific software extension for the **testo 400** system.
This extension to the standard software for the instrument and PC is based on extensive discussions with the users of our equipment in the field, and is especially designed to meet the requirements of the existing VDI guideline 2080, as well as the implementation of the current EN 12599.
The central theme is the determination of volume flow in air conditioning ducts, the corresponding error calculation, as well as the subsequent documentation of measured data in conformity with standards.

The software extensions for the **testo 400** measuring system and PC software facilitate, or make possible, the following tasks for the user:
- Simple generation for measurement on the PC.
- User-guided on-site application of measurement specifications in accordance with standards.
- Error calculation for the measured results on the spot, without the need for further equipment.
- Assessment of the quality of the measuring point and minimisation of the time spent at the measuring point.
- Retraceable data transmission to the PC.
- Calibration data correction.
- Documentation of measurement results in standard layout.

System requirements

testo 400 instrument with VAC module (direct from factory) or:
testo 400 instrument after UPDATE at one of our service points.
Memory upgrade recommended.

One of the following velocity probes:
Vane probe ø 12, 16, 25, 60 or 100 mm incl. telescopic handle
(Part nos.: 0635.9443/0935.9540/0635.9640/0635.9440/0635.9340)
Hot wire probe with telescopic handle (Part no.: 0635.1041)
Pitot tube with pressure probe
(Part no.: 0638.1345, 0638.1445, or 0638.1545)
High temperature vane probe (Part no.: 0635.6045)

Minimum system requirements

- PC with operating system
  - Microsoft Windows 95 or newer (if compatible)
  - Microsoft Windows NT 4, Service pack 4, or newer (if compatible).
  - Windows 2000 or newer (if compatible).
- CD-Rom drive
- Pentium 100 MHz
- 32 MB RAM
- 15 MB hard disk space free
- Free serial interface (COM) or corresponding adapter.

VAC module in instrument

The purchase of the VAC module Part no. 0554.4030 includes enabling this software option in the hand-held instrument (for instrument version **testo 400** with VAC module ex-works or **testo 400** following UPDATE at one of our service stations).

This instruction manual includes descriptions of the functions on the PC and how to carry out complete measurements with the instrument on site.

Installing PC software

The instructions in this Instruction Manual require that you are familiar with operating your computer using DOS and WINDOWS®. If this is not the case, please read the DOS and WINDOWS® manuals first and spend some time familiarising yourself with both on your computer.

Installation

1. Place CD-ROM in drive
2. The installation menu starts up automatically after a short time. If this is not the case, please click twice on “Setup.EXE“ on the CD-ROM
3. You will be asked to enter your licence number (see sticker on CD-ROM).
   You may be required to reboot your system when installing.
   Note: If the entered number is not accepted, the following may apply:
   - Is the shift button activated?
   - Is “Num” activated in the separate keypad?
   - Was l entered instead of 1?
   - Was o entered instead of 0?
4. Once you have confirmed, installation will continue and you will be asked to enter your name and the company name.
5. The following process continues menu-driven. Follow the notes and explanations near the buttons.

VDI 2080/EN 12599

One of the main focuses of the VDI 2080 or EN 12599 is to describe measuring procedures for the inspection and approval of ventilation and air conditioning (VAC) systems, whose results provide the most objective picture possible of the performance installed. The results must be comprehensible and reproducible. They must be able to withstand disputed issues and be documented accordingly. In this regard, particular value is placed on:

- Measuring instruments with known error limits, which are recorded on a calibration certificate.
- Measuring protocols which, in addition to the individual measured values, also contain all relevant marginal data for the measurement.

With the testo 400/VAC module system the “standard measuring procedure” has been automated as far as possible, in order to avoid transcription errors and careless mistakes in the hectic rush on site.

Example: Standard Measuring Procedure

The determination of measuring uncertainty and total error τ_t performed in this example is carried out by **testo 400**.
The uncertainty is then displayed immediately after the measurement together with the value of the determined volume flow. For further details, see VDI 2080 or EN 12599.

The prerequisite for the measurement of the air flow in ventilation systems is the selection of a suitable measuring location. Direct measurements on air passages are, as a rule, only successful on simple structures and cannot usually be performed without additional equipment. Therefore, such measurements must be performed in ducts in which usable results can be obtained via a system measurement, even in the case of unequal velocity distribution. The irregularity of the profile can be assessed empirically by means of the distance from disturbance points, or it can be obtained from a sample measurement of the deviation of the average values in the four quarters of the duct cross-section (method in **testo 400**).

Example of a velocity measurement with a Pitot tube:

1) Duct cross-section 200 mm x 200 mm (±2mm)
τ_S = 1%

2a) After a first measurement with10 points, the uncertainty of the measurement location can be determined via the measured results:
U=Profile irregularity

$$U = \frac{\bar{V}_{max} - \bar{V}_{min}}{2\,\bar{V}}$$

$\bar{V}$ arithmetic average in the total cross-section

$\bar{V}_{max}$, $\bar{V}_{min}$: Extremes of the mean values in quarters of the total cross-section.

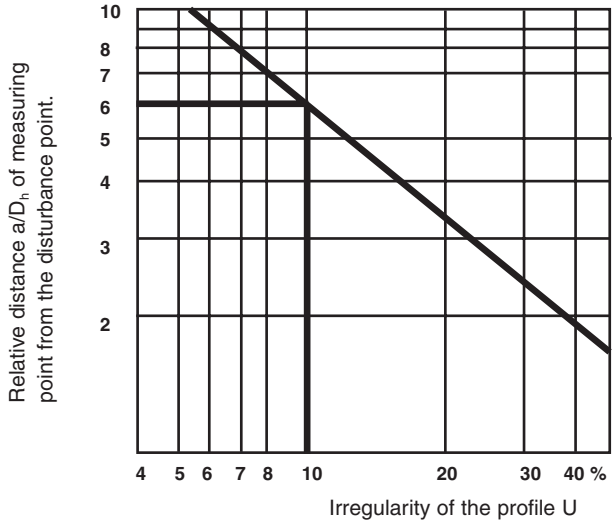
2b) The measurement cross-section lies behind a bend (a=1200 mm):
L,W: Duct dimensions

$$D_h = \frac{2 \times L \times W}{(L + W)} = 200$$

$a/D_h = 6$

Example: Standard Measuring Procedure

The **irregularity of the profile** =10 % is obtained from the table :



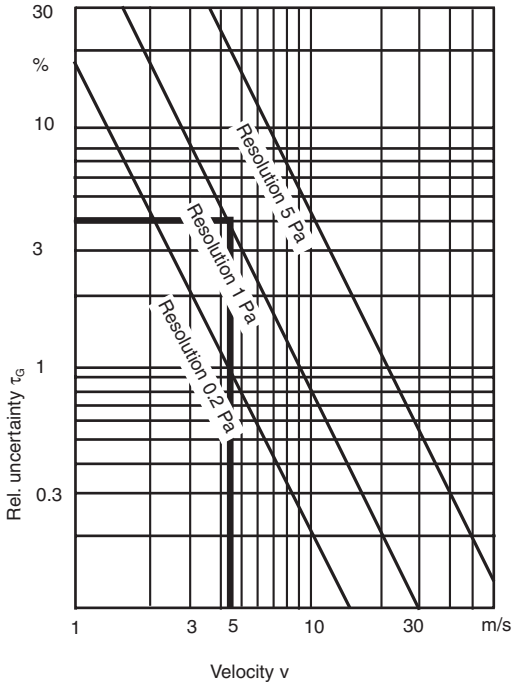
The **uncertainty of the measurement location** is obtained from the accepted number of measuring points = 10: $\mathbf{T_U}$ =7 %.

Number	Irregularity of the profile					
Points	2	10	20	30	40	50
4	6	12	20	28	36	42
5	5	11	17	24	31	36
6	5	10	15	21	27	32
8	4	8	13	18	23	27
10	3	7	12	16	20	24
20	2	5	8	11	14	16
30	2	4	7	9	11	14
50	1	3	5	7	8	10
100	1	2	3	5	6	7
200	1	1	2	3	4	5

3) Accuracy of Pitot tube ± 1 % of P_{Dyn}
τ_P = 1%

Example: Standard Measuring Procedure

4) Pressure measurement with 1Pa resolution at 5 m/s: τ_G = 4%



5) Uncertainty of atmospheric density τ_d = 2 %

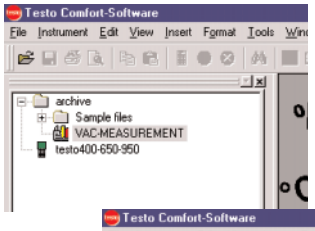
$$\text{Total uncertainty } \tau_t = \sqrt{(2\,\tau_s)^2 + (\tau_u)^2 + \left[\frac{1}{2}\tau_p\right]^2 + (\tau_G)^2 + \left[\frac{1}{2}\tau_d\right]^2} =$$

$$= \sqrt{4 \times 0.0001 + 0.005 + \frac{1}{4} \times 0.0001 + 0.0016 + \frac{1}{4} \times 0.0004}$$

$$= \sqrt{0.007125} = 8.4\ \%$$

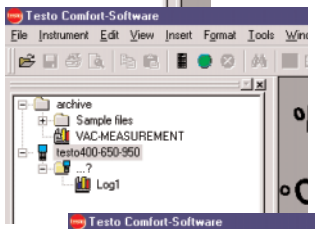
To reduce the measuring uncertainty, the distance from the disturbance point or the number of measuring points must be increased.

Preparation for Measurement

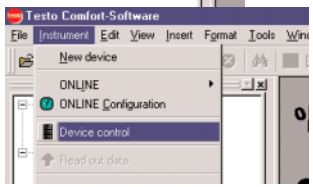


Connect **testo 400** to PC via RS 232 cable.

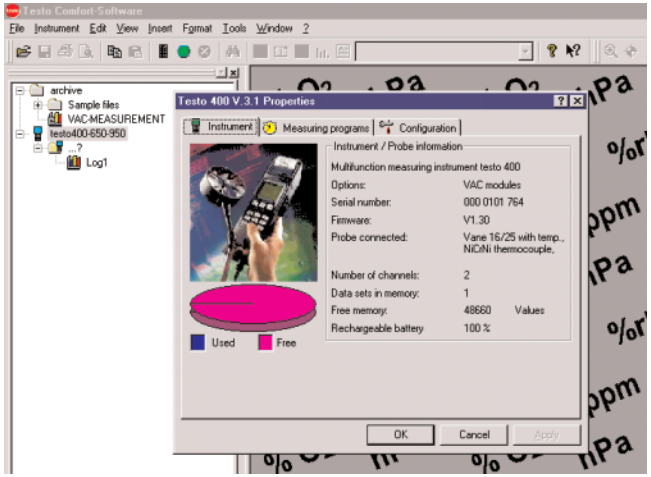
Start Comsoft, the Testo 400-650-950 instrument driver starts automatically.



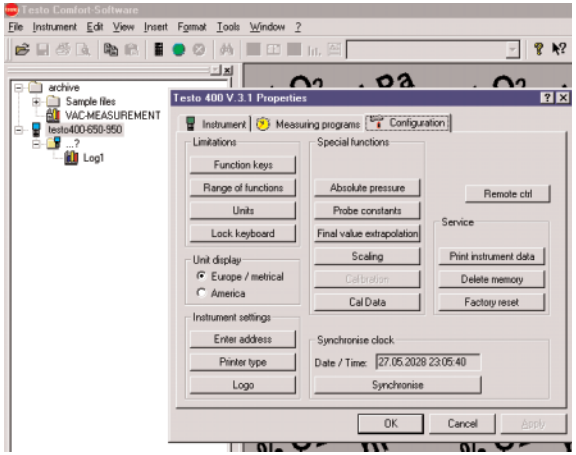
The connection is set up by clicking twice on the instrument driver.



The instrument is configured in the **"INSTRUMENT - Device control"** menu.



testo 400 (see Instruction Manual on Comsoft) appears with an overview of the instrument properties.

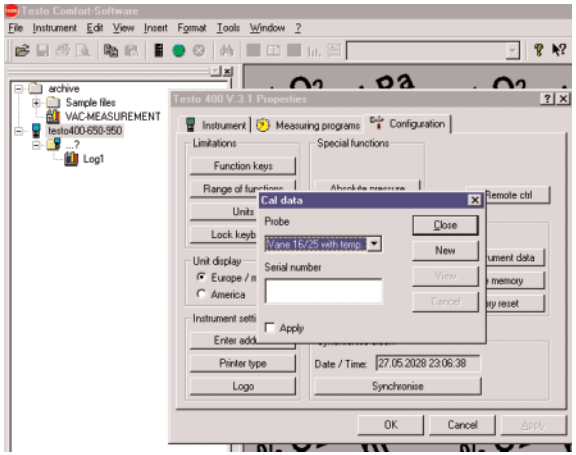


The data from the calibration certificates for your measuring system may be entered in the **"CONFIGURATION"** submenu. The measured data is then adjusted in accordance with the correction data entered here, during subsequent protocol generation.

The PC´s system time must be synchronised with the instrument´s. Press synchronise to do this.

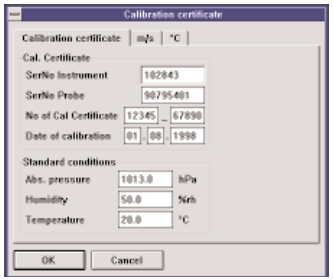
After clicking on **"CAL DATA"** the following selection window appears.

Select the probe (e.g. velocity probe) which is to be connected to the **testo 400** for the measurements, or whose calibration data is to be included in the protocol to be printed out.



If there are several probes of the same type, you should also enter the probe's series number.

"NEW" enables the calibration data for this probe to be entered in the input window.
"VIEW" shows calibration certificate data already entered.
"CANCEL" removes the series number of the probe and the associated calibration data.
"APPLY" offsets the data of the selected probe in the protocol.



"NEW" opens the input window.

In the register, under the appropriate measured variable, enter the nominal and actual values for each probe channel.
1 - 5 calibration points can be entered per channel.
The data from the basic certificate, the certificate number and the date of calibration are located under **"CALIBRATION CERTIFICATE"**.

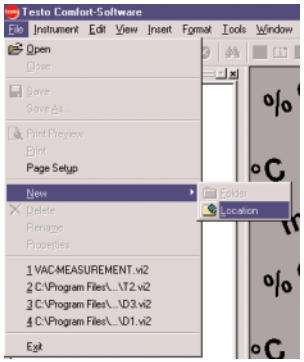
Integrating your company logo in
- the PC protocol
- the instrument display
- protocols of Testo's attachable printer

After pressing the **"LOGO"** button under **"CONFIGURATION INSTRUMENT SETTINGS"** the following window appears: Ex-works, the Testo logo appears. On the left is the high-resolution variant for the PC print-out, on the right is a reduced resolution version for the instrument and attachable printer.

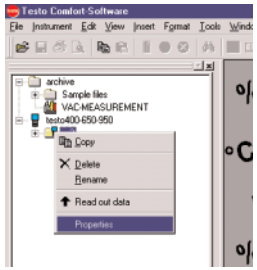
Please note:

"OPEN FILE" allows you access to other logos.
A customer-specific logo for PC print-out can be generated and processed by SCANNING a logo using a commercially available program. (Save as a bmp).
Select this bitmap file in the left-hand field using **"OPEN FILE"** and copy to the right with **"MINIMIZE"**. The resolution automatically decreases to the dimension of the instrument's LCD.
This method only produces satisfactory results with simple logos. As a rule, the bitmap file must be processed using a standard commercial program. This processing, contrary to the simple SCANNING procedure, is very expensive.
Testo will undertake this service on request.

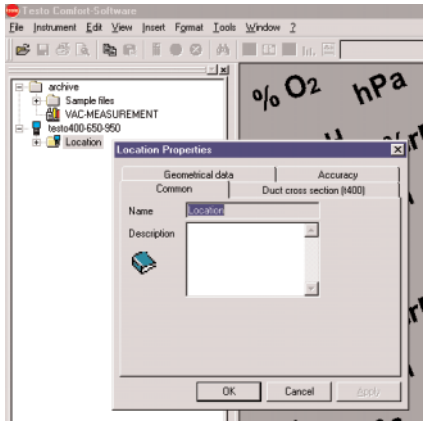
"TRANSFER" saves the selected logo in the PC, or in the hand-held device connected to the PC.



Locations can be set up under **File-New-Location**. All of the relevant data can be saved according to location.



In order to assign specific properties to the location, click with the right mouse button on the name of the location and select “Properties”.

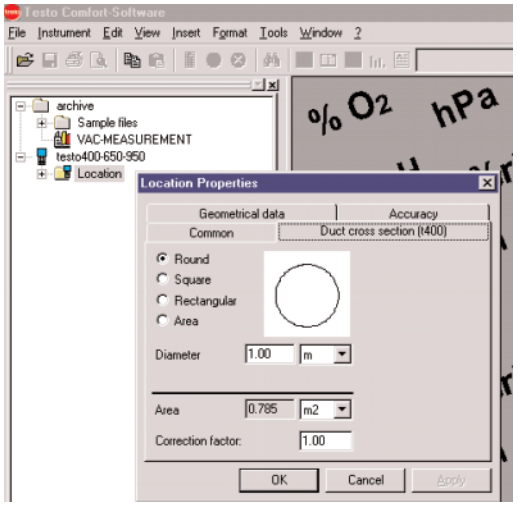


The window opposite appears.

All relevant data for subsequent measurement may be defined as specific to the measuring locations:

- Location
- Info field (additional information)
- Duct geometry
- Number and arrangement of measuring points in the duct cross-section
- Uncertainties for error calculation.

After defining the measuring locations and, if appropriate, entering additional information in the info field, clicking on **“Duct cross-section”** will take you to the following register:



Select the location beforehand and enter the duct cross-section (round or rectangular for use by the VAC module). For **“Correction factor”** it is possible to enter a value which will correct the area and consequently the calculated volume flow in relation to the measuring location. For example:

-Consider the influence of the shape of the duct
-Take account of effects of duct grids
-In the case of a small duct cross-section, consider the reduction in the cross-section caused by the insertion of the probe.

Under **“Geometrical data”** specify the number and position of the measuring points in the duct cross-section.

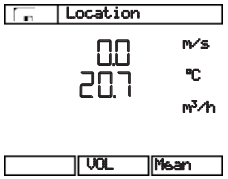
- Round: one and two measuring axes
  number of measuring points per radius
  distance of furthest measuring points from the duct wall
- Rectangular: max. 10 by 15 measuring points
  - Horizontal distance from the duct wall
  - Vertical distance from the duct wall

Then define the position of the measuring holes in the duct and thus the reference point for all distances in the measuring plane.

Under **“Accuracy”**, uncertainties for subsequent error calculation are defined:

- Accuracy of the definition of the duct dimensions
- Accuracy of atmospheric density (for Pitot tube measurements)

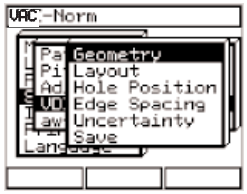
Preparation for Measurement



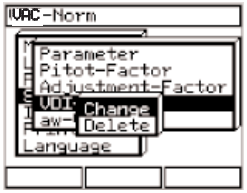
After connecting the probe and switching on the instrument, configure the F-keys (see Instrument Instruction Manual) with “**VOL**” and “**MEAN**”.
Only **one** probe may be connected!
For measurement with a Pitot tube, switch from the pressure display to the velocity display. Configure F-key with m/s and execute.
Activate the volume flow display by pressing the “**VOL**” F-key. If the setting is correct, you will obtain the display opposite.
Select the current measuring location.

If no measuring specification has previously been used by the PC for this measuring location:

Switch into the main menu with OK and activate a measuring specification under **SPECIAL-VAC-NORM-NEW** input.

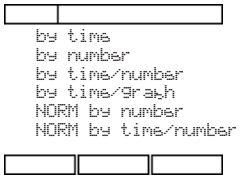


As with the PC, the following data can also be entered on site:
- **GEOMETRY**: Information on the cross-section for the current location. (VAC module offers only a circle or a rectangle. If a value is entered under “areas”, further entries are blocked.)
- **LAYOUT**: Define position of hole.
  Max. 15 horizontal points, 10 vertical points.
  or: Max. 2 axes (4 radii altogether) and max. 5 points per radius.
- **HOLE POSITION**: Select reference point. The coordinates for the individual measuring points are derived from this.
- **EDGE SPACING**: Distance of the outer measuring points from the duct wall.
- **UNCERTAINTY**: Define errors for the parameters entered for use in the error calculation.
- **SAVE**: Enables determination of volume flow at the selected measuring location in accordance with standards.

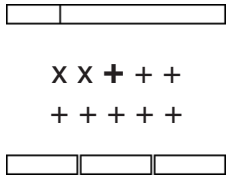


If a measuring specification already exists, it can be modified with “**CHANGE**”, or removed with “**DELETE**”..

Measuring

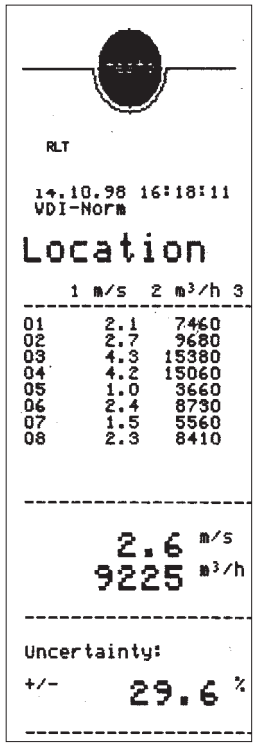


Measuring:
Press the “Mean” F-key and select the type of mean calculation.
NORM by number: multi-point mean calculation
NORM by time/number: averaged at any measuring point over the preset period.



Position the flow probe according to the information on the LCD.
\+ Measuring points designated according to measuring specification
+ Selected measuring point
X Previously measured measuring point

OK confirms the correct position..
“**START**” saves the measured value at this position.
The counter in the top left of the display is increased by 1. Position the probe at the next designated measuring point and repeat the measuring sequence until all preset points have been processed.



“**END**” terminates the mean value formation and shows the measured result, including all errors.
Depending on the measuring location selected, the error for the volume flow value may be unacceptably high. You should then select a better measuring location a good distance away from disturbance points, with a more uniform flow profile or increase the number of measuring points.

When the measurement has been completed, the results and marginal parameters are automatically saved in the instrument memory and can be a) printed out or b) read out at any time.

a) The results can be printed on the spot using the attachable printer.
Note: *For setting and activation of “Attachable printer”, see Instrument Instruction Manual.*

The print-out is shown in the illustration opposite.

Stored protocols

b) The measured results can be read out in the main menu under **READ OUT MEMORY.**
The required measuring location must be selected.
Confirm the time of the required protocol with OK and you will obtain the values of the individual measuring points.

The INFO F-key displays the mean values with the calculated deviations.

→ Additional information supplied:
- general information about the measuring location
- mean values
- maximum values
- minimum values
- basic instrument uncertainties
- basic probe uncertainties
- profile irregularity, measuring location uncertainty
- duct geometry and overall measurement error

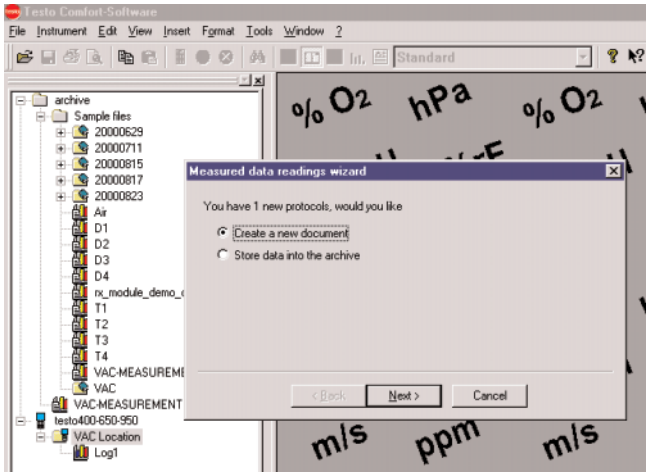
DELETE removes the protocol - but not the measuring specification - from the memory.

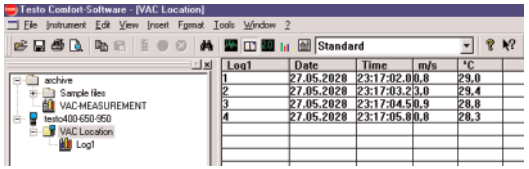
Note!

The instrument configuration (hardware) is called up during booting. Therefore, switch the instrument off and on again after each hardware modification (e.g. probe exchange)!

Please note: If a probe different from the one saved in the software is used for measurement, the probe calibration data will no longer agree. You will then obtain an invalid protocol!

Reading Out Measured Data





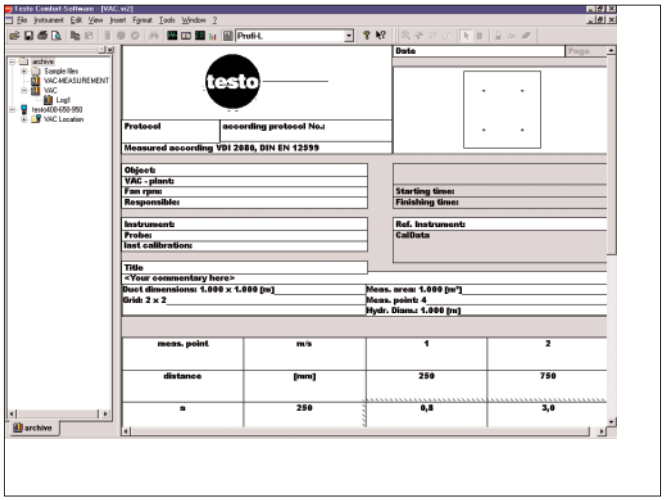
Connect the instrument to the PC. After starting Comsoft and selecting **testo 400**, the current memory contents are displayed. Select the required protocol and the location and then drag the file to the work area by keeping the right mouse button pressed.
Select the "Form" view type from the toolbar.

3 types of layout can be used for the print-out:
L: Extensive expert version with marginal information and text input.
M: Regular version
S: Minimum version with measured data -clear, with little text.
If "**Apply**" has been activated in **CONFIGURATION-CAL DATA**, then the values defined are offset in the subsequent protocol.

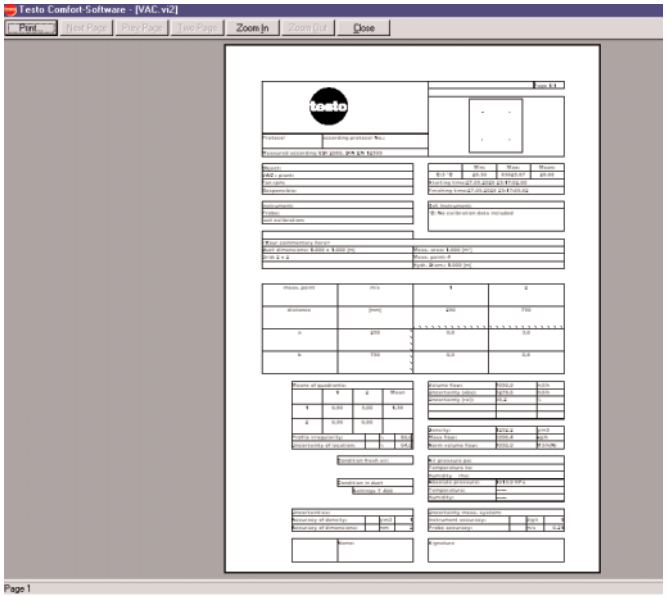
Some of the fields shown are automatically filled with measured data and additional information. Please complete all other fields with text.
The following are of particular importance:
-Details of the measuring point
-Operator responsible .....

Print-out is started using the print symbol in the tool bar.

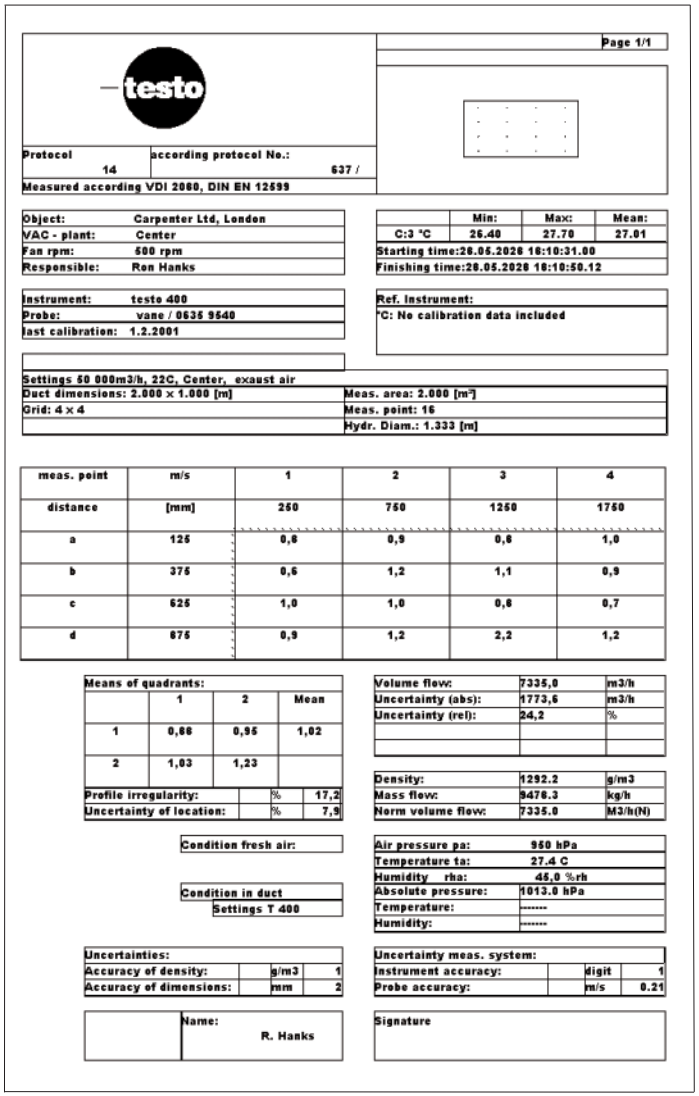
Text input



Print Preview



Printed form



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