

Pressure balance

Automatic version to 5,000 bar [72,500 lb/in²]

Model CPB9500



WIKA data sheet CT 32.06

Applications

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

Special features

- Total measurement uncertainty up to 30 ppm of reading
- Available to 5,000 bar [72,500 lb/in²] hydraulic
- Automatic mass-load system with a resolution down to 0.1 g
- Automatic pressure generation



Automatic pressure balance, model CPB9500

Description

Reference primary standards

Pressure balances are high-precision fundamental pressure standards that define the derived unit of pressure directly from the base units of mass, length and time following the formula $p = F/A$. The direct measurement of the pressure with a pressure balance in combination with the know-how of DH-Budenberg guarantees 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

The CPB9500 has been developed to not only provide the best possible metrological specifications, but also to meet the requirements of the industry.

Thanks to the high MTBF values, the pressure generation system of the CPB9500 can also generate and control pressures for large test volumes.

Automation and metrology

The servo-controlled spindle 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 rack is handled carefully providing the highest stability. Finally the pressure is automatically fully corrected taking in account all ambient parameters.

The CPB9500 is available with a hydraulic fine increment mass handling system. For optimal fulfilment of special requirements, a wide range of piston-cylinder systems is available.

Automatic pressure balance with pressure generation system

The complete CPB9500 pressure balance consists of four interconnected systems, which are built into two separate rack enclosures.

- 1 **The electronic interface**
The 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.
- 3 **Pressure generation system**
The automatic system works with a servo-controlled spindle pump, including a prefilling unit, with which the standard can work with larger volumes.
- 4 **The pneumatic module**
It contains several solenoid valves which operate the pneumatic cylinders to control the mass load.



The control unit

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

- Via the built-in multi-touch control panel
- Via commands using RS-232 interface

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 control is made via a touchscreen with a wide viewing angle.

The user enters the target pressure, the computer will then determine the value of masses required taking all influence factors into account. The system can operate with one of the 39 standard units.

The system comprises an **EMM** (environmental monitoring module) with sensors for ambient temperature, humidity and atmospheric pressure. These sensors are used to determine the air density and carry out corrections for air buoyancy effects. The temperature of the piston-cylinder system and the oil temperature are also measured, and appropriate corrections are applied.

With the air pressure sensor connected to an RS-232 interface, the instrument can be operated in absolute mode, allowing high-accuracy absolute pressure measurements to be carried out above the ambient pressure.



Critical parameters can be set individually on the display:

- The actual pressure
- Piston equilibrium status
- Piston stability zone
- Pressure set point
- Mass set point
- The calculated actual mass
- The pressure unit used

The variable volume position and the piston position of the spindle pump are graphically displayed on the touchscreen.

An additional screen for mirroring the touchscreen can be connected via a display port interface.

The piston-cylinder system

Kn conversion factor

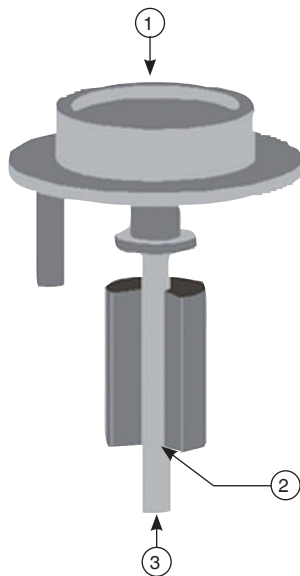
What is the Kn factor?

All piston-cylinder systems and mass loads for the model CPB9500 pressure balances have been designed for a nominal mass-force conversion coefficient, Kn. The nominal effective area of each piston-cylinder size is such that, under standard conditions, the piston with a mass load of 1 kg is floating at an integral pressure value.

All mass values, including the mass of the piston are adjusted to be an integral multiple or fraction of the kilogram.

The nominal pressure defined for a model CPB9500 is calculated as Kn, multiplied by the mass applied in kg. Kn corrections are carried out to calculate the defined pressure within the measurement uncertainty for the standard CPB9500 used.

The use of Kn and integral masses in no way affects the traditional pressure equation or the factors that affect a pressure measurement made with a pressure balance. With the CPB9500, the Kn forms the basis of a coherent relationship between mass, cross-sectional area and pressure. It is intended as a tool that reduces operator confusion and errors by simplifying the calculation of mass loads and measured pressures.



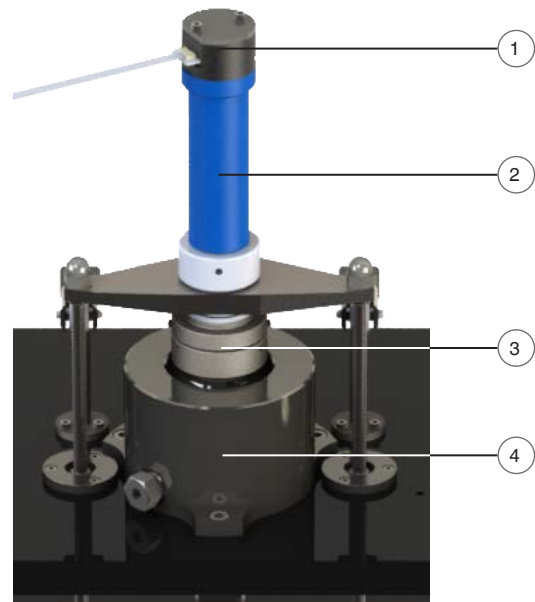
The basic principle of piston-cylinder systems $p = F/A$

- ① Force F
- ② Effective area A
- ③ Pressure p

The piston cylinder - "heart of the system"

The piston-cylinder system is the heart of the pressure balance. It is made of tungsten carbide and is honed and lapped to provide critical geometry better than 0.1 μm . The piston-cylinder system is available in different sizes which cover the range of 20 ... 5,000 bar [290...72,500 lb/in²]. Depending on the piston diameter, they are installed in different mounting cases.

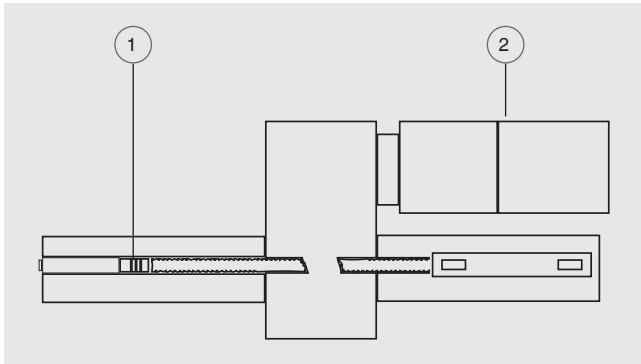
The piston-cylinder systems are easily exchangeable within the same type of mounting column. The RTD temperature probe is also included in the mounting column.



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

Hydraulic pressure generator

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



- ① Piston
- ② Motor

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

The prefilling unit can also be used to carry out several complete strokes 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 subassemblies can be accessed by the front by simply opening a door.

In addition, the system is equipped with a remote maintenance module to carry out a quick remote fault diagnosis, troubleshooting or system maintenance online.

The mass set and the mass loading mechanism

The mass set of the CPB9500 with high resolution is unique worldwide. It is made of austenitic, non-magnetic stainless steel AISI 316 and is composed of several masses corresponding to multiples or dividers of 1 kg in binary progression.

The smallest is 0.1 g and the largest 16,384 g. Thanks to this unique concept, the machine can load any mass with a value between 2 kg (starting point of the machine) and 100 kg in steps of 0.1 g. This gives a mechanical resolution of 1 ppm.

Each mass is loaded onto the piston with a single actuator or removed. The entire support or removal process of a mass value is carried out within 10 seconds.

Each mass is calibrated and set to a tolerance of up to 10 ppm of its nominal value. All values are stored in the control cabinet for the calculation.

The main masses are loaded or removed with a connected pneumatic actuator.



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 centring of the piston and not apply lateral perturbation force.



Automatic fine increment mass handling

The kilogram

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

Table of masses

The following table shows the number of masses within a mass set with their nominal mass value.

Quantity	Individual weight in gram
5	16,384
1	8,192
1	4,096
1	2,048
2	512
2	256
2	128
2	64
2	32
2	16
3	8
1	4
1	2
1	1
1	0.8
1	0.2
1	0.1

Specifications

Basic information		
Instrument		
Instrument version	Rack system	
Weight	CPB9500 without mass set	620 kg [1,367.10 lb]
	Mass set	100 kg [220.50 lb]
Pressure connection	M16 x 1.5	
Digital display		
Display range	15.6" TFT colour display with capacitive touchscreen	
Display resolution	Resolution 1366 x 768 (16:9)	
Number of lines, digits	4 ... 6 digits, depending on range and units	
Menu languages	<ul style="list-style-type: none"> ■ German ■ English ■ Others on request 	
Unit	39 standard pressure units	
Pressure transmission medium	Sebacate oil	
Lubricant	Sebacate oil	
Pressure ranges	<ul style="list-style-type: none"> ■ 20 ... 1,000 bar [290...14,500 lb/in²] ■ 40 ... 2,000 bar [580...29,000 lb/in²] ■ 100 ... 5,000 bar [1,450...72,500 lb/in²] 	
Pneumatic supply		
Drive air supply	8 ... 10 bar [116 ... 145 psi]	
Quality of air	Processed, oil- and water-free	
Material		
Piston-cylinder system	Tungsten carbide	
Mass set	Austenitic, non-magnetic stainless steel AISI 316	
Mass set		
Weight	100 kg in binary progression	
Mass set resolution	100 mg	

Accuracy specifications / Repeatability			
Pressure transmission medium	Sebacate oil		
Piston-cylinder system / Kn	P_{max}	Typical sensitivity of the measured value ¹⁾ in 1.0E-6 x P (ppm)	Typical measurement uncertainties ¹⁾ in ppm
1 MPa/kg respectively 10 bar/kg	1,000 bar	10	30
2 MPa/kg respectively 20 bar/kg	2,000 bar	10	30
5 MPa/kg respectively 50 bar/kg	5,000 bar	15	50

1) The specified uncertainty values for the effective cross-section and for the mass values correspond to the expanded measurement uncertainty, which results from the standard measurement uncertainty through multiplication with the coverage factor $k = 2$. It was determined in accordance with EA-4/02 M. The value of the measurand lies within the assigned range of values with a probability of 95 %. A component for the long-term stability is not included.

Output signal	
Communication	
Interface	<ul style="list-style-type: none"> ■ RS-232 ■ Ethernet ■ USB-A ■ Display port
Communication protocol	<ul style="list-style-type: none"> ■ EtherCAT ■ IO-Link ■ Serial
Command sets	<ul style="list-style-type: none"> ■ SCPI ■ GPIB

Voltage supply and performance data	
Operating voltage	AC 240 V, 50/60 Hz ¹⁾
Power consumption	AC 230 V / 16 A
Fuse	16 A fuse slowly
Connection	
Number of phases	1/N/PE
Connection cross-section	<ul style="list-style-type: none"> ■ Min. 1.5 mm² ■ Max. 4 mm²
Connection type	<ul style="list-style-type: none"> ■ Connection terminals in the control cabinet ■ Fixed connection without FI

1) For countries with AC 110 V, a power transformer is required

Operating conditions	
Place of use	Laboratory
Operating temperature	18 ... 28 °C [64 ... 82 °F]
Humidity	15 ... 85 % relative humidity
Condensation	Non-condensing
Humidity (storage location)	<ul style="list-style-type: none"> ■ 35 ... 85 % relative humidity for instrument base and mass set ■ 35 ... 65 % relative humidity for piston-cylinder system
Condensation (place of storage)	Non-condensing
Noise emission	LpA: < 70 dB(A)

Approvals

Approvals included in the scope of delivery

Logo	Description	Country
CE	EU declaration of conformity	European Union
	Pressure Equipment Directive	
	Low Voltage Directive	
	Machinery Directive	

Certificates

Description	
Calibration	
Complete instrument CPB9500	3.1 inspection certificate per DIN EN 10204 (factory calibration)
Mass set	DAkKs calibration certificate (mass calibration)
Set of fine increment masses	DAkKs calibration certificate (mass calibration)
Piston-cylinder system	COFRAC calibration certificate
Recommended calibration interval	1 to 5 years (dependent on conditions of use)

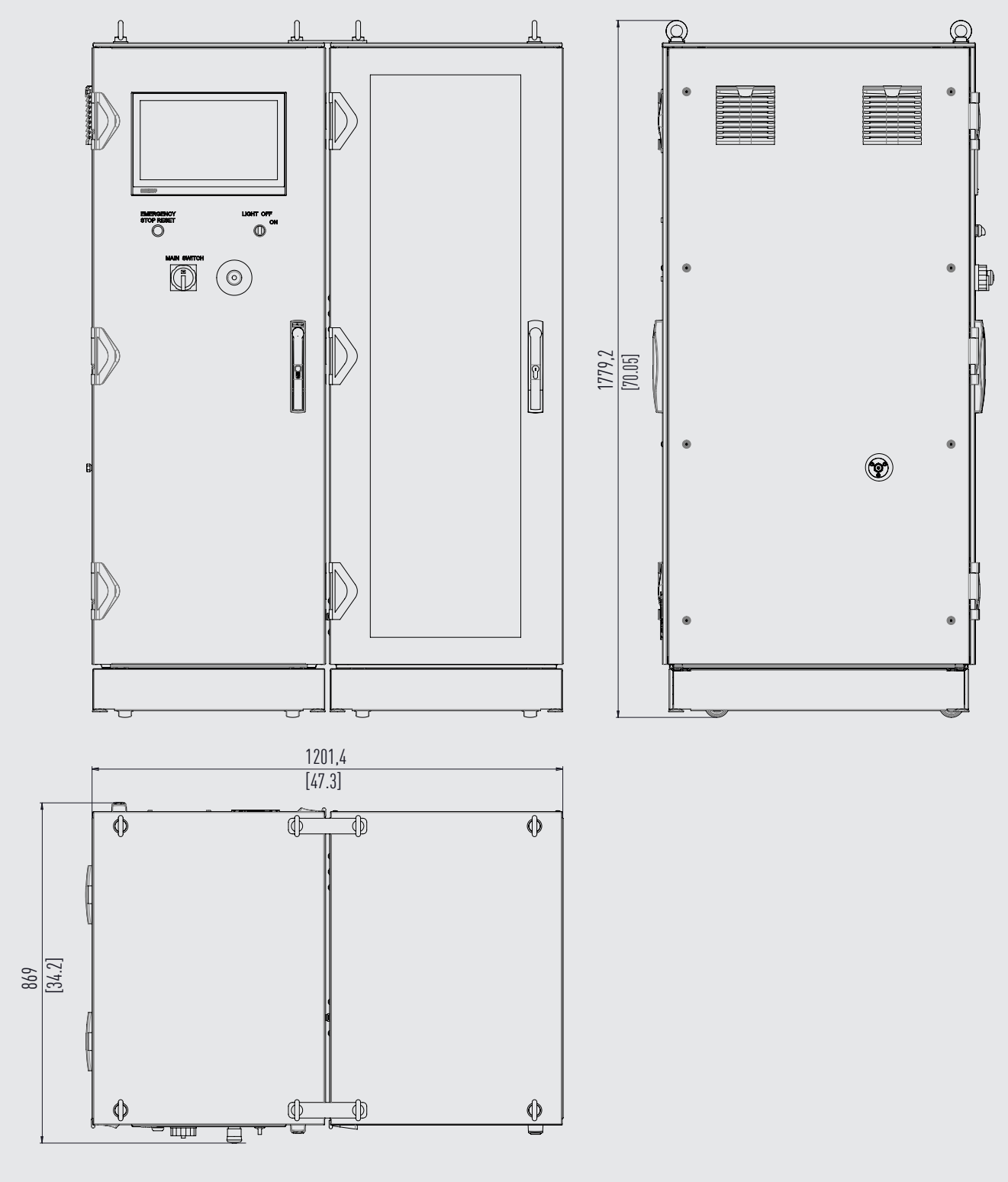
→ For approvals and certificates, see website

Transport dimensions for the complete instrument

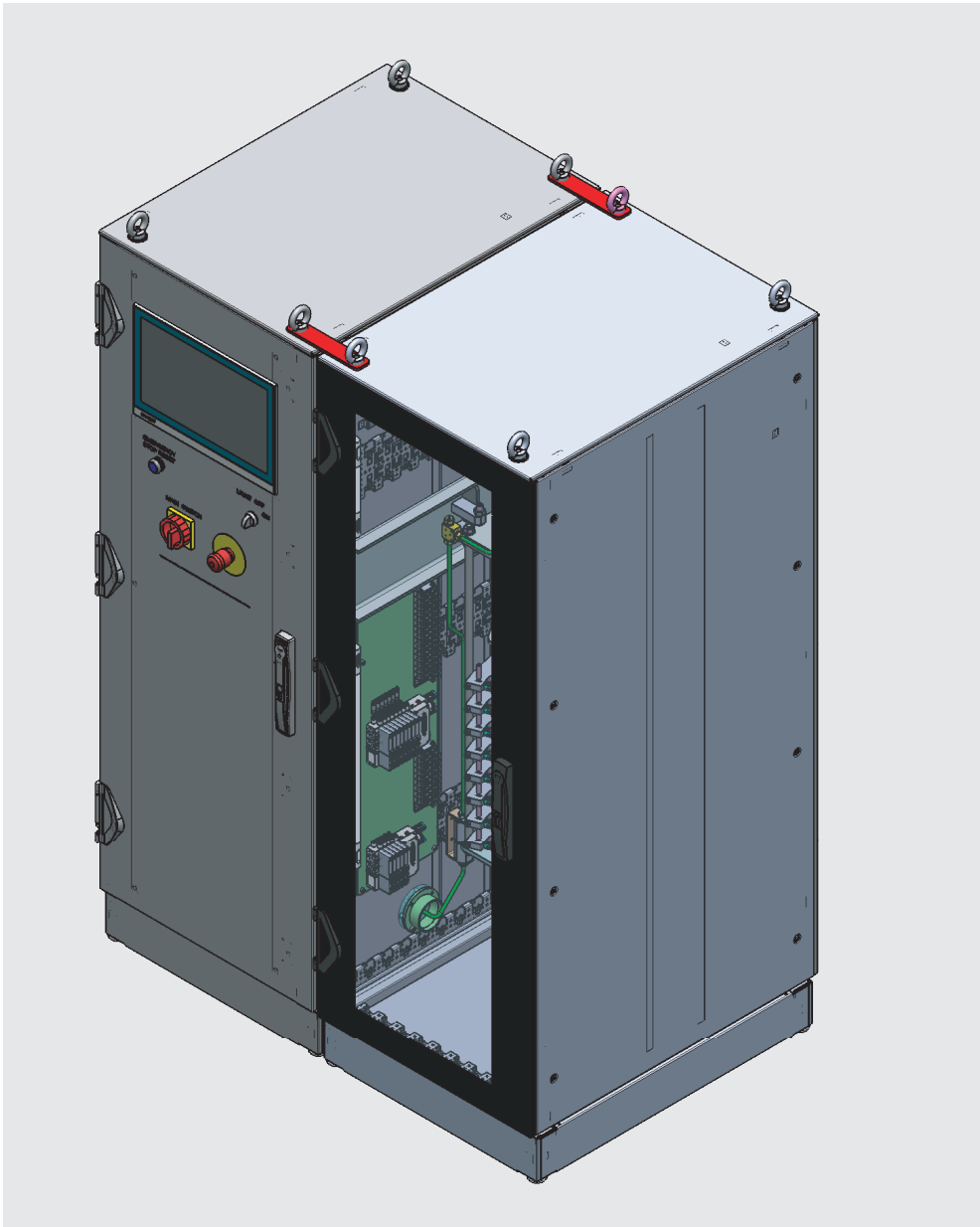
The complete instrument in standard version and standard scope of delivery consists of several packages. A package for the weight cabinet without weights, a package for the pump cabinet and a package for the mass set and accessories. The overall dimensions and the overall weight depend on the mass set and accessories.

Package with	Dimensions	Weight
Weight cabinet without weights	1,070 x 770 x 2,070 mm [42.13 x 30.32 x 81.5 in]	Approx. 500 kg [1,102.50 lb]
Pump cabinet	1,070 x 1,070 x 2,070 mm [42.13 x 42.13 x 81.5 in]	Approx. 320 kg [705.60 lb]
Mass set and accessories	Depending on the accessories	Depending on the accessories

Dimensions in mm [in]



Isometric view



Accessories and spare parts

Description	Order number
Hydraulic fluid Sebacate oil In plastic bottle, content 0.5 litre	14770504
Transmission oil Type Renolin EP150 In plastic bottle, content 1 litre	14771072
Plastic bottle 1 litre without contents	0510408

Scope of delivery

- Pressure balance, automatic version, model CPB9500
- 100 kg mass set in a carrying 5 carrying case
- Piston-cylinder system
- Tools for piston replacement
- Operating instructions
- 3.1 inspection certificate per DIN EN 10204 (factory calibration)

Piston-cylinder system ¹⁾

- Piston-cylinder system in our own storage case
- COFRAC calibration certificate

Mass set ¹⁾

- Mass set in series of storage cases
- DAkkS calibration certificate for the main weights
- DAkkS calibration certificate for set of fine increment masses

1) Depending on the version, the pressure balance can also be delivered without mass sets and piston-cylinder systems.

Ordering information

Model / Piston-cylinder system / Mass set / Accessories and spare parts / Additional ordering information

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