

Automatic pressure balance

Models CPB8000-PX and CPB8000-HX



WIKA data sheet CT 32.03

Applications

- Combining automation with high-level primary pressure balance
- A powerful solution to test and calibrate high-specifications pressure sensors
- Automatic calibration and verification of pressure instruments
- Large-volume calibrations

Special features

- Total measurement uncertainty down to 20 ppm of reading
- Available up to 1,000 bar (14,500 psi) pneumatic and 5,000 bar (72,500 psi) hydraulic
- Automatic mass-load system with a resolution down to 0.1 g
- Automatic pressure generation

Description

Reference primary standards

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

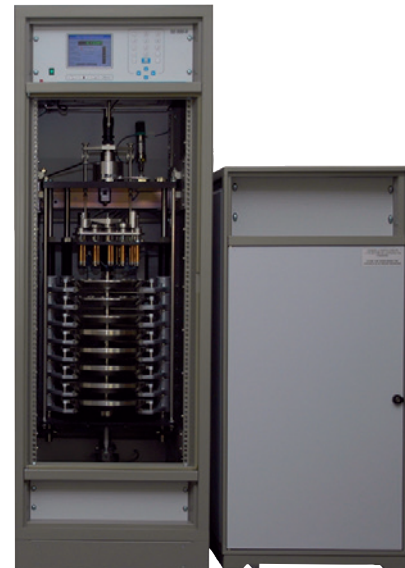
The direct measurement of the pressure with a pressure balance combined to the know-how of Desgranges & Huot guarantee the best metrological specifications on the market.

- High-quality piston-cylinder systems (high floating time and long-term stability)
- Protection and smooth handling of the mass set

This type of pressure balance has been successfully tested by national institutes, calibration laboratories and all type of industries.

Large-volume calibration

CPB8000 has been designed to provide the best available metrological specifications but also to respond to industry requirements. Providing a high MTBF, the CPB8000 pressure



Automatic pressure balance, model CPB8000

generation system can also generate and regulate with large volume under test.

Automation and metrology

The servo-controlled spindel pump for pressure generation, combined to the built-in optical detection used to measure the piston position, offers fine and reliable pressure regulation. The mass set protected in a cabinet is handled carefully providing the highest stability. Finally the pressure is automatically fully corrected taking in account all ambient parameters.

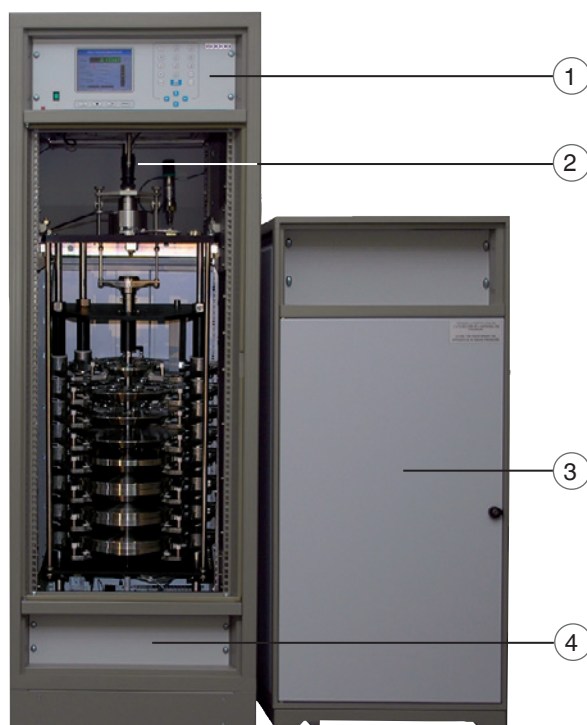
Our models

CPB8000 is available in four versions: pneumatic or hydraulic pressure, with or without the trim mass set handling system (optional down to 10 mg). A large range of piston-cylinder systems is available to best meet your specific requirements.

Automatic pressure balance with pressure generation system

The complete CPB8000 pressure balance consists of four inter-connected systems mounted into two separate standard rack enclosures.

- ① **The electronic interface**
The PC-based electronic module is used to control mass load, piston position, pressure generation and displays current system status.
- ② **The pressure balance**
It consists of the mass set, mounting post for the piston and cylinder and the interchangeable tungsten carbide piston-cylinder system. Hydraulic operation requires the model CPB8000-HX and for gas the model CPB8000-PX is used.
- ③ **Pressure generation system**
The automatic system uses a servo-controlled spindle pump. As an option a pre-filling system is available, this allows the standard to work with larger volumes. A manual system is available as an alternative.
- ④ **The pneumatic module**
It contains several solenoids which operate the pneumatic cylinders to control the loading of the masses.



The control unit

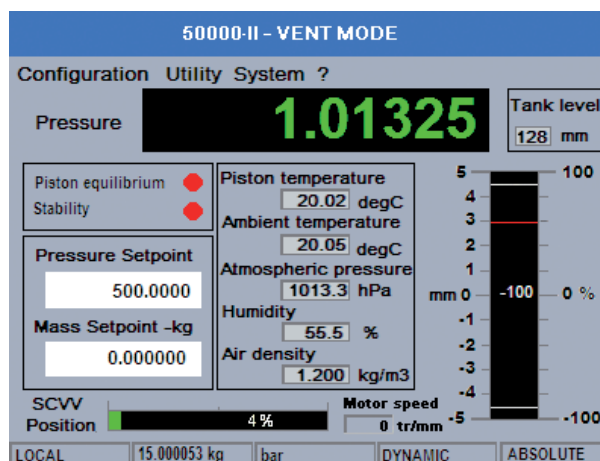
The model CPB8000 pressure balance can be controlled and monitored in two ways:

- By using the in-built electronic control module and its keypad.
- By using external computer and software via IEEE-488 (SCPI protocol)

The computer-driven controller provides all monitoring, control functions and does all metrological corrections of the influence factors, the pressure displayed is therefore the true pressure.

The standard consists of an internal computer, a TFT screen with a wide viewing angle and a 23-key keypad. It controls the pressure generation and the mass-load components. The user can enter the target pressure, the computer will then determine the value of masses required taking all influence factors into account or alternatively, the user can input the value of mass to be loaded directly. The system can operate in one of 10 standard pressure units or a user defined unit.

The system includes an **EMM** (Environmental Monitoring Module) with sensors for ambient temperature, humidity and air pressure. This sensors are used to determine the air density and carry out corrections for air buoyancy effects. The temperature of the piston-cylinder system is also measured and appropriate corrections are applied.



The display shows all critical parameters, including: true pressure, piston equilibrium status, piston stability zone, pressure set point, mass set point, calculated true mass and pressure unit in use, plus graphical display of variable volume position and most important piston position.

The unit can operate in absolute pressure mode with the optional **DPM** barometric sensor connected to an RS-232 port, this provides high accuracy absolute pressure measurement above ambient pressures.

The piston-cylinder system

Kn conversion factor

What is the Kn factor?

All piston-cylinder systems and masses mountable on CPB8000 pressure balances are built around a nominal mass to pressure conversion coefficient, Kn. The nominal effective area of each piston-cylinder size is such that, under standard conditions, the piston loaded with 1 kg of mass floats at a whole number pressure value such as 20 bar (2 MPa or 100 psi).

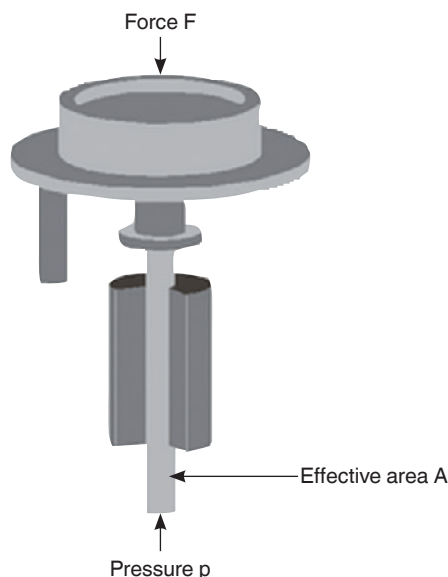
All mass values, including the mass of the piston are adjusted to be a whole number or fraction of the kilogram.

The nominal pressure defined by any model CPB8000 is calculated as Kn multiplied by the mass loaded in kg. Corrections are applied to Kn to calculate the pressure defined within the uncertainty budget of the model CPB8000 standard used.

The use of Kn and whole number masses in no way affects the traditional pressure equation or the factors that affect a pressure measurement made with a pressure balance. Kn is the basis of a coherent relationship between mass, effective area and pressure throughout the CPB8000 series. It is intended as a tool that reduces operator confusion and errors by simplifying the calculation of mass loads and measured pressures.

The piston cylinder “heart of the system”

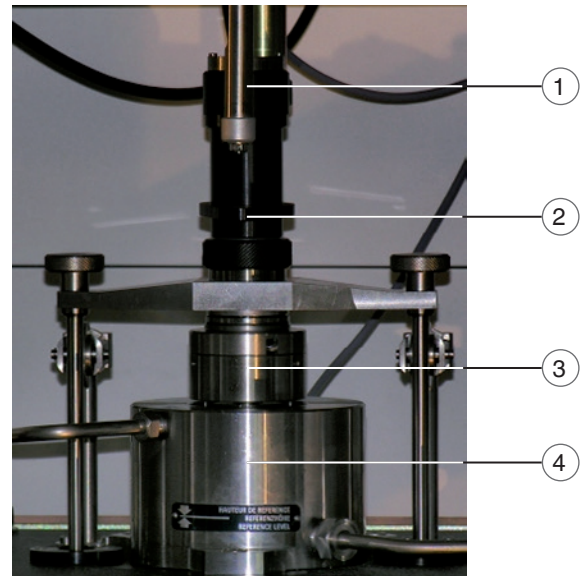
The piston-cylinder system is the heart of the pressure balances and the key to its performance.



The basic principle of piston-cylinder systems $p = F/A$

The piston-cylinder system is the heart of the pressure balance. These are manufactured in tungsten carbide and are honed and lapped to provide critical geometry better than 0.1 μm . There are 13 sizes of piston-cylinder systems available to cover range from 2 ... 5,000 bar (0.2 ... 500 MPa or 29 ... 72,500 psi). Dependent on the diameter of the piston, they are mounted in four types of mounting exposures.

Piston-cylinder systems can be exchanged very easily within the same type of mounting post. The mounting post also holds the RTD temperature probe.



- ① Piston position sensor
- ② Piston-cylinder system rotation motor
- ③ Piston-cylinder system
- ④ Piston-cylinder system exposure

The mass set and the mass-load mechanism

The mass set of the CPB8000-HR for high resolution is unique in the world. Made in AISI316 austenitic, non-magnetic stainless steel, it is composed of several masses multiple or sub-multiple of the kilogramme and in binary progression. The smallest one is 0.1 g and the biggest one is 16,384 g. This unique design allows the machine to load any mass value between 2 kg (the starting point of the machine) and 100 kg by steps of 0.1 g. This gives a mechanical resolution of 1 ppm.

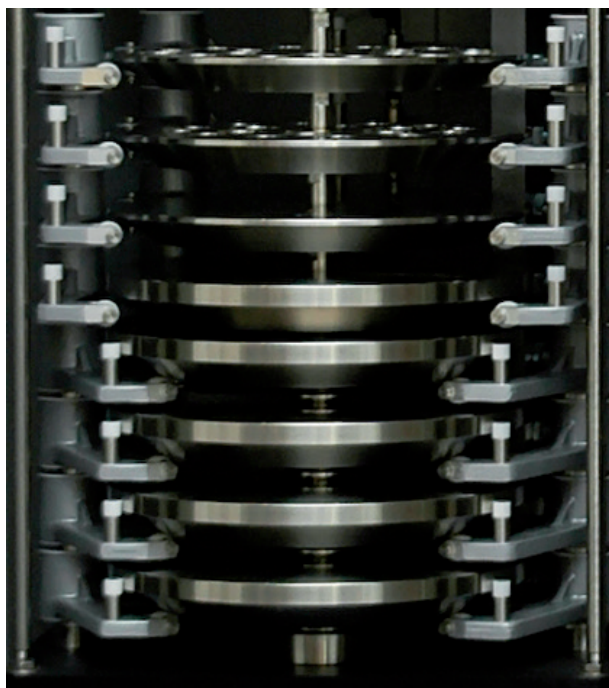
A option is available with masses down to 0.01 g. With this option is a resolution of 0.1 ppm possible!

The mass set of the CPB8000-LR, low resolution is a simplified version with a resolution of 1 kg only.

Each mass is loaded or unloaded onto the piston with an individual actuator. The complete sequence to load or unload a mass value is done within 10 seconds.

Each mass is calibrated and adjusted with a tolerance down to 10 ppm of its nominal value. All values are stored in the electronic rack for the calculation.

The main masses are loaded or unloaded with three arms linked to a pneumatic actuator. All movement are user adjustable.



Automatic mass handling system

The small masses are directly loaded or unloaded with a small actuator. The masses from 16 g up to 1,024 g are composed of 2 masses of half weight (i.e. 32 g = 2 masses of 16 g) and they are physically in opposed position to keep a good centering of the piston and not apply lateral perturbation force.



Automatic fine increment mass handling

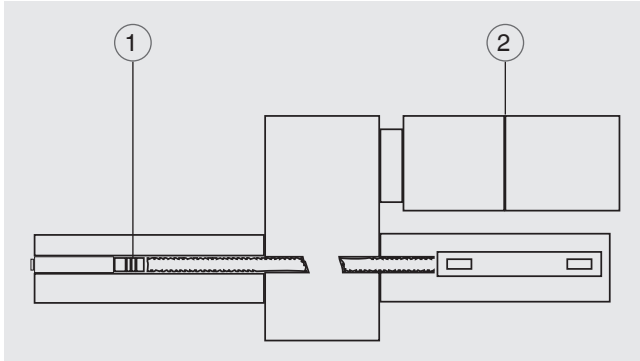
The kilogram

The unit of mass used is always the kilogram because the kilogram is the SI unit and the national and international standard for mass from which all other mass units are derived. The kilogram also offers the convenience of being based on the decimal system, which facilitates mass totalling and data reduction.

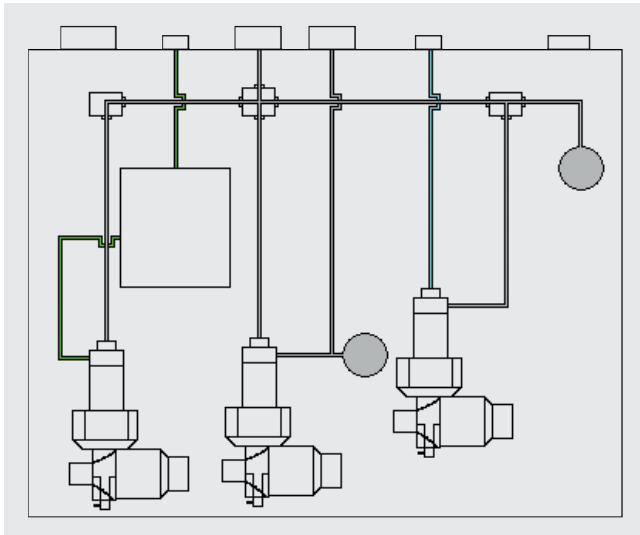
Pressure generator

Hydraulic

The pressure is generated by a servo-controlled spindle pump. A piston ① moves in a chamber to compress the fluid. It is controlled by a brushless motor ② and is linked to the position of the measuring piston cylinder.



The priming can be done by applying the drive air in the oil reservoir or by using a priming rack with an enclosed hydro-pneumatic pump and several valves.



The priming rack allows also performing several complete stroke of the spindle pump. If the spindle pump arrives at the end of his stroke, the circuit under test is then isolated and the spindle pump recharged. This feature is useful when the volume under test is large. It is completely managed by the electronic interface of the mass-load rack.

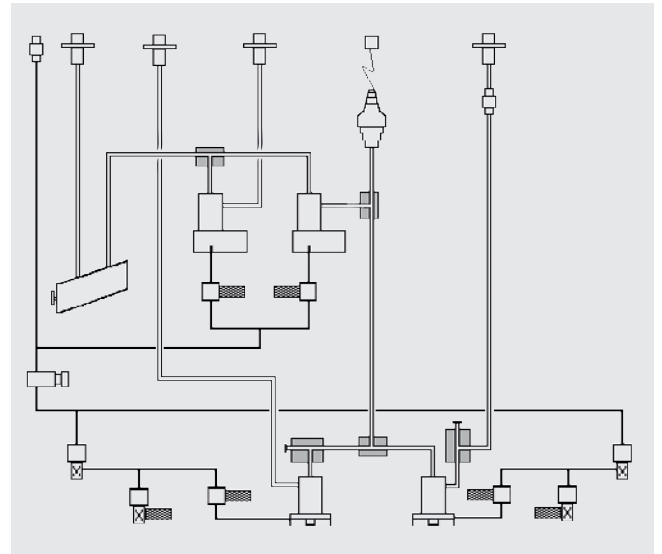
This pressure generator has been developed keeping in mind an easy accessibility by the user if maintenance is required. All sub-assemblies can be accessed by the front by simply opening a door.

Pneumatic

The pneumatic gas pressure generator is in fact a pressure controller. Depending on the pressure range, an external gas or air pressure source such as a nitrogen cylinder or a compressor is required. The pressure source must be at least equal to the maximum pressure needed.

99 % of the generation is done by using a pressure controller with enclosed several pneumatic operated valves as well as classical valve.

This pressure controller is also fully managed by the software of the CPB8000. Several versions are available up to 1,000 bar (14,500 psi).



The fine tuning is done by using the same servo-controlled spindle pump as the hydraulic version.

This controller operates with nitrogen or clean and dry compressed air correctly filtered (0.1 µm recommended).

Specifications Series CPB8000

Model	CPB8000-PX pneumatic	CPB8000-HX hydraulic
Pressure transmission medium	Clean and dry air or nitrogen	Sebacate
Lubrication medium	Drosera™	Sebacate
Pressure ranges	0 ... 1,000 bar (0 ... 14,500 psi)	0 ... 5,000 bar (0 ... 72,500 psi)
Drive air supply	8 ... 10 bar (116 ... 145 psi)	
Voltage supply		
Power supply	AC 240 V, 50 ... 60 Hz (For country using AC 110 V, a power transformer is required)	
Communication		
Interface	GPIB (SCPI protocol)	
Material		
Piston-cylinder system	Tungsten carbide	
Mass set	Material AISI316 austenitic, non-magnetic stainless steel	
Mass set	100 kg in binary progression	
Mass set resolution	Standard: (LR) 1 kg Optional: (HR) 10 mg	
Weight		
Mass-load rack	200 kg (440 lbs)	
Pressure generator	170 kg (375 lbs)	
Permissible ambient conditions		
Operating temperature	18 ... 28 °C (64 ... 82 °F)	
Relative humidity	15 ... 85 % r. h. (non-condensing)	
Dimensions (B x T x H)		
Mass-load rack	600 x 600 x 1,800 mm (23.6 x 23.6 x 70.9 in)	
Pressure generator	550 x 1,250 x 1,000 mm (22 x 49.2 x 39.4 in)	

Piston-cylinder system / Kn	Pmax	Typical sensitivity of reading ¹⁾ in 1.0E-6 x P (ppm)	Typical measurement uncertainties ¹⁾ in ppm	
			Usable media	
			Oil	Gas lubricated
0.1 MPa/kg respectively 1 bar/kg	100 bar	10	50	20
20 psi/kg	2,000 psi	10	50	20
0.2 MPa/kg respectively 2 bar/kg	200 bar	10 / 5	30	20
50 psi/kg	5,000 psi	10 / 5	30	20
0.5 MPa/kg respectively 5 bar/kg	500 bar	5	30	30
100 psi/kg	10,000 psi	5	30	30
1 MPa/kg respectively 10 bar/kg	1,000 bar	10 / 5	30	30
200 psi/kg	20,000 psi	10 / 5	30	30
250 psi/kg	25,000 psi	10	30	--
2 MPa/kg respectively 20 bar/kg	2,000 bar	10	30	--
300 psi/kg	20,000 psi	10	30	--
500 psi/kg	50,000 psi	15	50	--
5 MPa/kg respectively 50 bar/kg	5,000 bar	15	50	--

1) The total measurement uncertainty is defined as the uncertainty in measurement attributed via the reference standard uncertainty, influence of environmental conditions, resolution of the instrument, repeatability and hysteresis characteristics during the measurement with the coverage factor k = 2.

CE conformity and certificates

EC conformity

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

Calibration	COFRAC calibration certificate Option: LNE/PTB calibration certificate
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Approvals and certificates, see website

Transport dimensions for complete instrument

The complete instrument, in its standard version and standard scope of delivery, consists of one package for the mass-load rack, one package for the pressure generator and one package for the mass set and accessories with the following dimensions and weights.

Package with	Dimensions	Weight
Mass-load rack	1,210 x 760 x 1,600 mm (47.6 x 29.9 x 63 in)	approx. 280 kg (616 lbs)
Pressure generator	1,940 x 750 x 910 mm (76.4 x 29.5 x 36 in)	approx 258 kg (567.6 lbs)
Mass set and accessories	840 x 500 x 740 mm (33.1 x 19.7 x 29.1 in)	approx 136 kg (299.2 lbs)

Scope of delivery

- Automatic pressure balance, model CPB8000-PX or CPB8000-HX
- Mass-load rack
- Pressure generator for hydraulic version or pressure controller for pneumatic version
- Mass set of 100 kg delivered in 5 carrying box
- Rigid tube for connection between mass-load rack and pressure generator/controller
- At least 1 piston-cylinder system
- Power cord
- IEEE-488 interface cable
- Set of accessories for standard operation of the CPB8000
- Operating instructions

With piston-cylinder system

- Piston-cylinder system delivered in its storage box
- COFRAC calibration certificate

With mass set

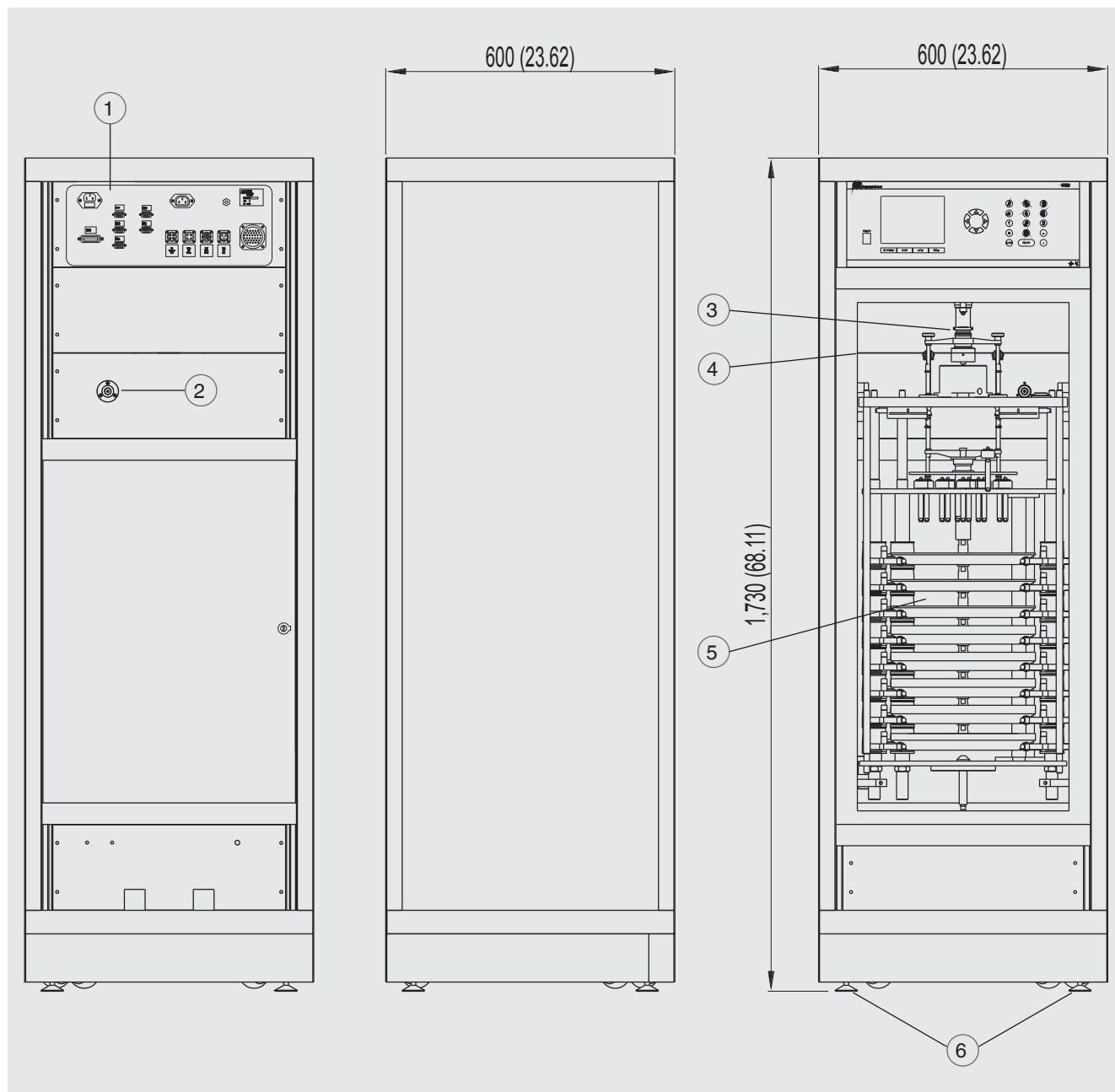
- Mass set in series of storage boxes
- COFRAC calibration certificate for main weights
- Set of fine increment

Options

- Gas booster for pneumatic version
- Premium uncertainty incl. LNE/PTB calibration certificate
- Pressure connections and pipes

Dimensions in mm (in)

Mass-load rack

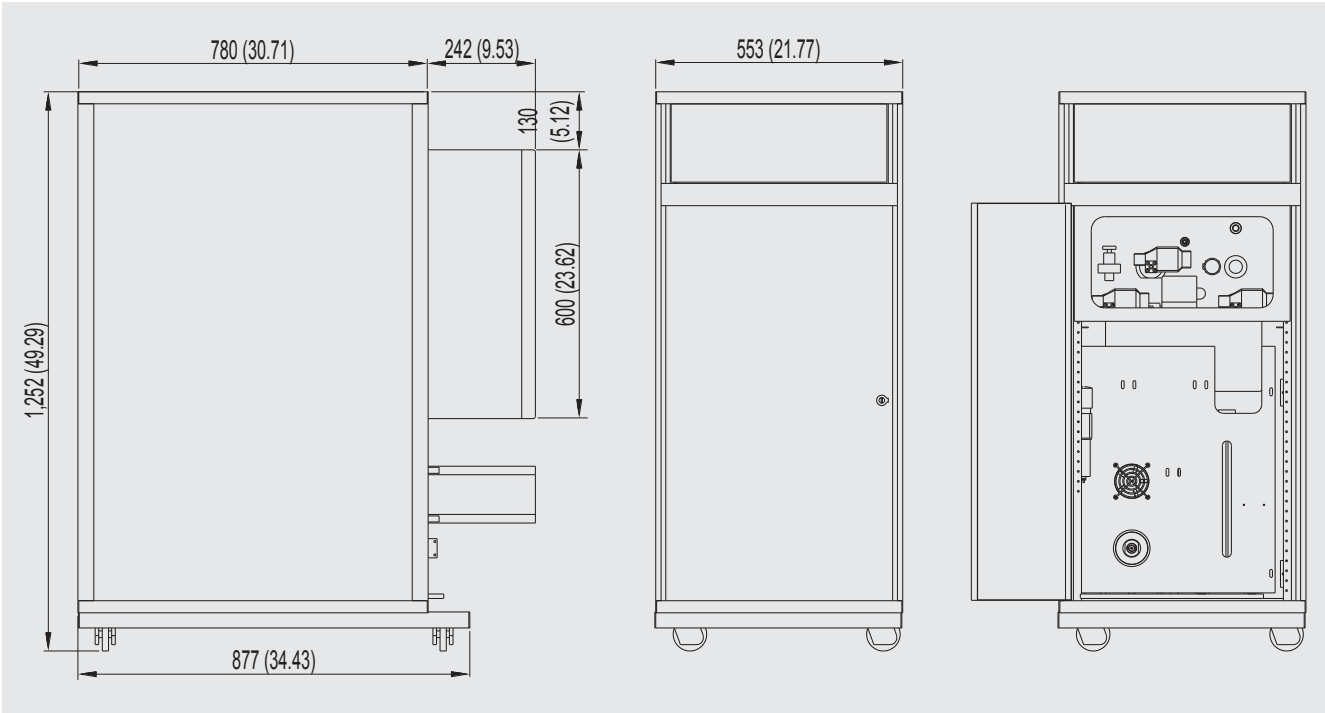


- ① Electrical connections
Piston position indicator
Power supply
Temperature sensor
- ② Pressure connection
- ③ Piston-cylinder system
- ④ Reference level

- ⑤ Automatic mass handling system
- ⑥ Levelling feet

Dimensions in mm (in)

Automatic pressure generator



Further pressure balances within our calibration technology programme

Primary-standard pressure balance, model CPB6000

Measuring ranges:

Pneumatic up to 1,000 bar (14,500 psi)

Hydraulic up to 5,000 bar (72,500 psi)

Measurement uncertainty: down 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 (11,600 psi)

Measurement uncertainty: 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

Digital pressure balance, model CPD8000

Measuring ranges:

Pneumatic up to 500 bar (5,000 psi)

Measurement uncertainty: 0.005 % of reading
up to 0.002 % of reading (optional)

For specifications see data sheet CT 32.04



Digital pressure balance, model CPD8000

Ordering information

Model / Instrument version / Accuracy / Piston-cylinder system / Mass set / Terminal 5000 / Calibration for pressure balance / Additional order information

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