HM 170 Open wind tunnel

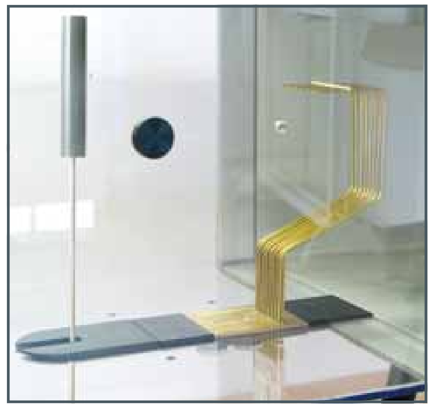
GUNT offers an “Eiffel” type open wind tunnel as a classic experimental plant in the field of flow around bodies.

The flow medium of air is brought up to the desired velocity by a fan and flows around the model being studied in a measuring section. Additional experiments, such as investigation of the boundary layer or pressure distribution of drag bodies immersed in a flow are available as options.

The new design of the open wind tunnel HM 170

Training at the HM 170 Open wind tunnel at the Technical College for Aeronautical Engineering in Hamburg (Germany)

Measuring lift and drag forces as a function of the angle of attack of an aerofoil with flap and slot

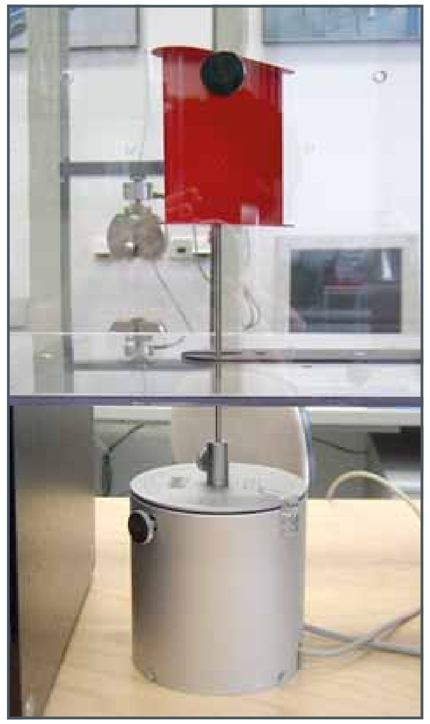


HM 170.28
Measurement of the wake of a cylinder immersed in a flow and demonstration of a wake depression, wake rake consisting of 15 Pitot tubes

HM 170.70
Demonstration of a wind power plant with rotor blade adjustment and variable-speed generator

Measuring lift and drag forces on the streamlined body with the two-component force sensor

Pressure distribution on an aerofoil immersed in a flow

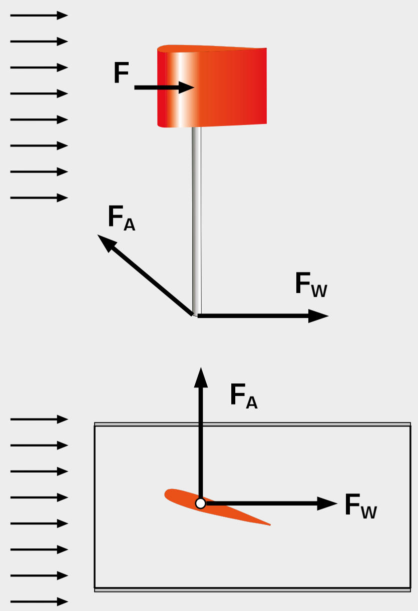


Measuring lift and drag forces and moment on the aerofoil drag body with the three-component force sensor HM 170.40

HM 170
Selected experiments

Flow around various drag and lift bodies HM 170.01 – HM 170.14

- determining drag and lift coefficients
- two-component force sensor for measuring drag and lift forces included in HM 170
- visualisation of streamlines by using fog



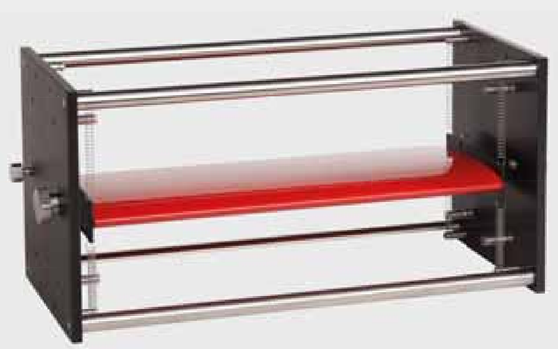
Force measurement on the drag body

F_A lift force, F_W drag

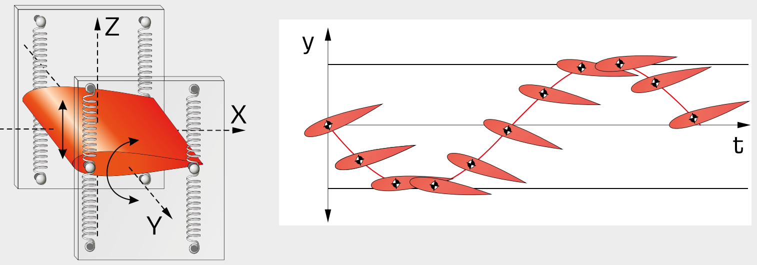
Demonstration of flutter

HM 170.20 Airfoil, spring-mounted

- demonstrate flutter (self-excited vibrations)
- natural oscillation behaviour can be influenced by different spring settings



Air flows along an elastic system. Motion-controlled flow forces can cause vibrations with significant amplitudes in the elastic system. This instability phenomenon is called flutter. Flutter is crucial in the design of aircraft, bridges, chimneys and high-voltage power lines. This model is used to demonstrate the aerodynamic excitation of vibrations and instability. By using a stroboscope it is possible to observe the natural oscillation of the wing.

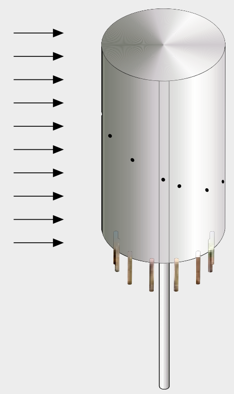


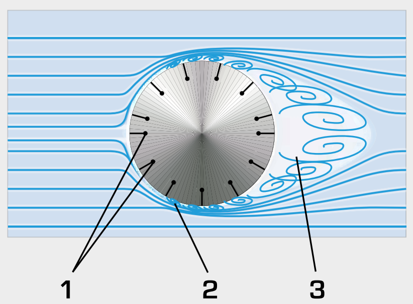
Flutter shown over time

Pressure distribution at the perimeter of a cylinder immersed in a flow

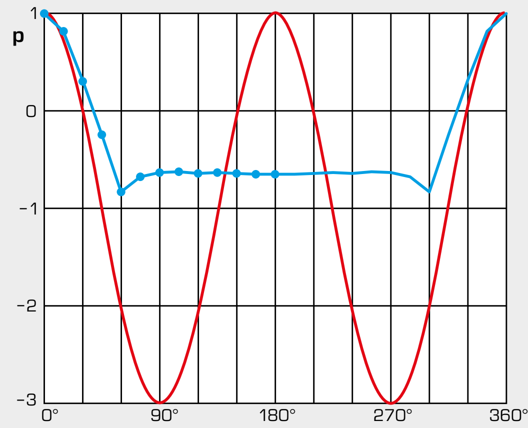
HM 170.23 Pressure distribution on a cylinder

- record pressure distribution on the perimeter of the cylinder
- measuring the static pressure
- each pressure measuring point is equipped with a hose connection



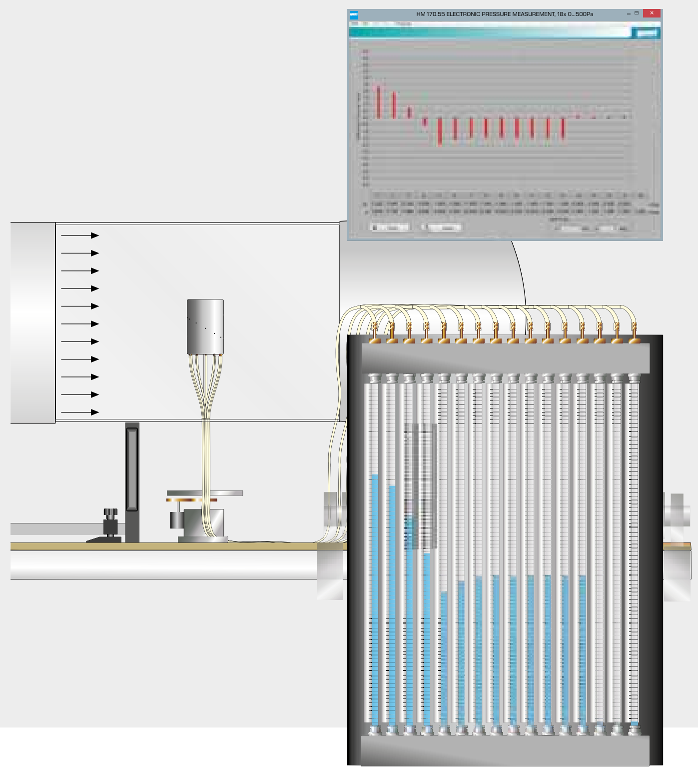


1 measuring point, **2** flow separation, **3** turbulence



Comparison between measured and ideal pressure distribution when flowing around a cylinder

ideal pressure distribution (frictionless), measured pressure distribution



In conjunction with the electronic pressure measurement HM 170.55:

- recording and display of the pressure distribution on a PC
- saving of measured values

In conjunction with the HM 170.50 16 tube manometers:

- recording the pressure distribution
- particularly clear display of the pressure distribution by the simultaneous measurement of all pressure measuring points with the tube manometers HM 170.50

HM 170.70
Wind power plant with rotor blade adjustment

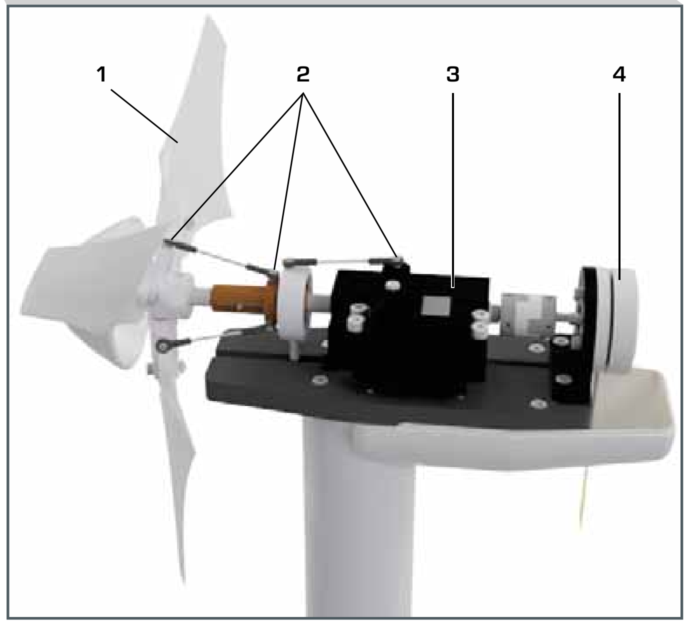
HM 170.70, together with the HM 170 wind tunnel, allows you to demonstrate a wind turbine with rotor blade pitching and variable-speed generator. The axial fan in the wind tunnel has a variable speed and provides the air flow required for the experiments. The generator is driven directly by a 3-blade rotor. A servo motor is used to change the angle of the rotor blades.

In order to approach different operating points, the nominal speed of the generator can be set via a controller. The rotor speed is precisely measured by Hall sensors built into the generator.

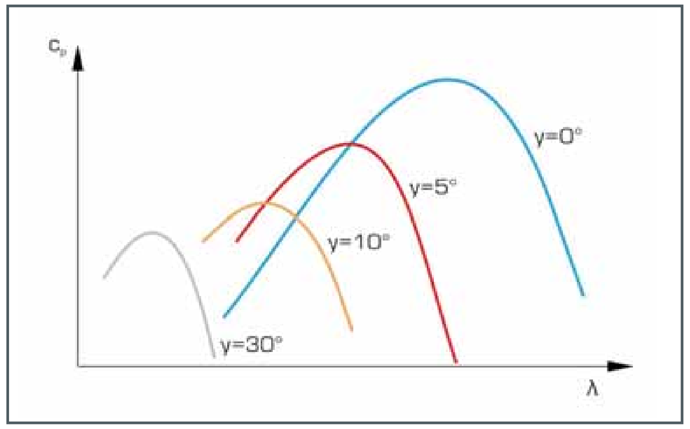
HM 170.70 connected to the open wind tunnel HM 170

Features

- wind turbine with variable speed
- rotor blades adjustment angle adjustable via servo motor
- investigation of own rotor blade shapes (3D printing) possible
- network capability: observe, acquire, analyse experiments via customer's own network



1 rotor blade, **2** rotor blade pitching, **3** servo motor, **4** generator



Determination of the power coefficient tip-speed ratio characteristic diagram

For the investigation of different shapes, rotor blades with straight and with optimised profile are included in the scope of delivery. Using suitable 3D construction and printing methods, new rotor blade shapes developed in-house can also be used.

HM 170
Accessories for the wind tunnel

HM 170.01
Drag body sphere

diameter: 80mm

HM 170.02
Drag body hemisphere

diameter: 80mm

HM 170.03
Drag body circular disc

diameter: 80mm

HM 170.04
Drag body circular ring

outer diameter: 113mm
inner diameter: 56,5mm

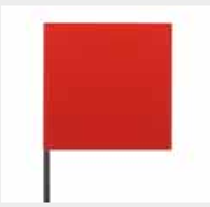
HM 170.05
Drag body square plate
LxW: 71x71mm

HM 170.12
Lift body square plate
LxW: 100x100mm

HM 170.09
Lift body aerofoil

Aerofoil profile NACA 0015
LxWxH: 100x100x15mm

additional aerofoil profiles available:
HM 170.13 NACA 54118
LxWxH: 100 x 100 x 19,65 mm
HM 170.14 NACA 4415
LxWxH: 100 x 100 x 15,5 mm



HM 170.06
Lift body flag

LxW: 100x100mm

HM 170.07
Drag body cylinder

height: 100mm
diameter: 50mm

HM 170.08
Drag body streamlined shape

length: 240mm
diameter: 60mm

HM 170.10
Drag body paraboloid

length: 90mm
diameter: 80mm

HM 170.11
Drag body concave shape

length: 68,65mm
diameter: 80mm

HM 170.21
Aerofoil with slat and slot flap

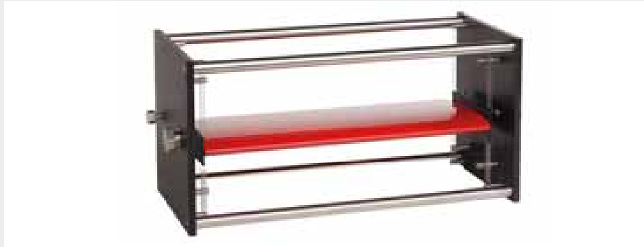
Aerofoil profile NACA 0015
LxWxH: 100x100x15mm

HM 170.22
Pressure distribution on an aerofoil
Aerofoil profile NACA 0015
LxWxH: 100x60x15mm
- recording the pressure curve
- measuring the lift force

additional aerofoil profiles available:
HM 170.26 NACA 54118
LxWxH: 100 x 60 x 19,65 mm
HM 170.27 NACA 4415
LxWxH: 100 x 60 x 15,5 mm

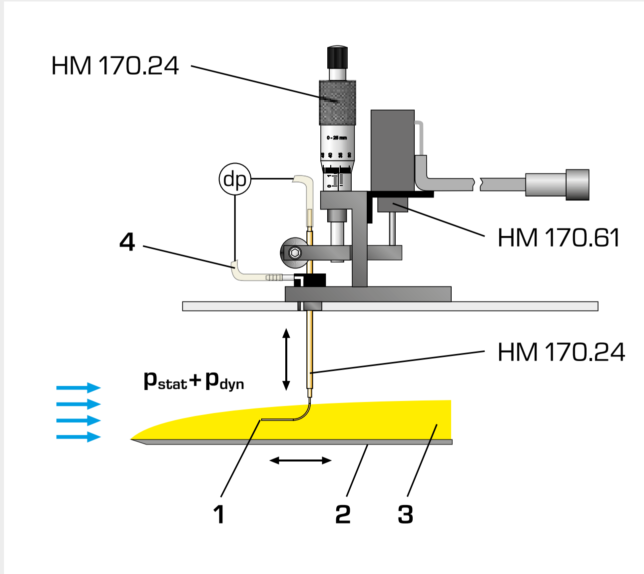
HM 170.23
Pressure distribution on a cylinder

height: 75,5mm
diameter: 50mm



HM 170.20 Airfoil, spring-mounted
Aerofoil profile NACA 0015
LxWxH: 200x100x15mm

- transverse rigidity: 216 N/m
- torsion rigidity: 0,07...0,28 Nm/rad



HM 170.24 Boundary layer analysis with Pitot tube
Two plates, rough and smooth, LxWxH = 279x250x3mm

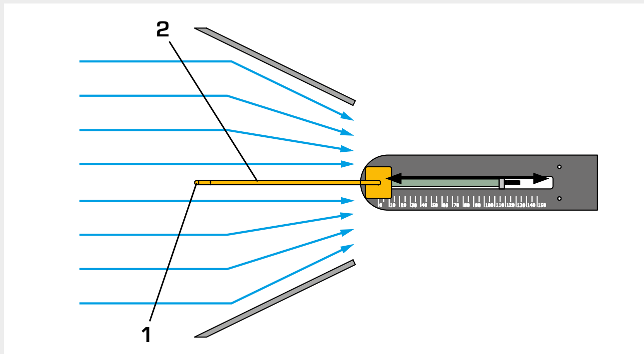
- vertically movable Pitot tube measures the pressures at various distances from the plate surface
- horizontally movable plate for recording pressures along the flow
- displaying measured values on the PC using HM 170.60 System for data acquisition and HM 170.61 Electronic displacement measurement

Measuring pressures:

1 stagnation point at the Pitot tube (total pressure), **2** flat plate, **3** boundary layer, **4** measuring point for static pressure, **dp** differential pressure measurement

HM 170.61 Electronic displacement measurement

Displacement measuring range: 0...10mm

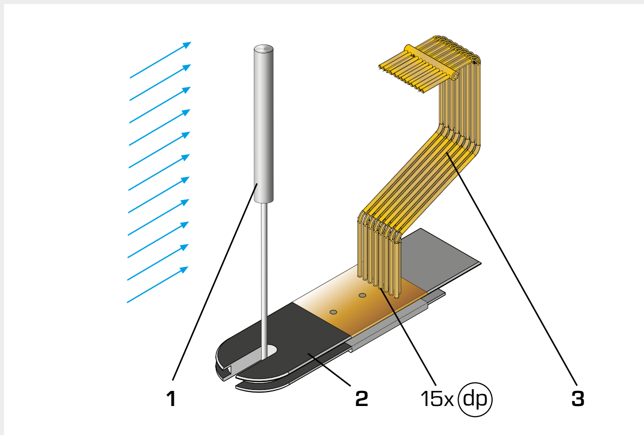


HM 170.25 Model "Bernoulli"
Air inlet: 292mm, air outlet: 146mm,
opening angle 52°, Pitotstatic tube, outer diameter: 4mm

- horizontally movable Pitotstatic tube
- wedge-shaped inserts forming a measuring section whose cross-section steadily narrows

Measuring pressures:

1 stagnation point at the Pitotstatic tube (total pressure),
2 Pitotstatic tube



HM 170.28 Wake measurement
Cylinder: DxH: 20x100mm
Wake rake consists of 15 Pitot tubes,
outer diameter: 2mm,
distance between the Pitot tubes: 3mm

- display of measured values on tube manometers HM 170.50 or on the PC using HM 170.55 Electronic pressure measurement

Measuring pressures:

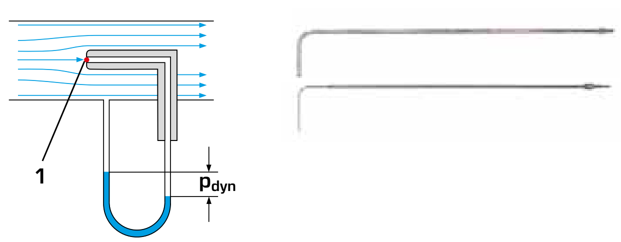
1 cylinder,
2 bracket,
3 wake rake,
dp differential pressure measurement

HM 170
Accessories for the wind tunnel

HM 170.70 Wind power plant with rotor blade adjustment
gearless wind power plant with 3-blade rotor, adjustable rotor blade angle via servo motor, investigation of own rotor blade shapes (3D printing) possible

- replaceable rotor blades with straight and optimised profile
- variable speed generator system
- recording of wind speed, rotor speed and generated electricity

1 connection for wind tunnel HM 170, **2** flow straightener, **3** tower, **4** wind power plant, **5** protective cover

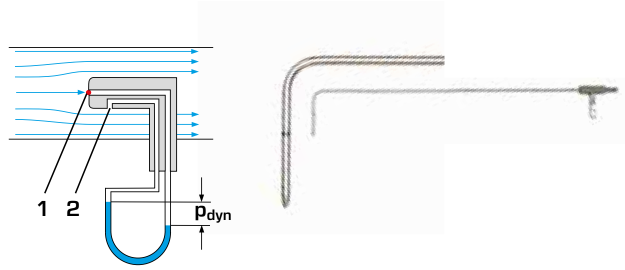


HM 170.31 Pitot tube
outer diameter: 4 mm

HM 170.32 Pitot tube, small
outer diameter: 2 mm

Determining the total pressure:

1 stagnation point
The pressure in the stagnation point is equal to the total pressure



HM 170.33 Pitotstatic tube
outer diameter: 3 mm

Determining the dynamic pressure:

1 stagnation point, **2** measuring point for static pressure
The difference between total and static pressure gives the dynamic pressure

HM 170.53 Differential pressure manometer

- differential pressure: 0...5 mbar
- graduation: 0,1 mbar

HM 170.50 16 tube manometers
L x W x H: 670 x 220 x 750 mm

- manometer inclination up to max. 1/10
- max. 600 mmWC
- height-adjustable manometer
- individual zero points can be set

The tube manometer operates on the principle of communicating tubes

HM 170.52 Fog generator
L x W x H: 350 x 500 x 300 mm

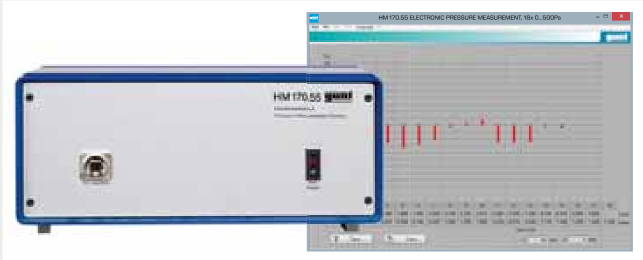
- power consumption: 500 W

HM 170.40 Three-component force sensor
L x W x H: 370 x 315 x 160 mm (measuring amplifier)
D x H: 115 x 150 mm (force sensor)

- measuring amplifier with connections for forces and moment
- connection to HM 170.60 possible
- display of drag, lift and moment

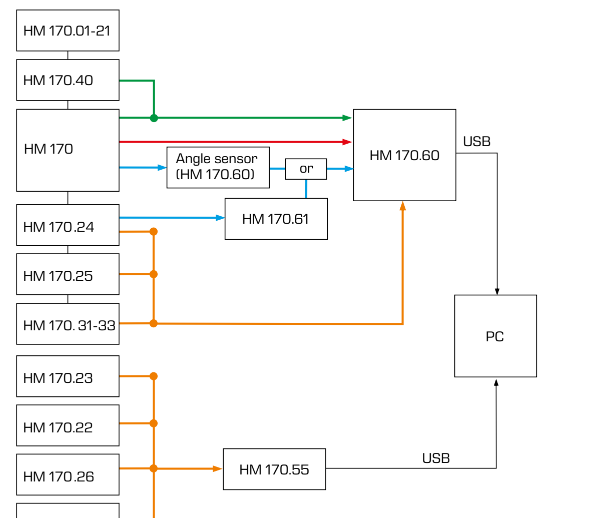
Measuring ranges
- drag: ±4 N
- lift: ±4 N
- moment: ±0,5 Nm
- angle: ±180°

1 force sensor, **2** measuring amplifier

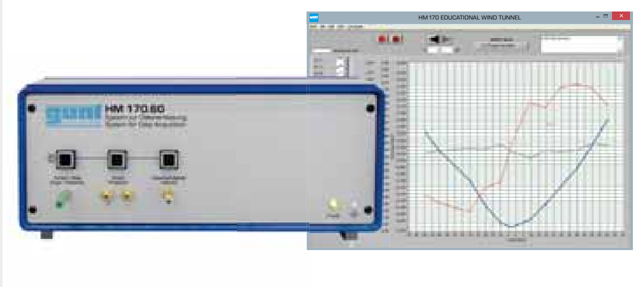


HM 170.55 Electronic pressure measurement for HM 170
L x W x H: 370 x 315 x 160 mm

- 18 inputs, ±5 mbar
- CD with GUNT software included
- data acquisition via USB under Windows



pressure, drag, lift force, moment (only with HM 170.40)
displacement / angle, velocity



HM 170.60 System for data acquisition
L x W x H: 360 x 330 x 160 mm (interface module)

- CD with GUNT software included
- data acquisition via USB under Windows
- angle sensor

Measuring ranges
- displacement: 0...10 mm
- angle: ±180°
- differential pressure: ±5 mbar
- velocity: 0...28 m/s
- drag: ±4 N
- lift: ±4 N
- moment: ±0,5 Nm
  (only for HM 170.40 Three-component force sensor)