

Digital pressure balance Model CPD8000



WIKA data sheet CT 32.04

Applications

- High-level digital primary standard
- Reference instrument for factory and calibration laboratories for the testing, adjustment and calibration of pressure measuring instruments
- Unique working principle
- Complete, stand-alone system, also suitable for on-site use

Special features

- Absolute and gauge pressure
- Resolution down to 1 ppm
- Several ranges up to 5 MPa
- Accuracy down to 20 ppm of reading
- Ideal for automatic calibration systems



Model CPD8000-AL digital pressure balance fitted with low-pressure head

Description

Reference primary standards

Pressure balances are high-accuracy fundamental pressure standards that define the derived unit of pressure directly from the fundamental units of mass, length and time following the formula $p = F/A$.

The model CPD8000 digital pressure balance is a worldwide exclusivity combining two high-level technologies:

- Best available piston-cylinder units, with precisely known effective area (A).
 - High-accuracy force cell which measures the force F
- CPD8000 is defined as a digital pressure balance and is a high-accuracy pressure measurement standard.

Basic principle

The CPD8000 measuring concept is a primary principle; it combines the measurement accuracy and reliability of fundamental pressure standards with the ease of use of automatic digital instruments.

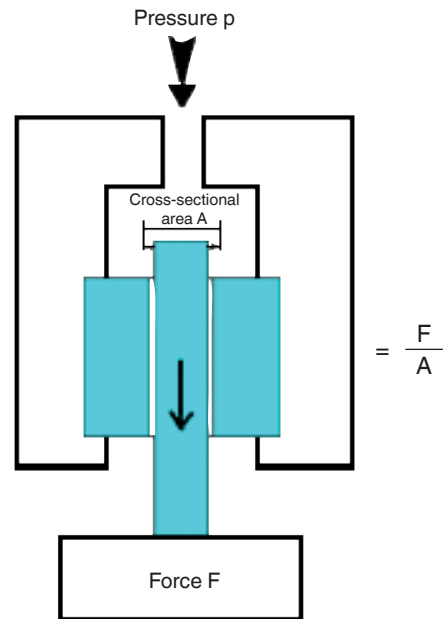
Easy operation

The model CPD8000 offers the same high accuracy as a high-end pressure primary standard with the benefits of:

- No weights manipulation
- Built-in reference mass for auto calibration
- Displaying of fully corrected pressure

The working principle

- The pressure is applied on the piston and turned into a proportional force that is transferred to the measuring-force cell.
- A microprocessor calculates the force corresponding to the pressure, corrects the environmental influences and finally transfers the pressure value to the display and to the communication interface.
- The measuring-force cell continuously measures and calculates the pressure-generated force.



Model CPD8000 basic principle

Absolute and gauge pressure

The model CPD8000 is available in two versions:

CPD8000-GH (gauge pressure)

Measurements ranging from 0 ... 50 MPa with atmospheric pressure reference.

CPD8000-AL/-AH (absolute and gauge pressure)

Measurements ranging from 0 ... 50 MPa in gauge mode and 0 ... 500 psi/3,447 MPa in absolute mode.

Versatile measurement, the force cell is placed in a reference chamber which can be at the atmospheric pressure for gauge measurement or vacuum for absolute measurement.

- Absolute pressure measurement is a simple and fast solution. It is capable to operate in an absolute pressure mode without interrupting the vacuum between each pressure point, as it is with the classical pressure balances.



Model CPD8000-GH



Model CPD8000-AL/-AH

General assembly

CPD8000's measurement quality and long-term performance are based on five key concepts.

Assembly of the piston-cylinder system

■ Key element

The role of the piston-cylinder assembly is to precisely convert the pressure into force. The quality of this transformation is due to its excellent geometry and very low sensitivity to external influences.

The Desgranges & Huot's piston-cylinder units (PCUs) are manufactured in a special grade of tungsten carbide, which is perfected over more than 50 years.

The manufacturing tolerances are typically below 0.1 µm which provides best in class sensitivity, linearity and a repeatability.

Our PCUs are made of tungsten carbide, which has the advantage of minimal distortion under temperature and pressure. Therefore, the piston maintains the metrological qualities regardless of the operating conditions.

■ A large choice of pressure ranges

Desgranges & Huot manufactures 21 piston-cylinder units of different areas (6 for the CPD8000-AL/-AH, 15 for the CPD8000-GH) with each of them offering a different measuring range.

In order to increase the ease of use, nominal area for each PCU is designed to have a linear conversion coefficient (Kn) of pressure to mass.

The measuring head

■ An essential role

The measuring head is focused on containing, operating and protecting the piston-cylinder assembly.

The head is fitted with a motorised rotating system which ensures the noise free rotation of the piston so that the force transmitted to the force cell is perfectly vertical.

It is equipped with a 4-wire platinum resistance thermometer allowing the most accurate measurement of the piston-cylinder unit temperature.

The coupling of the measuring head with the force cell allows easy dismantling of the measuring head.

The measuring cell

■ A force-transferring function

The electronic measuring-force cell has been developed for the highly accurate mass comparators.

It uses the MONOBLOC technology manufactured by electro erosion. This technology reflects the latest innovations realised in mechanics, electronics, computer science and opto-electronics.

Hence eliminating all the complicated mechanical links fit in a force sensor.

The measuring-force cell is associated with an auto-calibrating function which, whenever necessary, enables easy application of a reference force ($F = M \times g$) for recalibration purposes.

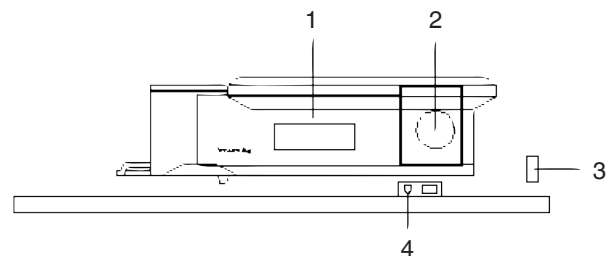
The auto-calibrating function (ACF)

The CPD8000 force cell response may drift with time. This drift is a result of the change in the environmental parameters ambient temperature, relative humidity and atmospheric pressure.

The CPD8000 is equipped with an auto-calibration function which minimizes the drift even when the measuring head is fitted.

The **ACF** provides a internal standard mass which can be easily loaded and by applying this standard mass, you readjust the deviation the force cell.

Optionally you can use a set of external standard masses.



- 1 Measuring-force cell
- 2 Internal standard mass
- 3 Computer connection
- 4 EMM sensors

The auto-calibrating function (ACF) basic principle

The environment monitoring module (EMM)

In order to determine whether it is necessary to use the **ACF**, the CPD8000 is equipped with an environment monitoring module which consists of 6 sensors for ambient temperature, relative humidity, atmospheric pressure.

The **EMM** monitors the ambient conditions continuously and instructs the CPD8000 to display a warning flag for **ACF**, if a noticeable change exists from previously stored conditions.

Displayed pressure calculation

The pressure displayed by the CPD8000 is calculated according to the following formula where:

$$P = Kn \times \frac{N}{N_k} \times \frac{g_l}{g_n} \times (1 - (\lambda_{PC} \times P)) \times (1 - \alpha_{PC} \times (t - 20)) \times \left(\frac{\rho_{ac} - \rho_m}{\rho_{an} - \rho_m} \right) + P_{Vac}$$

- **Kn** is the specific coefficient of the piston-cylinder unit
- **N** is the indication of the measuring-force cell in count
- **N_k** is the sensitivity of the measuring-force cell
- **g_l** is the local gravity in m/s²
- **g_n** is the normal gravity in m/s²
- **λ_{PC}** is the pressure-distortion coefficient of the piston-cylinder unit
- **α_{PC}** is the thermal-dilation coefficient of the piston-cylinder unit
- **t** is the temperature of the piston-cylinder unit in °C
- **ρ_{ac}** is the air density during the adjustment of the measuring-force cell in kg m⁻³. This parameter is null when the CPD8000-A operates in absolute mode.
- **ρ_m** is the density of the adjustment mass in kg m⁻³
- **ρ_{an}** is the normal air density in kg m⁻³
- **P_{Vac}** is the residual vacuum in the reference chamber

Variable parameters

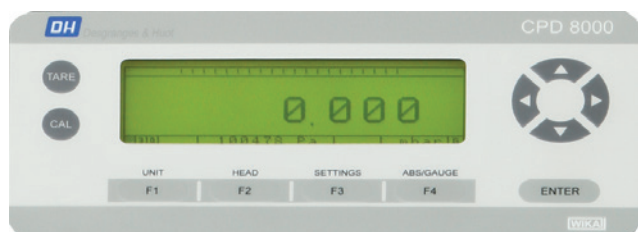
The variable parameters affecting the calculation of the pressure are automatically measured and integrated in the expression of the pressure:

- Temperature of the piston-cylinder unit (t)
- Ambient temperature ¹⁾
- Humidity ¹⁾
- Atmospheric pressure ¹⁾
- Residual vacuum (P_{Vide})

1) Defining the air density during the calibration (ρ_{ac})

The pressure is automatically converted into any of the common pressure units and the user has the possibility to configure the system to special units.

This rigorous metrology enables an ease of use as well as speed of measurement operation.



Display of the model CPD8000

Constant parameters

The constant parameters entering in the computing of pressure are stored in the non-volatile memory of the CPD8000:

- Kn of the piston-cylinder unit
- Sensitivity of the measuring-force cell (**N_k**)
- Normal gravity (**g_n**)
- Local gravity (**g_l**)
- Pressure-distortion coefficient of the piston-cylinder unit (**λ_{PC}**)
- Thermal dilation coefficient of the piston-cylinder unit (**α_{PC}**)
- Density of the calibration mass (**ρ_m**)
- Normal air density (**ρ_{an}**)

Some of these parameters are specific to each piston-cylinder unit and are determined during the calibration. You can easily modify them if necessary and the internal memory allows saving the parameter of three different piston-cylinder units

Measuring ranges

The pressure measuring ranges of the CPD8000 depend on the specific coefficient (Kn) of the piston-cylinder unit with which the measuring head is equipped.

Various measuring heads can be used with the same CPD8000.

CPD8000's internal memory has the ability to save the metrological coefficients for 6 different piston-cylinder units.

Measuring head	Pressure ranges	Resolution	Measurement uncertainty ¹⁾		Piston-cylinder unit Kn	Usable medium
			Standard	Premium		
Absolute and gauge pressure CPD8000-AL / -AH						
A01	0.001 mbar ... 1 bar	0.001 mbar	0.005 %	0.0025 %	0.1 bar/kg	Pure gas
A02	0.002 mbar ... 2 bar	0.002 mbar	0.005 %	0.0025 %	0.2 bar/kg	Pure gas
A03	0.005 mbar ... 5 bar	0.005 mbar	0.005 %	0.0025 %	0.5 bar/kg	Pure gas
A04	0.01 mbar ... 10 bar	0.01 mbar	0.005 %	0.0025 %	1 bar/kg	Pure gas
A05	0.02 mbar ... 20 bar	0.02 mbar	0.005 %	0.0025 %	2 bar/kg	Pure gas
A06	0.05 mbar ... 50 bar	0.05 mbar	0.005 %	0.0025 %	5 bar/kg	Pure gas
A07	0.0005 ... 500 psi	0.0005 psi	0.005 %	0.0025 %	50 psi/kg	Pure gas
Gauge pressure CPD8000-GH						
G01	0.001 mbar ... 1 bar	0.001 mbar	0.005 %	0.0025 %	0.1 bar/kg	Pure gas
G02	0.002 mbar ... 2 bar	0.002 mbar	0.005 %	0.0025 %	0.2 bar/kg	Pure gas
G03	0.005 mbar ... 5 bar	0.005 mbar	0.005 %	0.0025 %	0.5 bar/kg	Pure gas
G04	0.01 mbar ... 10 bar	0.01 mbar	0.005 %	0.0025 %	1 bar/kg	Lubricated gas
G05	0.02 mbar ... 20 bar	0.02 mbar	0.005 %	0.0025 %	2 bar/kg	Lubricated gas
G06	0.05 mbar ... 50 bar	0.05 mbar	0.005 %	0.0025 %	5 bar/kg	Lubricated gas
G07	0.1 mbar ... 100 bar	0.1 mbar	0.005 %	0.0025 %	10 bar/kg	Lubricated gas
G08	0.2 mbar ... 200 bar	0.2 mbar	0.005 %	0.003 %	20 bar/kg	Lubricated gas
G09	0.5 mbar ... 500 bar	0.5 mbar	0.005 %	0.0035 %	50 bar/kg	Lubricated gas
G20	0.0002 ... 200 psi	0.0002 psi	0.005 %	0.0025 %	20 psi/kg	Lubricated gas
G21	0.0005 ... 500 psi	0.0005 psi	0.005 %	0.0025 %	50 psi/kg	Lubricated gas
G22	0.001 ... 1,000 psi	0.001 psi	0.005 %	0.0025 %	100 psi/kg	Lubricated gas
G23	0.0025 ... 2,500 psi	0.0025 psi	0.005 %	0.003 %	250 psi/kg	Lubricated gas
G24	0.003 ... 3,000 psi	0.003 psi	0.005 %	0.003 %	300 psi/kg	Lubricated gas
G25	0.005 ... 5,000 psi	0.005 psi	0.005 %	0.003 %	500 psi/kg	Lubricated gas

¹⁾ Measurement uncertainty is equivalent to $\sqrt{(\text{Repeatability}^2 + \text{Resolution}^2 + \text{Linearity}^2 + \text{Hysteresis}^2)}$ and is expressed in % of reading.

Other pressure ranges on request.

Specifications Model CPD8000

Piston-cylinder system

Material	Tungsten carbide
Poisson's ratio	0.218
Young's modulus	$6 \cdot 10^{11}$ N/m

Typical geometry researched

Straightness	0.1 μm (typical manufacturing tolerance)
Roundness	0.1 μm (typical manufacturing tolerance)
Parallelism	0.1 μm (typical manufacturing tolerance)
Clearance between the piston and the cylinder	0.2 ... 0.4 μm according to the model
Stability of the effective area	≤ 1 ppm/an

Standard masses

Internal mass

Material	304L non magnetic stainless steel
Mass density	7,900 kg/m ³ ± 10 %

External optional calibration masses

Material	304 L steel
Mass density	7,920 kg/m ³ ± 10 %
Composition of the set	5 x 2 kg

Base instrument

Case

Dimension (L x W x H)	530 x 400 x 320 mm
Weight	20 kg

Display

Screen	Large LCD back-lighting graphic screen with contrast adjustment
Indication	Pressure display in 12 pressure units and a user unit EMM parameters display Permanent display of the residual vacuum

Front panel	Tare key CAL button, automatic calibration function (ACF)
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Sensor specifications

Maximum overpressure	110 % FS
Pressure transmission medium	Clean, dry, non-corrosive gases

Voltage supply

Power supply	AC 110 ... 240 V, 50/60 Hz
Power consumption	20 VA

Base instrument

Environmental measuring module (EMM)	Sensor type	Accuracy	Alarm setting
Ambient temperature	4-wire Pt100	±0.2 °C	±2 °C
Relative humidity	Capacitive sensor	±5 % r. h.	±20 % r. h.
Atmospheric pressure	Strain sensor	±2 mbar	±10 mbar
PCA temperature	DIN 43760 4-wire Pt100	±0.1 °C	N/A
Residual vacuum	Pirani gauge ≥ 1 Pa ±1 E ⁻⁴		
Researched metrological specifications			
Linearity	2 E ⁻⁶ FS		
Hysteresis	2 E ⁻⁶ FS		
Sensitivity	7 E ⁻⁶ FS		
Repeatability	≤ 5 E ⁻⁶ FS		
Temperature effect	Full compensation		
Measurement uncertainty	down to 25ppm of rdg. depending on range		
Permissible ambient conditions			
Operating temperature	18 ... 28 °C		
Relative humidity	15 ... 85 % r. h. (non-condensing)		
Communication			
Interface	RS-232-C		
Sampling rate	250 ms		

Approvals and certificates

CE conformity

Pressure equipment directive 97/23/EC (Module A)

Certificate

Calibration Standard: COFRAC certificate
Option: LNE/PTB certificate

Scope of delivery

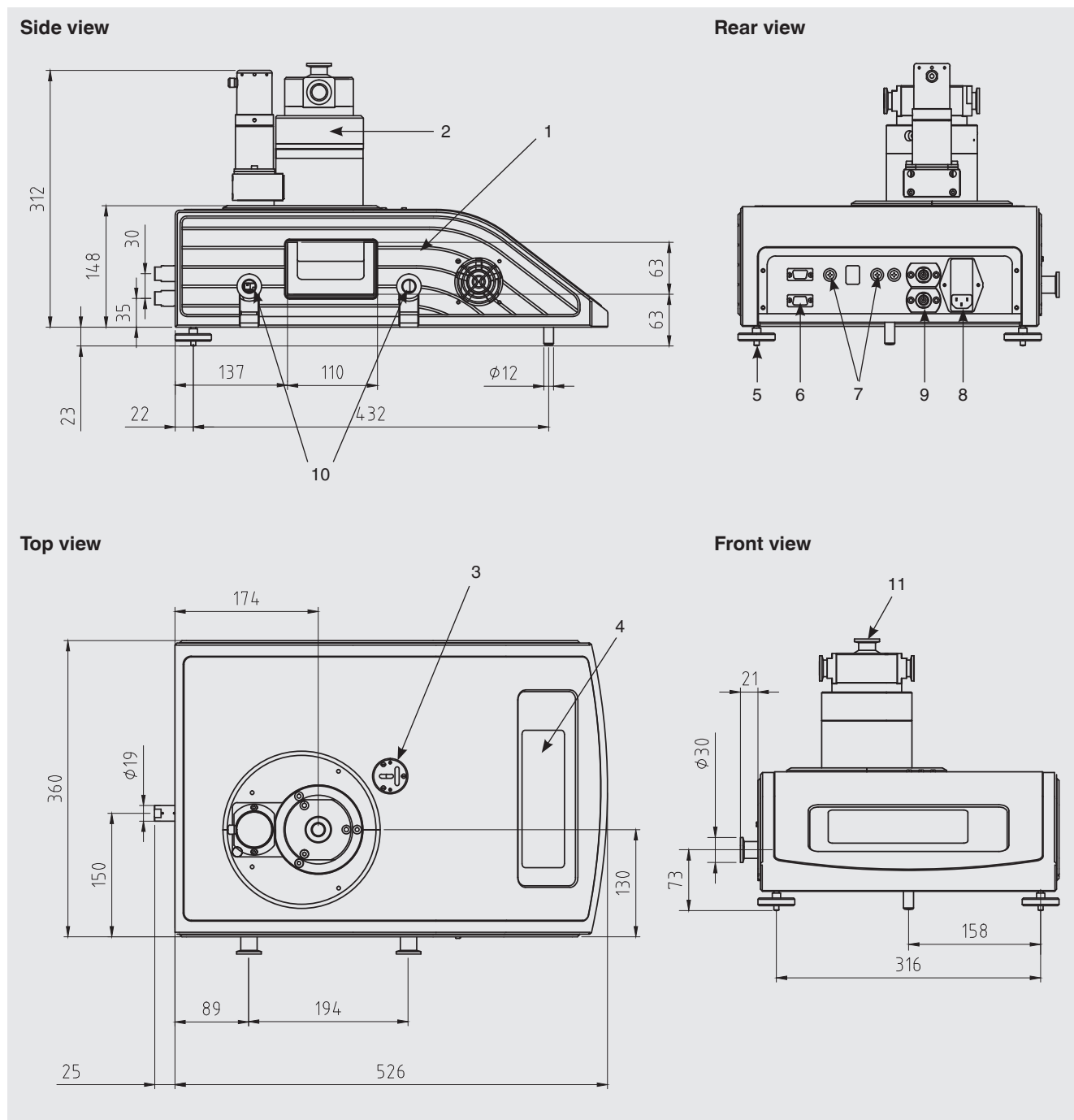
- Digital pressure balance, model CPD8000 incl. transport case
- Measuring head
- 1 Pt100 probe
- Cover for measuring head and measuring post
- 1 power cord
- 1 RS-232 interface cable
- Tool set consisting of: 1 tool for CPD8000 belt, 1 hexagon wrench key with 5 mm A/F, and 1 open-ended spanner 10/12
- Set of tubing and accessories to set up the machine
- Operating instructions
- COFRAC calibration certificate

Options

- Premium accuracy incl. LNE/PTB calibration certificate

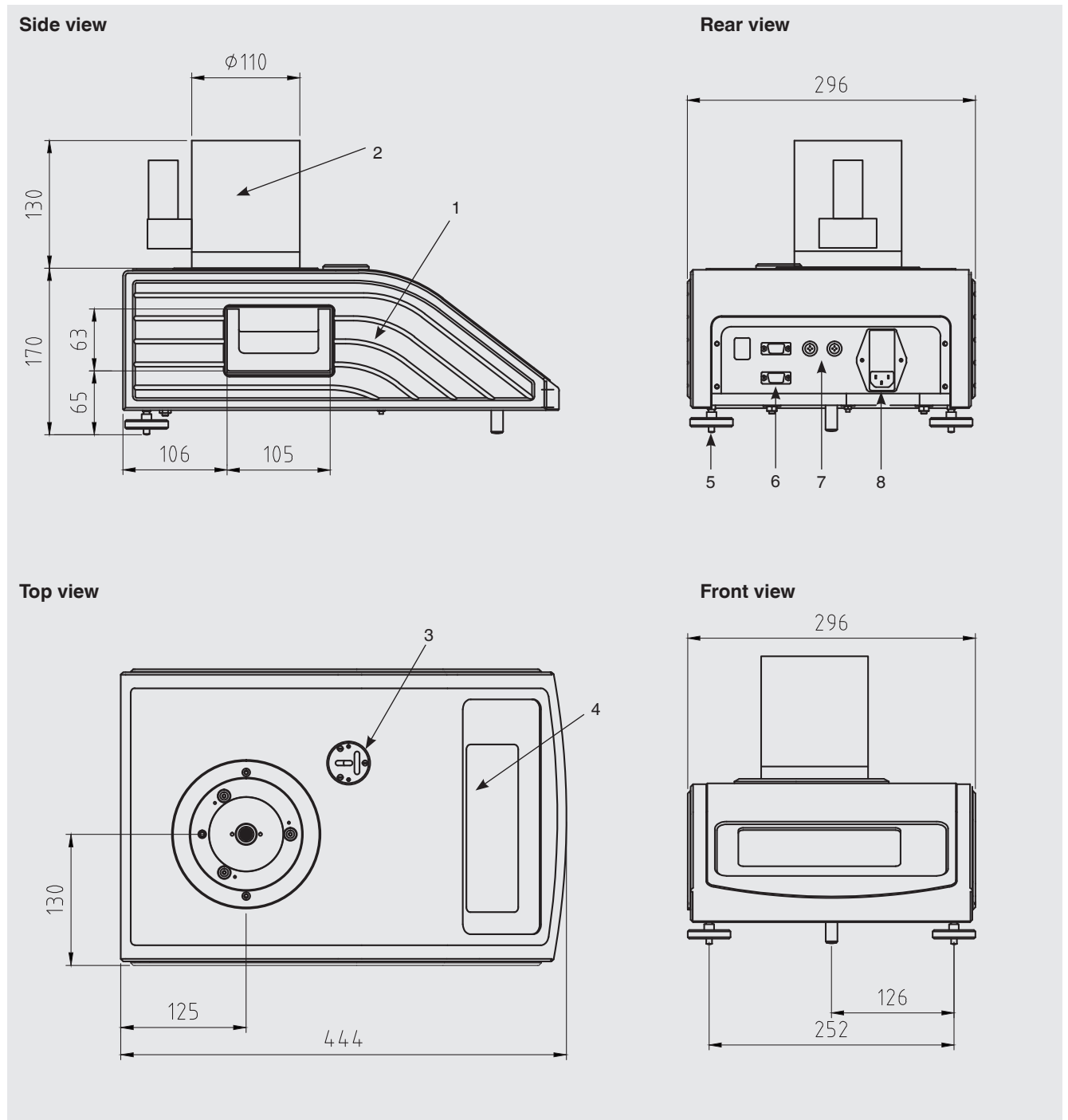
Dimensions in mm

Model CPD8000-AL / -AH



- | | |
|---------------------|---|
| (1) Measuring cell | (7) Connection port for motor and platinum resistance thermometer (PRT) |
| (2) Measuring head | (8) Power supply |
| (3) Bubble levels | (9) Lubrication connection (for AH version) |
| (4) Digital display | (10) Reference vacuum connections |
| (5) Levelling feet | (11) Connection flange to instrument under test |
| (6) COM port to PC | |

Model CPD8000-GH



- (1) Measuring cell
- (2) Measuring head
- (3) Bubble levels
- (4) Digital display
- (5) Levelling feet
- (6) COM port to PC

- (7) Connection port for motor and platinum resistance thermometer (PRT)
- (8) Power supply

Remote control

All of the CPD8000 functions, even the **ACF** running command, can be executed from an external computer through serial interface (RS-232-C), which enables it to be integrated in an automatic calibrating system.

A programming example is provided in the user's manual.

Maintenance

The CPD8000 is delivered with the operating instructions, consumables and tools allowing its general maintenance. No other maintenance is necessary if the standard is used in accordance with the routine instructions described in the manual. Recalibration is recommended every five years depending on the condition of usage.

Calibration

All CPD8000 are delivered with a gauge calibration certificate issued as standard by the COFRAC accredited Degranges & Huot's laboratory (accreditations 2-1033 and 2-1129). This assures the user that the presented calibration results are unbiased.

The COFRAC calibration guarantees the traceability of the measurements done by the CPD8000 to the national and international standards, and it takes into account:

- The Kn specific coefficient determination
- The ACF calibration control

The uncertainty calculation presented in the certificate respects the ISO TAG4 and EAL recommendations and shows the enlarged uncertainty of the CPD8000 with a coefficient $k = 2$.

It takes into account the CPD8000's intrinsic measurement errors, the uncertainty of the reference as well as the influence of the environment conditions.

CE compatibility

The CPD8000 complies with the following European directives and standards:

- N° 89/336/CEE **Electromagnetic Compatibility Directive** dated May 3th, 1989 modified by the N° 92/31/CEE directive dated May 12th, 1992 and the N° 93/68/CEE directive dated July 22th, 1993
- N° 73/23/CEE Low Tension Directive dated February 19th, 1973 modified by the N° 93/68/CEE directive dated July 22th, 1993
- EN 50082-1 Ed.92 standard (Emission with the 89/336/CEE directive)
- EN 55022 B Class Ed. 87 standard (Immunity with the 89/336/CEE directive), EN 61010 standard (Safety rules for the use of measuring, regulating and laboratory electric instruments with the 73/23/CEE directive)

Option

By using a special adaptation kit, it is possible to use the gauge head model of the CPD8000-GH with the CPD8000-AL/-AH.

These heads can be used to work only in gauge mode but allow extending the range capability of the CPD8000-A up to 50 MPa.

Conclusion

Due to the design and performance, the model CPD8000 digital pressure balance is unique in the world. The operations with the balance do not necessitate a bell to create the vacuum and masses load.

Connected to an automatic controller, the CPD8000 enables performing fast calibrations, without having to break the vacuum between each pressure point, with a high metrological reliability.

These instruments are used by national laboratories, calibration labs, meteorology, the R&D laboratories, sensor manufacturers and aerospace or avionic companies.

Summary of the functions

The CPD8000 has a great variety of functions aimed at facilitating its use and assuring the quality of its long-term operation:

- Menus in English, French, German and Spanish
- Saving of the metrological characteristics for 6 pressure ranges
- Overpressure visual and sound warning
- Mechanical protection against overpressure up to 110 %
- User-adjustable pressure stability criterion
- Choice between internal/external calibration
- Calibration visual warning when the calibration is necessary
- Piston-cylinder unit temperature measuring circuit with auto calibration by resistance of integrated reference

Further pressure balances within our calibration technology programme

Primary-standard pressure balance model CPB6000

Measuring ranges:

- Pneumatic up to 1,000 bar
- Hydraulic up to 5,000 bar

Accuracy: Total measurement uncertainty up to 0.002 % of reading depending on model

For specifications see data sheet CT 32.01



Primary-standard pressure balance, series CPB6000

Primary-standard differential pressure balance, model CPB6000DP

Measuring range = (static pressure + differential pressure):

- Pneumatic up to 800 bar

Accuracy: 0.005 % of reading
up to 0.002 % of reading (optional)

For specifications see data sheet CT 32.02



Primary-standard differential pressure balance, model CPB6000DP

Automatic pressure balance, model CPB8000

Measuring ranges:

- Pneumatic up to 1,000 bar
- Hydraulic up to 5,000 bar

Accuracy: 0.005 % of reading
up to 0.003 % of reading (optional)

For specifications see data sheet CT 32.03



Automatic pressure balance, model CPB8000

Ordering information

Model / Instrument version / Accuracy / Measuring head / Calibration for pressure balance / Additional order information

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