Applications:

- Primary standard for defining the pressure scale in a range up to 1200 bar hydraulic
- Reference instrument for factory and calibration laboratories for the testing, adjustment and calibration of pressure measuring instruments
- Complete, stand-alone system, also suitable for on-site use

Special features:

- Total measurement uncertainty to 0.025% of measured value
- Factory calibration includes traceability to national standards, as standard; with UKAS-calibration possible as an option
- High long-term stability with recommended recalibration cycle every five years
- Masses manufactured from stainless steel, can be adjusted to local gravity
- Compact dimensions

Description:

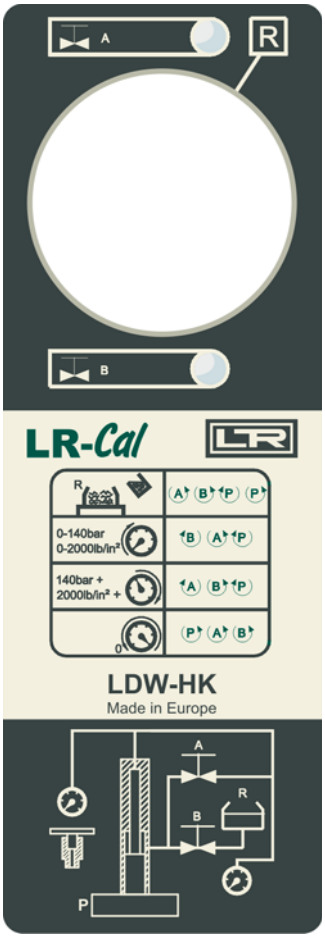
Proven primary standard
Pressure balances / Deadweight testers are the most accurate instruments available on the market for the calibration of electronic or mechanical pressure measuring instruments. The direct measurement of the pressure (p = F/A), as well as the use of high-quality materials enable a very small measurement uncertainty, in conjunction with an excellent long-term stability of five years (recommended in accordance with the German Calibration Service DKD/DAkkS).
The deadweight tester has therefore been used for years in factory and calibration laboratories in industry, national institutes and research laboratories.

Stand-alone operation
Due to ist integrated pressure generation and the pure mechanical measuring principle, the model **LR-*Cal* LDW-HK** is ideal for on-site use for maintenance and service.

Basic principle
Pressure is defined as the quotient of force and area. The core component of the **LR-*Cal* LDW-HK** is therefore a very precisely-manufactured piston-cylinder system, which is loaded with masses in order to generate the individual test points.

The masses applied are proportional to the target pressure and this is achieved through optimally graduated masses. As standard, these masses are manufactured to the standard gravity (9.80665 m/s²), though they can be adjusted to a specific location and also UKAS calibrated.

Easy operation



The integrated dual-area spindle pump enables rapid priming of the test system and smooth pressure generation up to 1200 bar. At the same time, the precise adjustable spindle pump also enables fine pressure adjustment. A control schematic for pressure generation on the instrument base facilitates quick and easy operation.

As soon as the measuring system reaches equilibrium, there is a balance of forces between the pressure and the mass load applied. The excellent quality of the system ensures that this pressure remains stable over several minutes, so that the pressure value for comparative measurements can be read without any problems, or also so that more complex adjustments can be carried out on the item under test.

Compact instrument design

The **LR-*Cal* LDW-HK** deadweight tester is also particularly notable for ist compact dimensions, which are not altered during operation, since the spindle runs within the pump body.

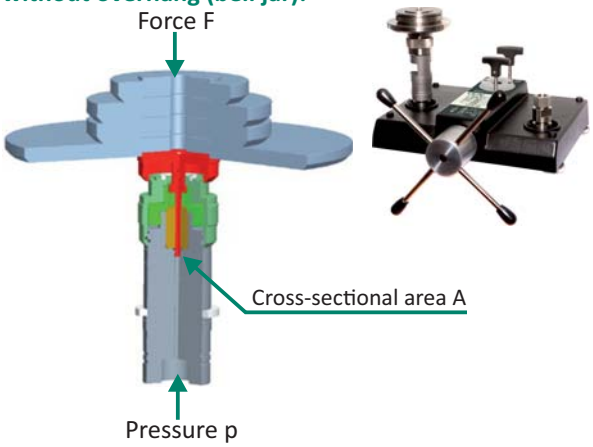
With its compact dimensions, the exceptionally robust ABS plastic housing and the low weight associated with these, the **LR-*Cal* LDW-HK** pressure balance is also particularly suited to on-site applications.

The piston-cylinder system

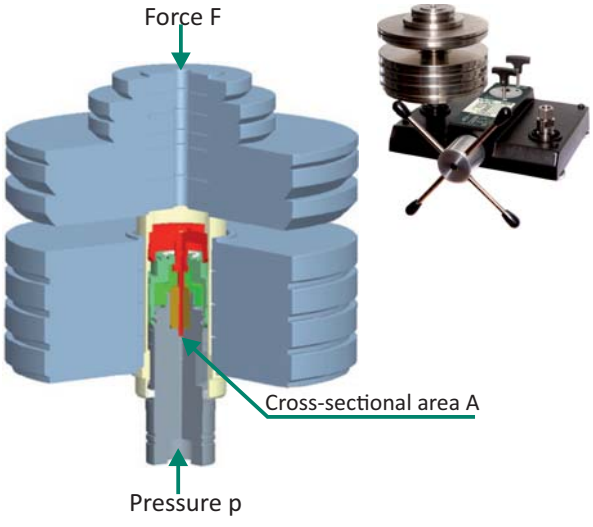
The piston and cylinder of the **LR-*Cal* LDW-HK** are manufactured from tungsten carbide.
This pairing of materials, in comparison to other materials, has very low pressure and temperature coefficients of expansion, which results in a very good linearity for the cross-sectional area and a very high accuracy.

Piston and cylinder are very well protected, against contact, impacts or contamination from outside, in a solid stainless steel housing. At the same time, overpressure protection is integrated, which prevents the piston from being forced out vertically and avoids damage to the piston-cylinder system in the event of mass removal under pressure.

Piston-cylinder system with masses, without overhang (bell jar):



Piston-cylinder system with masses, with overhang (bell jar):



The masses are stacked on an overhang (bell jar), which sits on the piston shaft. The construction of the overhang (bell jar) provides a very low centre of gravity for the stacked weights, which minimises both the side thrust on the piston-cylinder system and the friction. For smaller starting pressures, the masses can also be stacked directly onto the piston shaft, without using the overhang (bell jar).

The overall design of the piston-cylinder unit and the very precise manufacturing of both the pistion and the cylinder, ensures excellent operating characteristics with long free-rotation time and low sink rates.
Thus a high long-term stability is ensured. Therefore the recommended recalibration interval is five years depending on the conditions of usage.

Tables of masses

The following tables show, for the respective measuring range, the number of masses within a set of masses, with their resulting nominal pressures.

Should you not operate the instrument under reference conditions (ambient temperature 20°C, air pressure 1013 mbar, relative humidity 40%), the relevant corrections must be made, for example with the Intelligent Calibration Module **LR-*Cal* IKM**, see page 7.

The masses are manufactured, as standard, to the standard gravity (9.80665 m/s²) although they can be adjusted for any particular location.

Measuring range [bar]	1…120 Quty.	1…120 nom.pressure per pc. [bar]	2,5…300 Quty.	2,5…300 nom.pressure per pc. [bar]	5…700 Quty.	5…700 nom. ressure per pc. [bar]	10…1,200 Quty.	10…1,200 nom.pressure per pc. [bar]
Piston and make-up weight	1	1	1	2,5	1	5	1	10
Piston, overhang (bell jar) and overhang make-up weight	1	20	1	50	1	100	1	200
Masses (stackable on bell jar)	3	20	3	50	4	100	3	200
Masses (stackable on piston)	1	20	1	50	1	100	1	200
	1	10	1	25	1	50	1	100
	2	4	2	10	2	20	2	40
	1	2	1	5	1	10	1	20
	1	1	1	2,5	1	5	1	10

Measuring range [psi]	10…1,600 Quty.	10…1,600 nom.pressure per pc. [psi]	25…4,000 Quty.	25…4,000 nom.pressure per pc. [psi]	50…10,000 Quty.	50…10,000 nom.pressure per pc. [psi]	100…16,000 Quty.	100…16,000 nom.pressure per pc. [psi]
Piston and make-up weight	1	10	1	25	1	50	1	100
Piston, overhang (bell jar) and overhang make-up weight	1	190	1	475	1	950	1	1900
Masses (stackable on bell jar)	5	200	5	500	7	1000	5	2000
Masses (stackable on piston)	1	200	1	500	1	1000	1	2000
	1	100	1	250	1	500	1	1000
	2	40	2	100	2	200	2	400
	1	20	1	50	1	100	1	200
	1	10	1	25	1	50	1	100

Scope of delivery:

- Base
- Dual-area spindle pump for filling, pressure generation and fine pressure adjustment
- Piston connection with 3/4" BSP male thread
- Test item connection with 1/2" BSP female thread, loose union connection
- Adapter set for test item connection, 1/2" male to 1/4" BSP female and 3/8" BSP female threads
- Piston-cylinder system with overhang (bell jar)
- Set of masses manufactured to standard gravity (9.80665 m/s²)
- Operating fluid (special mineral oil VG22) 0.5 l
- Tool and maintenance set
- Operating instructions in German and English language
- Factory calibration certificate (traceable)

Options:

- System with increased accuracy to 0.025% of measured value
- Set of masses manufactured to local gravity
- Storage case for base, mass set and the piston-cylinder system
- UKAS-calibration certificate

Specifications model LR-*Cal* LDW-HK piston-cylinder systems:

Measuring range "bar" 1)	[bar]	1...120	2,5...300	5...700	10...1200
Required masses	[kg]	41	50	58	50
Smallest step 2) (standard mass set)	[bar]	1	2,5	5	10
Nominal cross-sectional piston area	[inch²]	1/16	1/40	1/80	1/160
Measuring range "psi" 1)	[psi]	10...1600	25...4000	50...10000	100...16000
Required masses	[kg]	38	47	58	47
Smallest step 2) (standard mass set)	[psi]	10	25	50	100
Nominal cross-sectional piston area	[inch²]	1/16	1/40	1/80	1/160
Accuracies					
Standard **3)**	[% v.Mw.]	0.05			
Option **3)**	[% v.Mw.]	0.025			
Pressure transmission medium	Hydraulic fluid mineral oil VG22 (0.5 l included in scope of delivery)				
Material					
Piston	Tungsten carbide				
Cylinder	Tungsten carbide				
Mass set	Stainless steel, non-magnetic				
Weight					
Piston-/Cylinder-System	[kg]	2.4			
"bar" set of masses incl. overhang	[kg]	41.5	50.5	58.5	50.5
"psi" set of masses incl. overhang	[kg]	47,5	47.5	58.5	47.5
Carrying case for set of masses (optional, 2 pieces required)	[kg]	5.8			
Dimensions					
Carrying case for set of masses (opt.)	[mm]	W 400 x D 310 x H 310			

1) Theoretical staring value; correspondends to the pressure value generated by the piston or the piston and its make-up weights (by their own weight). To optimise the operating characteristics more weights should be loaded.
2) The smallest pressure change value that can be achieved based on the standard weight set. To reduce this, a set of trim masses is avalable as option/accessory.
3) The accuracy from 10% to the measuring range is based on the measured value. In the lower range, a fixed error based on 10% of the range applies. Measurement uncertainty assuming reference conditions (ambient temperature 20°C, air pressure 1013 mbar, relative humidity 40%). For operation without an Intelligent Calibration Module **LR-*Cal* IKM** the corrections must be made (manually) if required.

Specifications model LR-*Cal* LDW-HK base unit:

Connection for piston-cylinder system: 3/4" BSP male
Test item connection: 1/2" BSP female thread, loose union connection, incl. adapter set to 1/4" BSP and 3/8" BSP female threads
Material Wetted Parts: Austenitic stainless steel, high tensile brass, nitrile rubber
Pressure transmission medium: Hydraulic fluid VG22 based on mineral oil (0.5 l included in scope of delivery)
Reservoir volume: 170 cm³
Base weight: 13.5 kg; **Optional storage case weight:** 8.5 kg
Permissible operating temperature: 18...28°C
Dimensions of the base: W 401 x D 397 x H 155 mm, for details see drawings on page 5

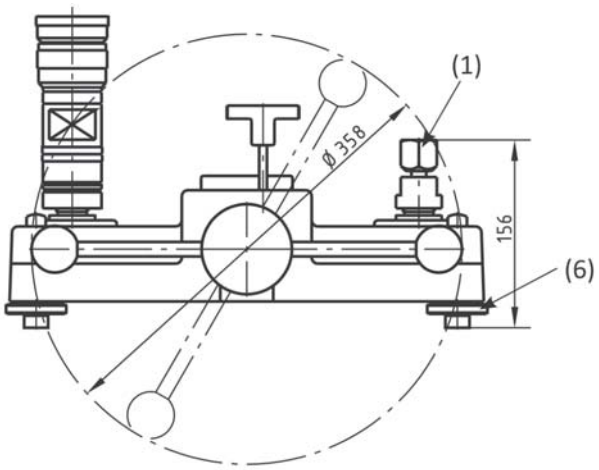
Approvals and certificates:

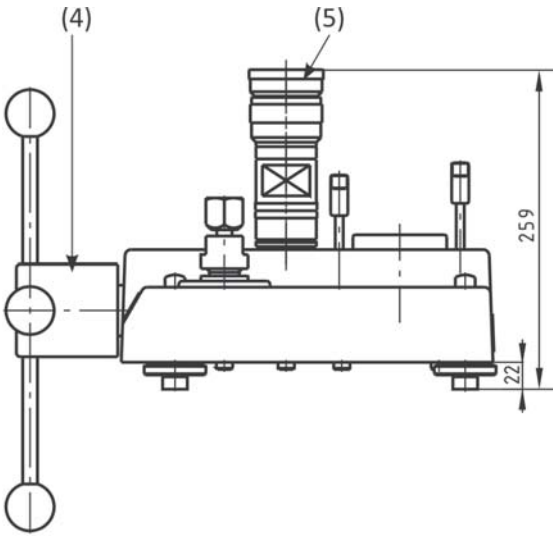
CE conformity: Pressure equipment directive 97/23/EC (Module A)
Certificate of Calibration: 3.1 calibration certificate (traceable); optional: UKAS-certificate of calibration

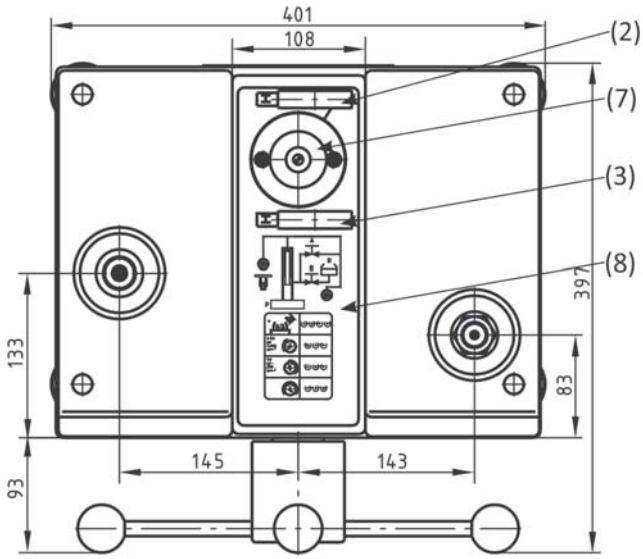
Transport dimensions for complete instrument:

The complete instrument, in its standard version and standard scope of delivery, consists of three packages on a single pallet.
The dimensions are 1,200 x 800 x 500 mm.
The overall weight is as follows (independent from pressure range):
• „bar“ pressure ranges: net 71 kgs / gross 89 kgs
• „psi“ pressure ranges: net 71 kgs / gross 89 kgs

Dimensions in mm (without masses):

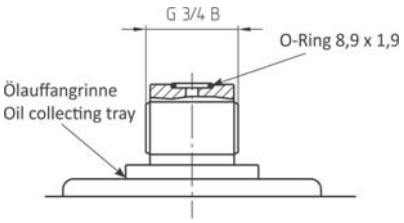




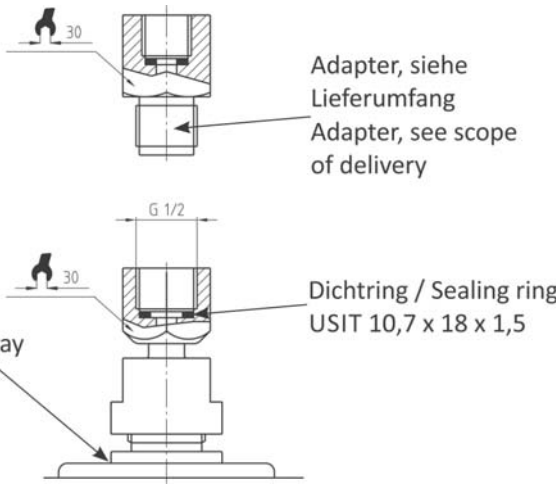


(1) Test item connection
(2) High-pressure shut-off valve
(3) Low-pressure shut-off valve
(4) Dual-area pump with star handle
(5) Piston-cylinder system
(6) Rotatable feet
(7) Reservoir with scewed sealing plug
(8) Pressure generation control schematic

Standard connection piston-cylinder system:



Test item connection:



Accessories

Trim-mass sets M1 and F1
The weights included in the standard mass set are ideally suited for everyday use.
If smaller intermediate values need to be generated, we recommend using a set of class M1 or F1 trim masses, with the following weights:
1 x 50 g, 2 x 20 g, 1 x 10 g, 1 x 5 g, 2 x 2 g, 1 x 1 g,
1 x 500 mg, 2 x 200 mg, 1 x 100 mg, 1 x 50 mg,
2 x 20 mg, 1 x 10 mg, 1 x 5 mg, 2 x 2 mg, 1 x 1 mg

Angle connector 90°

Gauge adapter
3/4" BSP female
to 1/2" BSP female

Test connections
With the existing standard test item connection, test items with radial bottom connection can be mounted. For units with axial rear connection, a 90° angle connector is available. With a 3/4" BSP female to 1/2" BSP remale, free-running connector, which can be mounted in plase of the piston-cylinder system on the piston connector, the **LR-*Cal* LDW-HK** instrument base can be used as a pressure comparison test pump.

Separators
The separators (with diaphram) have been specifically designed for measuring instruments, which should not come into contact with the medium of the deadweight tester or to protect against contamination of the pressure balance from the test items.

Separator
(with diaphragm)
700 bar

Separator
(with diaphragm)
1200 bar

Order-Codes (Accessories):

Order-Code	Description
LDW-FMS-F1	Set of trim masses (1 mg up to 50 g), class F1
LDW-FMS-M1	Set of trim masses (1 mg up to 50 g), class M1
LDW-HK-KOFFER-MS	Set of 2 carrying cases for set of masses
LDW-HK-KOFFER-BM	Storage case for **LR-*Cal* LDW-HK** instrument base
LDW-ADAPTER-BSP	BSP adapter set for test item connector: 1/2" BSP male to 1/8", 1/4", 3/8" and 1/2" BSP female
LDW-ADAPTER-NPT	NPT adapter set for test item connector: 1/2" BSP male to 1/8", 1/4", 3/8" and 1/2" NPT female
LDW-ADAPTER-M	Metric adapter set for test item connector: 1/2" BSP male to M12 x 1.5 and M20 x 1.5 female
LDW-PAS-G12	Test item connection, 3/4" BSP female to 1/2" BSP female, loose union
CPB5000-WA90	90° angle connection, for test items with back mounting connection
LDW-TV-M-0700	Separator (to separate 2 liquid media by a diaphragm), max. 700 bar
LDW-TV-M-1200	Separator (to separate 2 liquid media by a diaphragm), max. 1200 bar
LDW-HK-R-SET	Sealing set for **LR-*Cal* LDW-HK** instrument base
CPB5000-FLUID	Operating fluid 1 l, max. 4000 bar
LDW-HK-W-SET	Spare: Tool set consists of open-ended spanner, BSP adapter, replacement seals, pointer removal device and pointer press-on tool

Intelligent Calibration Module LR-*Cal* IKM

The Intelligent Calibration Module **LR-*Cal* IKM** is a compact tool for use with a deadweight tester / pressure balance. In particular when highly-accurate measuring values, with measurement uncertainties of less than 0.025%, are required, complicated mathematical calculations and corrections are necessary. With the **LR-*Cal* IKM**, all critical ambient parameters can be registered and automatically corrected.

LR-*Cal* IKM Basic package
The basic **LR-*Cal* IKM** package converts masses into the corresponding pressure value, or vice versa, it calculates the masses required for a specific pressure value with consideration to the local gravity, for location-independent measurements. The conversion can be carried out in all common pressure units. The input of all parameters takes place manually.

Metrology-Extension
The Metrology-Extension includes sensors to automatically register all critical parameters such as ambient temperature, air pressure, relative humidity and piston temperature and to update calculations continually.

Transmitter-Extension
Furthermore, with the Transmitter-Extension, a calibrator function for pressure transmitters can be integrated. With this, the sensor to be tested, without additional power can be supplied with 24 VDC voltage and the output signal (V, mA) can be measured. Besides the signal, the automatically converted pressure value is also shown on the display.

Visualisation-Extension
With the Visualisation-Extension for „piston position indication“, the piston position can be measured (contact free) and shown on the **LR-*Cal* IKM** with high resolution (not available for dual-range piston-cylinder systems).

Further specifications on the Intelligent Calibration Module **LR-*Cal* IKM** can be found in datasheet „IKM“.

Order-Codes:

Order-Code:	Description
CPB5000-KM-UB	Base packet (processor only) • Calculation of the mass loads • Manual input of all parameters
CPB5000-KM-ME	Metrology-Extension for measuring of • Ambient temperature • Atmospheric air pressure • Relative air humidity • Temperature of piston
CPB5000-KM-TE	Transmitter-Extension • Voltage supply 24 VDC • Measurement of output signal (V, mA) incl. conversion into pressure values
CPB5000-KM-VE	Visualisation-Extension • Contact-free measuring of piston position

Further LR-*Cal* deadweight testers / pressure balances:

Model LR-*Cal* LDW-P
Pneumatic

Ranges from -0.03...-1 to +0.4...+100 bar
from -0.435...-14 to +5,8...+1500 psi

Accuracy ±0.015% resp. ±0.008% of m.v.

Model LR-*Cal* LDW-H
Hydraulic

Single piston models
Ranges from 1...120 to 2...300 bar
from 10...1600 to 30...4000 psi

Dual piston models
Ranges from 1...60 / 10...700 bar to
1...60 / 20...1400 bar
from 10...800 / 100...10000 psi to
10...800 / 200...20000 psi

Accuracy ±0.015% resp. ±0.006% of m.v.

Model LR-*Cal* CPB5000-HP
High pressure, hydraulic

Ranges from 25...2500 to 25...5000 bar
from 350...40.000 to 350...70000 psi

Accuracy ±0.025% resp. ±0.02% of m.v.

Model LR-*Cal* CPB5600-DP

Differential pressure, pneumatic
Ranges from 0,03...2 to 0,4...100 bar
from 0,435...30 to 5,8...1500 psi

Differential pressure, hydraulic
Ranges from 0.2...60 to 2...1000 bar
from 2.9...1000 to 29...14500 psi

Accuracy ±0.015% resp. ±0.008% of m.v.

[m.v. = measured value]