Instruction Manual

HM 170.60  PC-Aided Data Acquisition

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1  Introduction

The apparatus **HM 170.60 PC-Aided Data Acquisition** facilitates a convenient measuring system for the **Educational Wind Tunnel HM 170**. When it is connected to a PC with the appropriate software, data such as lift, drag, pressure, velocity and distance as well as angle of attack can be acquired, represented graphically or numerically and stored as text or graphics. Provision is also considered for Print-out option. The software runs under *Windows*. The system is connected to the PC via a serial interface RS232. Thus the data acquisition is independent of the utilisation of the PC hardware.

The scope of delivery includes a connecting cable to the 2-component force balance, a readily constructed set with angle and distance sensors and hoses with quick fittings.

The apparatus is designed for experimental and training fields.

*Windows is a trade mark of the firm Microsoft*
2 Description

The PC-Data Acquisition HM170.60 comprises the basic unit, the mounted sets with Distance and angle sensors and the evaluating software.

2.1 Function

The basic unit receives the measurement data, digitises them and transmits them to a PC. The basic unit contains inputs for the following quantities:

- Lift (Voltage signal ± 4.096V)
- Drag (Voltage signal ± 4.096V)
- Distance / angle (Voltage signal 0 - 5 V)
- Differential pressure 0 - 10 mbar
- Velocity (pressure 0 - 10 mbar)

Whereas the voltage signals corresponding to lift, drag and Distance/angle are fed directly to the 12-bit A/D converter, the pressure signals are first transferred into voltage signals in the corresponding pressure transducers.

The converted signals are fed into a microprocessor. This carries a temporary scaling and calculations and displays the measured values for velocity, differential pressure and distance/angle on a LCD display.

The measured values can be transferred into a PC via a RS232 interface for further data processing.

2.2 Connections and Service Elements

On the front side you will find the connections (sockets) for Distance/angle (1) (5-pin DIN socket), differential pressure (2) (quick fitting NW ) and velocity (3) (quick fitting NW ). On the rear side you will find the connections for the measuring amplifier of the 2-component balance (lift/drag) (4) (3-pin
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1. Connector distance/angle-sensor
2. Connector differential pressure
3. Connector velocity
4. Connector measurement amplifier (lift/drag)
5. RS232-interface
6. Power supply
7. Main switch
8. Fuses
9. Tara-buttons
10. LCD-display

DIN socket) and serial RS232 interface (5) (SUB D-25 socket), as well as the connection for the power supply (6), the main switch (7) and the fuses (8).

The buttons (9) for Tare function are on the front side, where the displays can be preset to zero. The tare function is set again upon turning the unit off and on.

The values of velocity, differential pressure and distance/angle are displayed on-line on the LCD displays (10).

The displays and taring (zero setting) for lift and drag occur on the measuring amplifier of the 2-component balance.
3 Safety and Service Hints

Before the operation read the safety and service hints carefully. Users must be taught how to use this unit.

**DANGER of electric shock !**

Pull the mains plug out before opening the unit. Only professionals must work with electrics.

Protect the unit from humidity and dust.

**ATTENTION!**

Never overload the pressure measuring connections.

Max. pressure 10 mbar = 1000 Pa

Do not overload the voltage inputs.

Max. input voltages

Connection to measuring amplifier ± 5V

Connection to Distance/angle sensor 0 - 5V

In the case of connecting devices or sensors other than those considered by G.U.N.T. the function can not be guaranteed. The user is responsible for damages due to connection to foreign devices or sensors. Firm G.U.N.T. welcomes technical questions.
4 Operation

4.1 Connecting the 2-component Balance

- Connect the signal output on the rear side of the measuring amplifier with the force measurement input on the rear side of HM 170.60 by means of the delivered cable.
- Function can be tested only with PC and evaluating software.

4.2 Connection for Velocity Measurement

- Disconnect the hose (1) from the inclined tube manometer (2), fit the T-junction (3) and connect the branch to the pressure connection velocity (4) on the front side of HM 170.60 by means of a hose and a quick fitting.
- After switching the unit ON and air velocity reaches its highest set value in the wind tunnel the display of HM 170.60 indicates the current velocity.
4.3 Addition of distance and angle sensors

If HM 170.60 is not delivered together with the Wind Tunnel HM170 and the model Boundary Layer with Probe HM 170.24, the distance and angle sensors must be installed afterwards.

4.3.1 Distance Sensor

The distance sensor is built in the Pitot tube of the model HM170.24. It allows for the measurement of the probe position.

- Fix the distance sensor (1) with the screws M3 x 6 (2) on the holder (3) of the micrometer screw as shown. Don’t tighten the screws yet.
- Connect the distance sensor to the front socket angle/distance of HM170.60 and turn the unit ON.
- The display must indicate the x-value.
- Set the micrometer screw to zero.
- Adjust the distance height (long slot) so that the display also indicates zero. Tighten the securing screws. Slight deviations in the display (± 0.5 mm) can be compensated by means of taring device.

The differential pressure can also be measured electronically by connecting the tappings for static pressure (4) and total pressure (5) on the connection pressure of HM170.60.

- Static pressure (4) connection -
- Total pressure (5) on connection +
4.3.2 Angle sensor

The angle sensor is built in the 2-component balance of the wind tunnel. It enables electronic measurement of the adjusted angle of attack and the reception of lift, drag and pressure as functions of angle.

To install the angle sensor, the cover of the 2-component balance must be removed.

- Remove the pointer-plate (1) from the Plexiglas after loosening the two screws.
- Lift the model holder (2) together with the scale disc.
- Carefully remove the cover (3) after loosening the 4 screws (4).
- Put the angle sensor (5) on the side holes of the cover and tighten them from inside with two M4 x 8 screw (6). The toothed wheel must face upwards.
- Turn the model holder and loosen the hexagon nut (7) for tightening the scale disc.
- Mount the delivered toothed wheel (8) on the scale disc of the model holder with the help of the collar, and tighten the nut again. Make sure that the position of scale disc and model holder is not shifted.
- Install the 2-component balance again in a reverse order.
- Check whether the swing arm of the angle sensor moves easily and the cap swings like a spring.
- Check whether both toothed wheels are coupled to each other without problem.
- Connect the angle sensor to the front socket angle/distance of HM170.60 and turn the unit ON. The display must indicate $\alpha$-value.
- Set the scale disc (1) to 0° and clamp it tight.
- Swing the angle sensor towards outside and turn the toothed wheel (2) so that marking line (3) points to the outside. The display now shows 0°. Slight deviation can be compensated by means of taring device.
5 Evaluating software

5.1 Software installation

5.1.1 Hardware Requirements

The software runs on IBM compatible PCs. The PC must have a processor 80386SX or higher, RS232 interface port and a 3.5" Disk drive.

Die Graphic card must be a VGA colour with at least 256kB. Operating system must be MS-DOS Version 3.3 or higher and Windows 3.1.

Printing the data and graphs an Epson-compatible is needed.

5.1.2 Installation

- Run Windows. The Program Manager will be opened.
- Insert installation diskette in the appropriate drive.
- Open Menu File.
- Select command Execute. The dialogue field Execute will be opened.
- In the command line, type: [drive]:\setup (e.g. a:\setup), press the Enter button.
- A Menu appears with installation directory. This directory can be selected or give another directory name.

Note: Unavailable directories are not set automatically.

- The installation routine creates automatically a group window and a program symbol for the program.
  The program can be started by double click on the symbol.
- Set the right COM-Port in the Program under the Menu *Preset - communication*. The set value will be saved.
5.2 User screen

After starting the software the main window for HM 170.60 appears on the monitor.

From the main window, the following functions can be called:

- Start measurements (click the green icon "I" under Measurement).
  Individual measurements and continuous measurements are possible, see also the Menu Preset.
- Stop the Measurements (click the red icon "O" under Measurement)
- Print the screen content (Command field Print)
- Call the Menu with the following sub-Menus:
  - File
  - x-Axis
  - y-Axis
  - Preset
  - Info
5.2.1 Sub-Menu: File

File - new

The Menu File-new enable deleting the curves from screen and from the memory. The program returns to its original default settings.

File - load

It loads and displays saved curves.
- Select load in Menu File. A dialogue field appears.

Mark the data to be loaded.
1. Select the drive on which the data is found. A list appears with all available directories and files simultaneously.

2. Open the desired file by clicking the mouse.
3. Select the corresponding data format by clicking the mouse.
   (Default: *.dat). In the list field File Name, a list of files with selected data format appears.
Open a file by:
- giving file name direct in the text filed.
- Double clicking on the file name
- Marking file name and clicking on OK.

**Note:** Up to 10 curves can be loaded.

**File - save**

After ending the measurement, the following curves can be saved:

1. From Menu **File** select **save**.
   The following dialogue appears:

2. In this dialogue field (the field under the yellow block), select the current curve by clicking:
   - the drive in which the file to be saved
   - the directory to which it belongs
   - the file format (Default: *.dat)

3. Type new file name directly in the text filed.
4. Click on **OK** to save the file under the used file name, or **Cancel** if the file is not to be saved.

**Note:** There is no warning if you over-write an existing file.
File - End

With File - end the program will be ended. Unsaved curves will not be saved automatically.

5.2.2 Sub-Menu : x-Axis, y-Axis

The quantities represented on the x-axis and y-axis will be selected from this sub-Menu. It contains the following quantities to select from:

- Velocity (Velocity)
- Differential pressure (Pressure)
- Angle (Angle)
- Distance (Distance)
- Lift (Lift)
- Drag (Drag)

After selecting the quantities the following dialogue field appears:

The axes scaling can be set here:

1. Lowest measured value
   Minimum value
2. Highest measured value
   *Maximum value*

3. *Scale division*

These sub-Menus can also be called if the scale is to be changed and not the quantities.

### 5.2.3 Sub-Menu: Preset

**Preset-Communication**

It is necessary to configure the program of COM-Port to the used serial port. This configuration is made via the sub-Menu *Preset-Communication* and saved in the configuration file "HM170.CNF".

- From sub-Menu *Preset* select *Communication*. The password "FRED" must be given in the dialogue field.
A dialogue field is displayed:

![Communication Dialogue Field]

The set values for the RS232 interface port are displayed in the dialogue field. The COM-Port only can be changed. Ending the dialogue field with the command *Cancel* does not change the current configuration.

**Preset-Diagram**

Under this Sub-Menu the operation mode is set.

- **Continuous** switched ON: Measurement, display and drawing the curve happen continuously. Measuring rate is ca. 4 Hz. This operation mode is suitable for automatic drawing of a graph, e.g. in the case of high velocity of the fan.
- **Continuous** switched OFF: Measurement and display take place continuously, new point on the curve will be plotted only when pressing "I" under Measurement. In this operation mode, a new operation point can be moved to smoothly and a new measurement point can be taken after steadiness of the quantity. Then the curve will be plotted up to the new measurement point.

Ending the dialogue field by the command **Cancel** does not change the current setting.

5.3 Example

The following diagram shows the lift (y-Axis: Lift) of an aerofoil as a function of velocity (x-Axis: Velocity). The diagram has been taken with the operation mode **Continuous** in the case of the fan running with high velocity.
6 Sample Experiments

6.1 Measurement of Lift and Drag

The dependence of the lift and drag forces of an aerofoil on angle of attack will be measured.

- Connect HM170.60 according the schematic diagram.
- Mount the model and secure it tight.
- Start the software and configure it.
  \textit{x-Axis: Angle, }x_{\text{min}}: 0, x_{\text{max}}: 30
  \textit{y-Axis: Lift, }y_{\text{min}}: 0, y_{\text{max}}: 3.0
  \textit{Preset-Diagram: Continuous OFF}
- Run the wind tunnel at velocity of 20 m/s.
- Turn the aerofoil model so that the lift becomes zero (zero setting).
- Set the angle display to zero by pressing the Tare.
- Take the first measurement value by clicking on "I".
- Turn the model by ca. 2.5° and repeat the measurement.
- Save the diagram after ending the measurements (File-save) or print it (Print).
- The measurement procedure can be repeated for taking the drag.
  $x$-Axis: Angle, $x_{\text{min}}$: 0, $x_{\text{max}}$: 30
  $y$-Axis: Drag, $y_{\text{min}}$: 0, $y_{\text{max}}$: 3.0
  Preset-Diagram: Continuous OFF.
6.2 Measurement of Pressure Distribution on a Cylinder

The dependence of pressuredistribution on angle of attack in a cylinder exposed to flow.

- Connect HM170.60 according to the schematic diagram.
- Mount the cylinder and tighten it.
- Connect one tapping on the cylinder by means of a hose to the pressure measurement nozzle pressure (-) on HM 170.60. Select a measurement hole in middle length of the cylinder.
- Start the software and configure it.
  \( x\)-Axis: Angle, \( x_{\text{min}}: 0, x_{\text{max}}: 180 \)
  \( y\)-Axis: Pressure, \( y_{\text{min}}: 0, y_{\text{max}}: 500 \)
  Preset-Diagram: Continuous OFF
- Run the wind tunnel at a velocity of 20 m/s.
- Turn the cylinder so that the pressure becomes maximum. The measurement hole is then in the direction of flow. The mark (3) on the toothed wheel of the angle sensor will be pointing to the outside. If not, then lift the wheel up and correct the direction.
- Set the angle display to zero by pressing the Tare.
- Take the first measurement value by clicking on "I".
- Turn the cylinder by ca. 10° and repeat the measurement.
- Save the diagram after ending the measurements (File-save) or print it (Print).
6.3 Measurement of the Boundary Layer

The velocity distribution will be measured for the boundary layer of a plate under flow.

- Connect HM170.60 according to the schematic diagram.
- Mount the probe and the plate and tighten them.
- Connect pressure tapping of the Pitot tube by means of a hose to the pressure measurement nozzle *pressure* on HM 170.60 (see 4.3.1)
- Connect the distance sensor with HM170.60.
- Start the software and configure it.
  - *x*-Axis: *Distance*, $x_{min}: 0$, $x_{max}: 10$
  - *y*-Axis: *Pressure*, $y_{min}: 0$, $y_{max}: 500$
  - *Preset-Diagram*: *Continuous* OFF
- Adjust the Pitot tube so that it is about to touch the plate surface. Set the distance display to zero by pressing the Tare.
- Set the plate at the desired distance from the front edge.
- Run the wind tunnel at a velocity of ca. 20 m/s.
- Take the first measurement by clicking on "I".
- Move the Pitot tube 0.2 - 0.3 mm up and repeat the measurement. At distances larger than 2 mm the separation between measuring points can be increased to 1 mm.
- Save the diagram after ending the measurements (File-save) or print it (Print).
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7 Technical Data

Dimensions of basic unit
W x D x H : 370 x 350 x 160 mm
Weight: 5 kg
Power supply: 230V / 50Hz

Inputs:
Force input: ±4.00 V ±16 N
Pressure input: 0 - 1000 Pa
Velocity: 0 - 10 mbar 0 - 48 m/s
Distance: 0 - 5 V 0 - 20 mm
Angle: 0 - 5 V 0 - 360°
Resolution: 12 bit
Measuring rate: 4 Hz

Output:
Serial port RS232, 19200 Baud
8 Data, 1 Stop, Parity even

Display:
4 x 20 digit LCD, illuminated background
Velocity, pressure, distance, angle

Connections:
Pressure, Velocity:
Quick fitting NW2
Force 5V
Distance / angle: DIN 5 pol.
RS232: SUB-D25

Data Output: Printer or ASCII-Data
PC requirements:
Processor => 386SX or higher,
Graphic card 256k VGA-colour,
Diskette drive 3,5 or 5,25"
RS232-port
Epson compatible Printer
MS-DOS => Version 3.3 or higher
Windows Version 3.1